Argonne National Laboratory
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Argonne, Illinois 60439

**BIBLIOGRAPHY OF PROPERTIES DATA ON
ACTINIDE CARBIDES AND NITRIDES**

by

**A. Sheth, S. D. Gabelnick, M. S. Foster,
M. G. Chasanov, and C. E. Johnson**

Chemical Engineering Division

September 1974

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"It must be allowed that to elucidate and render accessible the labour of others may be a service as valuable as the addition of new material to the common store."

Lord Rayleigh (1874)

ERRATA

- P. 239 Abstract 478; should read "Mendez-Penalosa R"
- P. 277 Abstract 604; 13th line of abstract - should read " $0.25 < x < 0.35$ "
- P. 311 Abstract 697; 1st line of abstract - should read "The thermal diffusivity of mixed uranium and plutonium carbides, nitrides and carbonitrides with a C/N ratio of 20/80, 35/65,"

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ABSTRACT

The National Advanced Fuels program requires chemical, mechanical, and thermophysical properties of potential fast reactor fuel candidates. Properties data are given for carbides, nitrides, carbonitrides, oxycarbides, and oxynitrides of uranium and plutonium and mixed uranium and plutonium compounds. In all, 39 different properties are given for 25 different compounds and supported by 743 literature abstracts.

INTRODUCTION

Projections show that increased electrical energy demands through the 1980's will place a tremendous burden on our nation's electrical generating capacity. It has been recognized that these demands can be met most economically by adding nuclear power plants to the existing power system. Although it is anticipated that breeder reactors will not be introduced on a commercial basis before the mid-1980's, the introduction of breeder reactors is necessary to ensure reasonable electrical costs. Development of an oxide-fueled breeder reactor has been under way for some time; however, it has been recognized recently that fuels other than oxides may be required if we are to gain optimum performance of the breeder reactor. The carbides and nitrides of uranium and plutonium, in addition to possessing neutronic properties more conducive to breeding, have thermal conductivities that are about five times that of the oxide. These high thermal conductivities permit operation of fuel pins at higher linear power ratings and allow design flexibility to optimize breeding performance, fabrication cost, and fissile-material inventory.

These attractive features have renewed interest in carbide and nitride fuels. An effective research program on advanced fuels requires the review of all the relevant properties data in the literature. The purpose of this report is twofold; it is intended first to provide the necessary data base for advanced fuels technology, and secondly to indicate those deficiencies in our properties data which require additional experimental effort.

The information given in this document includes chemical, mechanical, and thermodynamic properties data for carbides, nitrides, carbonitrides, oxycarbides, and oxynitrides of uranium and plutonium and mixed uranium-plutonium compounds. Properties data were found for 25 different compounds covering some 39 different properties; these properties are listed in Table I. The compounds were organized by standard alphanumeric sorting procedures. In all, 743 entries are given.

Literature references were sought in Nuclear Science Abstracts, Chemical Abstracts, and recent IAEA Symposia on uranium and plutonium carbides and nitrides. Although references to the Libby-Cockroft Meeting are included for the sake of completeness, it should be noted that the proceedings of the meeting were not published, and information can only be gained by contacting authors of papers delivered at the meeting.

Although the center of effort for this report was the Chemical Engineering Division of Argonne National Laboratory, others were helpful in providing information. They are Adrian Roberts of the ANL Materials Science Division, who supplied mechanical properties data; Art Bauer of Battelle-Columbus, who supplied additional references for nitrides; and Jere Green of Los Alamos Scientific Laboratory, who supplied additional references for carbides.

The data compilation is organized into two separate sections. The first section lists the compound of interest, the property of interest, applicable temperature regime, pertinent comments, and a cross-reference number to the abstract. It should be noted that perusal of information under the key words *review* and *miscellaneous* must be undertaken by the reader, when applicable, if he is to gain complete information on a given compound. The second section is compiled according to the cross-reference number, under which is listed the full title of the manuscript,

TABLE I. Tabulated Properties*

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1. Compatibility; irradiation behavior
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 4. Tensile creep; including compressive and irradiation
 5. Deformation rates (and mechanisms)
 6. Density
 7. Diffusion; thermal and chemical
 8. Elastic constant; Youngs' modulus, etc.
 9. Electrical conductivity (or resistivity)
 10. Enthalpy
 11. Entropy
 12. Plastic flow
 13. Free energy of formation
 14. Grain growth
 15. Hot hardness (or microhardness)
 16. Heat of combustion
 17. Heat of formation
 18. Heat of sublimation
 19. Heat of vaporization
 20. Lattice parameters; crystal structure
 21. Melting point
 22. Miscellaneous
 23. Phase equilibrium/transitions
 24. Preparation
 25. Stress relaxation
 26. Review
 27. Seebeck coefficient
 28. Entropy of formation
 29. Thermal shock resistance; vibration resistance
 30. Sintering
 31. Solubility
 32. Bending and compressive strength
 33. Yield stress
 34. Surface tension
 35. Swelling and gas release
 36. Thermal conductivity
 37. Thermal diffusivity
 38. Thermal expansion
 39. Vapor pressure
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*Properties are listed in the order in which they appear in Section I.

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 11. Entropy
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 13. Free energy of formation
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 15. Hot hardness (or microhardness)
 16. Heat of combustion
 17. Heat of formation
 18. Heat of sublimation
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 38. Thermal expansion
 39. Vapor pressure
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*Properties are listed in the order in which they appear in Section I.

the first author, literature reference(s), and an abstract of the paper. As the compilation was printed out by a computer, certain constraints were imposed on the symbolism used in the text. Table II is a translation table for mathematical symbols and Greek letters that are unavailable for computer print-out.

TABLE II. Translation Table for Mathematical Symbols and Greek Letters

True Notation	Computer Notation
$\pm$	#
∂, Δ	@
$\circ$	DEG
α	A
β	B
γ	Y
ϵ	&
μ	U
ρ	P
σ	O
$\circ$	
$\hat{A}$	A

SECTION I. KEYWORD LISTING

**COMPOUNDS AND PROPERTIES WITH ABSTRACT REFERENCES
ARRANGED BY COMPOUND AND SUBCLASSIFIED BY PROPERTY
AND MAXIMUM APPLICABLE TEMPERATURE.**

(U,PU)C	FROM	TO	COMMENTS	ABSTRACT
	COMPATIBILITY			
	1573K	2373K	(U.85PU.15)C/MO,NB,TA,W	97
	973K	1373K	WITH FE,NI & V-BASE ALLOYS	403
	973K	1373K	/FE,NI,+V BASED ALLOYS	402
			(U.8PU.2)C WITH UP TO 20% SESQUICARBIDE	
	923K	1323K	/SS, EFFECT OF TI,MO	492
		1273K	(U.8PU.2)C.95;IRRAD NIOBIUM	658
	873K	1173K	/316SS NA AND GAS BONDED /NI BASED ALLOYS (U.85PU.15)	125
	923K	1173K	(U.85PU.15)C/316SS	299
	923K	1173K	/316SS, EFFECT OF OXYGEN	300
		1173K	316L	236
	863K	1093K	STEEL, NIOBIUM, ZIRC, V,INCONEL	635
		1089K	S.S,NB,NB-1%ZR,V,INCONEL ETC	636
	923K	1073K	316L; NIMONIC ALLOYS; MOLY	95
	923K	1073K	316L	96
	923K	1073K	(U.85,PU.15)C WITH NIMONIC ALLOYS 80A AND PE16	98
		1073K	/VARIOUS CLADDING MATERIALS, NA+GAS BONDED	405
		1073K	(U.8PU.2)C(1-X)/304SS NA+HE BONDED,EFFECT OF FE+CR	330
	1073K	1073K	(U.85,PU.15)C/304SS	307
		1073K	(U.8PU.2)C/V-ALLOYS	404
		1073K	(U.8PU.2)C/304,316SS NA-BOND EFFECT OF SESQUICARBIDE	565
		1073K	/V, V ALLOYS	732
		1023K	/316SS, V-ALLOYS NA-BONDED	30
		1023K	(U.8PU.2)C/316SS, V ALLOYS NA-BONDED	32
		1023K	(U.804PU.196)C.95 CO.016 / 316SS AND V-ALLOYS NA-BONDED	29
		1023K	(U.8PU.2) C/316SS, V-ALLOYS NA-BONDED	27
		1023K	(U.8PU.2)C/316SS, V-ALLOYS NA-BONDED, SOME O2 IMPURITY, EFFECT OF SESQUICARBIDE	26
	873K	1003K	/316SS NA-BONDED	175
	773K	973K	/NA	21
			/CLADDING NA-BONDED,EXP AND LITERATURE SURVEY	21
			/CLADDING NA-BONDED	20
			/CLADDING NA-BONDED	24
			/CLADDING NA-BONDED	23
			/NA,FISSION PROD DISTR IN NA	23
			/SS NA & GAS BONDED	252
			/SS NA & GAS BONDED	273
			(U.8PU.2)C NA-BONDED TO SS HEATED TO 30KW/FT	91
			/SS HE AND NA BONDED,HEATED TO 49.8KW/FT;BEHAVIOR	100

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(U,PU)C	FROM	TO	COMMENTS	ABSTRACT
COMPATIBILITY				
			/316SS, INCOLOY, NA & HE BONDED, IRRAD BEHAVIOR	483
			/CLAD, OTHER MISC PROP	731
			/SS, NA AND HE BONDED IRRADIATION BEHAVIOR	481
			/316SS, NB IRRAD BEHAVIOR	652
			(U,8PU,21C/316SS, CLADDING FREE ENERGIES OF REACTION FOR NA-BONDED FUEL/CLADDING POST-IRRAD EXAMINATION OF (U,PU)C FUELS & EFFECTS OF IRRAD ON PHYSICAL PROP	28
			/316SS, INCOLOY, IRRAD BEHAV	654
			EFFECT OF TI ADDITION ON CORROSION & COMPATIBILITY WITH S.S	482
			TESTED CARBIDE FUEL PINS WITH STAINLESS STEEL AND NICKEL ALLOY CLAD IN DFR.	98
			FUEL-CLAD REACTIONS	313
			OF U-PU-C, U-PU-C-ZR, U-PU-C-MO & U-PU-C-TI WITH TYPE 316 STAINLESS STEEL & AIR	113
			/SS, NB, V CLAD, IRRADIATION BEHAVIOR	651
			IRRADIATION BEHAVIOR	632
			316L; NI BASED ALLOYS	124
			TUNGSTEN; CALCULATED	696
			316SS; INCOLOY-800; IRRAD	13
			STAINLESS STEEL	337
			304 SS; 316SS; V-ALLOYS	47
			316 SS; NB, ZIRC	659
			STAINLESS STEEL; CALCULATED	45
			REVIEW	547
			FE & NI BASE ALLOYS: V-ALLOYS	7
			ALLOYS WITH MO, TI, & ZR	117
			EXPERIMENTAL WITH 316L STAINLESS STEEL	450
			WITH TYPE 316 STAINLESS STEEL	25
			WITH NA AND CLADDING MATER	22
			BEND TEST ON UC-20 W/O PUC SAMPLES FROM UNC PROGRAM	200

(U,PU)C

HEAT CAPACITY

723K

1473K

CALORIMETER

21
635

(U,PU)C

TENSILE CREEP

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C				
TENSILE CREEP				
		2073K		26
		1873K		236
	1473K	1773K	(U.8PU.2)C	27
	1473K	1773K	(U.8PU.2)C.96 2000-6000PSI	29
	1573K	1773K		89
	1573K	1773K	(U.79PU.21)C1.02 AT STRESSES	689
			OF 2000-6000 PSI	
	1573K	1773K	AT STRESSES OF 2000,4000 &	687
			6000 PSI;FOR UO.79 PUO.21 C	
			1.02	
	1573K	1773K	FOR UO.78 PUO.21 C1.02	685
	1573K	1773K	(U.8PU.2)C,2000-6000PSI	32
	1573K	1773K	COMPRESSIVE CREEP FOR UO.79	691
			PUO.21 C1.02; 2000-4000 PSI	
	1423K	1673K	FOR UO.79 PUO.21 C1.02	270
	1223K	1423K	FOR UO.85 PUO.15 C1#X;	376
			C VARIABLE	
			THEORETICAL AND EXPERIMENTAL	313
			DATA	
			(SEE ABSTRACT)	375
(U,PU)C				
DENSITY				
			OF U-PU-C,U-PU-C-ZR,U-PU-C-	113
			MO & U-PU-C-TI	
			AS A FUNCTION OF C-CONTENT	390
			MEASURED AS A FUNCTION OF	623
			SINTERING CONDITIONS AND	
			NICKEL CONTENT.	
			AS A FUNCTION OF NICKEL	549
			ADDITIONS AND SINTERING	
			CONDITIONS	
(U,PU)C				
DIFFUSION				
	1673K	1873K	CALCULATED APPARENT DIFFU-	126
			SION COEFFICIENT	
(U,PU)C				
ELECTRICAL CONDUCTIVITY				
	275K	1243K	(U.8PU.2)C	32
	298K	1093K		416
	373K	1073K	EXPERIMENTAL FOR UO.8 PUO.2	411
			C	
		298K	FOR UO.9 PUO.1 C, UO.8 PUO.2	413
			C & UO.7 PUO.3 C;COMPARED	
			WITH LITERATURE.	
			EFFECT OF TI	482
			REVIEW	240
			(U.8PU.2)C; (U.7PU.3)C	417

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C	ELECTRICAL CONDUCTIVITY		(SEE ABSTRACT)	549
(U,PU)C	ELASTIC CONSTANTS			
	298K	298K	AS A FUNCTION OF POROSITY FOR U0.85 PU0.15 C	206
	298K	298K	REVIEW	686
		298K	FROM SOUND VELOCITIES CALC CONSTS SUCH A YOUNG'S, SHEAR & BULK MODULUS AND POISSON RATIO: FUNCTION OF POROSITY (U.8PU.2)C	516
				32
(U,PU)C	ENTHALPY			
	723K	1473K		21
(U,PU)C	FREE ENERGY OF FORMATION			
	723K	1473K		21
(U,PU)C	HOT HARDNESS			
		1873K		236
	298K	1573K	HOT HARDNESS	89
	298K	1473K	FOR U0.78 PU0.21 C1.02	685
	298K	1473K	AS A FUNCTION OF COMPOSITION	688
	298K	1473K	EFFECT OF U/PU	689
	298K	1473K	AS A FUNCTION OF COMPOSITION	687
	293K	1273K	FOR U0.79 PU0.21 C0.95 AND U0.47 PU0.53 C1.03	691
	298K	1273K	REVIEW OF HOT HARDNESS DATA	686
	298K	1273K	(U.5,PU.5)C	30
	298K	1273K	(U.8PU.2)C, (U.5PU.5)C	32
			OF U-PU-C, U-PU-C-ZR & U-PU-C-TI	113
(U,PU)C	LATTICE PARAMETERS			
			(SEE ABSTRACT)	515
			REVIEW: FUNCTION OF COMP.	668
			X-RAY DIFFRACTION	526
			DETERMINED AS A FUNCTION OF COMPOSITION	604

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C	MELTING POINT			
	2773K	2808K	(U.95 PU.05) C.98	658
	2723K	2763K	(U.8 PU.2)C.95	635
	2518K	2758K	SOLIDUS/LIQUIDUS (U.8PU.2)C	29
	2548K	2758K	DTA; 20% PUC	577
	2703K	2753K	(U.8PU.2)C.95	636
			DETERMINED MELTING POINTS OF U-PU-C ALLOYS AS A FUNCTION OF COMPOSITION FROM U2 C3 TO PU2 C3	604
			(U,PU)C(1+X)	196
			MELTING BEHAVIOR;U.8 PU.2 C; CALCULATES HEAT OF FUSION TOO	579
(U,PU)C	MISCELLANEOUS			
			PERFORMANCE BOUNDARIES OF SS CLAD, NA-POONED FUEL PINS	714
			PROCESSING,FABRICATION, THERMAL REDISTRIBUTION OF PU IN MIXED TWO-PHASE CARBIDES	420
			PROPERTIES OF CERAMIC FUELS	2
			PROPERTIES	1
			FUEL PROPERTIES,PROGRESS REP	24
			HIGH TEMP THERMO PROP	23
(U,PU)C	PHASE EQUILIBRIUM			
	873K	2773K	U-PU-C	410
	1873K	2773K	U-PU-C SYSTEM, TRANSITION	29
	2273K	2773K	MELT BEHAVIOR (U,PU)C(1+X)	30
	2273K	2773K	0-50 MOLE% PU,SOLIDUS/LIQUID	32
	2558K	2758K	SOLIDUS,LIQUIDUS(U.8PU.2)C	28
	1673K	2373K	(U.8PU.2)C; DTA & METALLOG	89
		2273K	METALLOG & X-RAY	193
	673K	2000K	U-PU-C SYSTEM, REVIEW	561
	1773K	1973K	MICROPROBE	204
	723K	1473K		21
	673K	908K	X-RAY & METALLOGRAPHY	589
			TERNARY DIAGRAM	
		908K	X-RAY & METALLOGRAPHY	588
		908K	X-RAY,METALLOGRAPHY,& MP; TERNARY DIAGRAM BELOW 50 AT% C	592
		908K	X-RAY & METALLOGRAPHY; TERNARY DIAGRAM 0-35AT% PU	591
			CALCULATION OF EQUILIBRIA (SEE ABSTRACT)	465
			DTA & METTALOGRAPHY; 20%PUC	3
			WITH M	577
				308

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C	PHASE EQUILIBRIUM			
			EXPERIMENTAL	450
			EXPERIMENTALLY VARIFIED THE EFFECT OF FISSION PRODUCTS. (SEE ABSTRACT)	446
			OBSERVATIONS ON U-PU-C-FE SYSTEM TO EVALUATE COMPATIBILITY (SEE ABSTRACT)	549
			STUDIED MFLTING BEHAVIOR (SEE ABSTRACT)	507
			USING DIFF THERMAL ANALYSIS U-PU-C SYSTEM	564
			REVIEW	25
			PHASE BEHAVIOR IN U-PU-C-TI SYSTEM.	111
			REVIEW	18
				603
				668
				482
				415
(U,PU)C	PREPARATION			
	1373K		PREP AND BEHAVIOR VS TEMP (U.8PU.2)C(1+X) EFFECT OF BINDERS	435
			EFFECT OF PRESSING PRESSURE VARIOUS U/PU AND M/C RATIOS (SEE ABSTRACT)	27
			BY H SUB 2 REDUCTION	29
			BY ARC MELTING:(U.8PU.2)C, (U.8PU.2)C(1+X).	28
			(U.85PU.15)O2-3C REACTION	419
			THEORETICAL STUDY OF CARBOTHERMIC REACTION MDEL.	23
			CARBOTHERMIC REDUCTION	26
			CARBOTHERMIC REDUCTION	58
			REVIEW OF U.S. PROCESSES (U.8PU.2)C	438
			(SEE ABSTRACT)	526
			(U,PU)C(1-X)	528
			(U.85PU.15)C INHOMOGENEITIES	422
			PELLET FORMATION TECHNIQUES	624
			SINTERING EFFECTS	32
			FROM PUC AND UC WITH DISCUSSION.	522
			FABRICATION OF PELLETS & EFFECTS OF TECHNIQUES	560
			FLUIDIZED BED	504
			(U.95 PU.05)C.98	30
			(SEE ABSTRACT)	549
			(U.85 PU.15)C	25
			(SEE ABSTRACT)	6
			HYPOSTOICH	656
			(U.8PU.2)C.95:	45
			(U.95PU.05)C.98	71
				659
				47
				657

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C	PREPARATION		(U.8PU.2)C.95; (U.95PU.05)C.98	636
(U,PU)C	REVIEW			
	523K	1273K	TH COND	409
			PHYSICAL & THERMAL PROPS	177
			PHYS,CHEM,& NUCL PROPS	149
			TH COND & EL COND	240
			MIXED NITRIDES COMPARED WITH	320
			MIXED CARBIDES REGARDING	
			THERMAL AND NEUTRONIC PROPER	
			TIES,COMPATIBILITY,FABRICA-	
			TION COST AND IRRADIATION	
			BEHAVIOR	
			OF MECHANICAL PROPERTIES	690
			REVIEW OF PHYS PROPERTIES	620
			CRITICAL REVIEW OF VARIOUS	733
			PROPERTIES OF (U,PU)C SYSTEM	
			(SEE ABSTRACT)	111
			(SEE ABSTRACT)	547
			COMPILATION OF THERMOPHYS	655
			PROP,IRRADIATION BEHAVIOR,	
			COMPAT	
			OF THERMAL ANALYSIS & THERMO	412
			CHEMICAL PROPERTIES	
			FUEL PROPERTIES,IRRADIATION	396
			BEHAVIOR, PREPARATION	
			PROPERTIES + IRRADIATION	440
			BEHAVIOR	
(U,PU)C	THERMAL SHOCK RESISTANCE			
	298K	1253K	THERMAL SHOCK RESISTANCE FOR	575
			(U,PU)C PELLETS.	
			(SEE ABSTRACT)	603
(U,PU)C	SOLUBILITY			
			N2 AND O2	603
(U,PU)C	GAS RELEASE AND SWELLING			
		1873K	IRRADIATION	256
	1573K		UNDER VARIOUS BURNUP	72
		1173K		125
			BURNUP TO 150000MW/T	100
			FUEL SLIGHTLY HYPOSTOICH OR	273
			HAD ADDITION OF CR OR FE	

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C				
GAS RELEASE AND SWELLING				
			HIGH-FISSION-GAS RELEASE	585
			STUDIED SWELLING BEHAVIOR OF	126
			FUEL AND MIGRATION OF	
			FISSION PRODUCTS	
			(SEE ABSTRACT)	375
			SWELLING & GAS RELEASE	550
			IRRADIATION BEHAVIOR	653
			IRRADIATION BEHAVIOR	651
			IRRADIATION BEHAVIOR	652
			IRRADIATION BEHAVIOR	654
			IRRAD	650
			(U.8PU.2)C.95	658
			(U.8PU.2)C;IRRAD	660
(U,PU)C				
THERMAL CONDUCTIVITY				
	273K	2273K	OF U-PU-C,U-PU-C-ZR,U-PU-C-MO & U-PU-C-TI	113
	323K	2273K	HAS COMPILED AND ASSESSED	715
			THE EFFECT OF POROSITY.	
	293K	2073K	EXPERIMENTAL FROM THERMAL	450
			DIFFUSIVITY	
	317K	1289K	MEASURED THERMAL CONDUCTI-	336
			VITY FOR UO.8 PUO.2 C	
			AS A FUNCTION OF TEMP AND	
			THEORETICAL DENSITY	
	317K	1289K	(U.8PU.2)C	29
	391K	1274K	(U.8PU.2)C	28
	523K	1273K	REVIEW	409
	573K	933K	MEASURED FOR UO.8 PUO.2 C	17
	317K	677K	(U.8PU.2)C	27
	473K	673K	FOR UO.9 PUO.1 C, UO.8 PUO.2	413
			C & UO.7 PUO.3 C.	
	473K	673K	EXPERIMENTAL FOR UO.8 PUO.2	411
			C AND UO.7 PUO.3 C	
	538K	673K	EXPERIMENTAL FOR UO.9 PUO.1	411
			C	
	343K	343K	FOR UO.85 PUO.15 C MEASURED	604
			AS A FUNCTION OF COMPOSITION	
			REVIEW	240
			(U.8PU.2)C; (U.7PU.3)C	417
			(U.8PU.2)C.95	636
			REVIEW	418
			EFFECT OF TI;CALCULATED	482
			AS A FUNCTION OF COMPOSITION	126
			AND IRRADIATION EXPOSURE	
			(SEE ABSTRACT)	375
			(SEE ABSTRACT)	603
(U,PU)C				
THERMAL DIFFUSIVITY				

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C				
THERMAL DIFFUSIVITY				
	323K	2273K	ANGSTROM & COWAN METHODS	697
	500K	2200K	(U.9PU.01)C; MODUL ELECTRON BEAM	730
	500K	2200K		728
	773K	1773K	(U.8PU.2)C; LASER PULSE	491
	773K	1773K	(U.8PU.2)C	7
	523K	1273K	(U.8PU.2)C.95	740
			CALORIMETER	635
			REVIEW	418
			THEORETICAL AND EXPERIMENTAL DATA	313
(U,PU)C				
THERMAL EXPANSION				
	298K	1673K	(U.8PU.2)C.95;	636
			(U.95PU.05)C.98	
	298K	1673K	(U.8PU.2)C.95;	635
			(U.95PU.05)C.98	
		1673K	(U.8 PU.2)C.95	656
	298K	1273K	FOR UO.85 PUO.15 C MEASURED AS A FUNCTION OF COMPOSITION	604
	298K	1273K		603
	298K	1173K	AS A FUNCTION OF C-CONTENT FOR UO.87 PUO.13 C.	524
	298K	1173K	(U.87 PU.13)C; DILATOMETER	523
	298K	1173K	U.87PU.13 C; DILATOMETER	527
			EFFECT OF TI ADDITION	482
			OF U-PU-C, U-PU-C-ZR, U-PU-C-MO & U-PU-C-TI	113
(U,PU)C				
VAPOR PRESSURE				
	2100K	2600K	(U.8PU.2)C.95	636
	1450K	2170K	VARIOUS 2 PHASE REGIONS	89
	1703K	2073K	(U.85PU.15)C2-3C REACTION	58
	900K	1200K	EMF; PU PRESSURES CALC	7
			EFFUSION	635
			(U.8 PU.2) C.97	67
			(U.95 PU.05)C.98; EFFUSION	658
			(SEE ABSTRACT)	313
(U,PU)CN				
COMPATIBILITY				
		973K	/SS NA-BONDED, PU/(U+PU)=.15	548
			/SS, NA & HE BONDED	481
			IRRADIATION BEHAVIOR	
			EXPERIMENTAL WITH 316L STAIN	450
			LESS STEEL	

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)CN	TENSILE CREEP			
	1423K	1973K	STEADY STATE CREEP FOR UO.85 PU0.15 CO.65 NO.35	206
(U,PU)CN	ELASTIC CONSTANTS			
	298K	298K	AS A FUNCTION OF C CONTENT FOR UO.85 PU0.15 C1-X NX STUDIED VARIATION IN YOUNG'S MODULUS WITH COMPOSITION	206 450
(U,PU)CN	LATTICE PARAMETERS			
			REVIEW; FUNCTION OF COMP.	668
(U,PU)CN	MISCELLANEOUS			
			PREP, PROPERTIES, IRRAD BEHAV	567
(U,PU)CN	PHASE EQUILIBRIUM			
		298K	(U.85PU.15)-C-N SYSTEM REVIEW OF U-PU-C-N SYSTEM EXPERIMENTAL	548 668 450
(U,PU)CN	PREPARATION			
			(SEE ABSTRACT)	358
(U,PU)CN	SINTERING			
			OF UO.8 PU0.2 CO.18 NO.82	358
(U,PU)CN	GAS RELEASE AND SWELLING			
			HIGH-FISSION-GAS RELEASE FOR (U,PU) CO.5 NO.5	585
(U,PU)CN	THERMAL CONDUCTIVITY			
	323K	2273K	CALC FROM MEASURED TH DIFF	548
	293K	2073K	EXPERIMENTAL FROM THERMAL DIFFUSIVITY	450

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)CN	THERMAL DIFFUSIVITY			
	323K	2273K	ANGSTROM & COWAN METHODS	697
(U,PU)CNO	MISCELLANEOUS			
			APPROXIMATION OF RATE OF CONVERSION USING U-C-O-N DATA	438
(U,PU)CNO	PHASE EQUILIBRIUM			
			(SEE ABSTRACT)	77
(U,PU)CNO	PREPARATION			
			(SEE ABSTRACT)	77
(U,PU)CO	LATTICE PARAMETERS			
	1373K	1773K	EFFECT OF O ₂ SOLUBILITY DETERMINED AS A FUNCTION OF COMPOSITION	128 604
(U,PU)CO	PHASE EQUILIBRIUM			
			PREDICTION OF EQUILIBRIA IN U-PU-C-O SYSTEM. EXPERIMENTAL	564 450
(U,PU)CO	PREPARATION			
			(U _{0.9} PU _{0.1}) (OX C1-X)	674
(U,PU)CO	GAS RELEASE AND SWELLING			
			EFFECT OF O ₂ IMPURITY	72
(U,PU)CO	THERMAL CONDUCTIVITY			
	273K	2673K	ESTIMATION	715

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)C0	VAPOR PRESSURE			
	1873K	2073K	DECOMP PRESS OF OXYCARBIDES	125
(U,PU)C2	LATTICE PARAMETERS			
	1983K	2173K	FOR U.9 PU.1 C2, U.7 PU.3 C2 & U.2 PU.8 C2 ALLOYS	194
(U,PU)C2	MELTING POINT			
			AS FUNCTION OF PU/(U+PU)	196
			EXPT; AS A FUNCTION OF U/PU RATIO	194
			PHASE TRANSFORMATIONS	192
(U,PU)C2	PHASE EQUILIBRIUM			
	1773K	2773K	TRANSITION TEMPERATURES	26
			DILATOMETRIC STUDIES	194
			PHASE EQUILIBRIA BY DILATOMETRY	192
			PU/(U+PU)=.2-.9, MELT BEHAV	578
			FROM DTA & X-RAY POWDER	579
			DIFFRACTION STUDIES; ALSO TRANSFORMATION TEMP	
			DILATOMETER & X-RAY	195
(U,PU)C2	REVIEW			
			OF CHEMISTRY, STRUCTURE, PHASE RELATIONSHIPS, DENSITY, THERMO DYNAMIC & THERMAL PROPERTIES AND COMPATIBILITY	421
			OF THERMAL ANALYSIS	412
(U,PU)C2	THERMAL EXPANSION			
	2048K	2173K	(U.65PU.35)C2	30
(U,PU)N	COMPATIBILITY			
	1273K	1473K	304SS; NB-ZR; MOLY; (U.8PU.2)N	545
		1473K	WITH MO	356
	923K	1273K	304SS	718
	973K	1273K	(U.8PU.2)N; 304SS	12
	973K	1273K	/SS, EFFECT OF O2 IMPURITY AND NON-STOICHIOMETRY	285

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)N	COMPATIBILITY			
		1273K	OF UO.8 PU0.2 N WITH NB- 1W/ O ZR & TYPE 304 S.S;NA BOND	358
	1173K	1173K	/SS,EFFECT OF O2	68
	773K	973K	/NA	21
		973K	(U.8PU.2)N/304SS NA+HE BOND	286
			/CLADDING NA-BONDED	20
			/CLADDING NA-BONDED	23
			/CLADDING NA-BONDED	24
			65 KW/FT, IRRAD BEHAVIOR	167
			WITH VARIOUS CLADDING MATER.	361
			CALCULATION;WITH FE,CR,V,NB, ZR ETC.	358
			/SS,NA & HE BONDED	481
			IRRADIATION BEHAVIOR	
			STATUS REPORT ON CHEM STABI- LITY.	362
			CHEMICAL COMPATIBILITY	101
			IRRADIATION BEHAVIOR	632
			STAINLESS;REVIEW	34
			SERIES 300SS	357
			(U.8PU.2)N;	11
			304SS; 316SS; V-ALLOYS	
			WETTING BY SODIUM	12
			WITH TYPE 316 S S	25
			EXPERIMENTAL WITH 316L STAIN LESS STEEL	450
			COMPAT OF MIXED NITRIDES	360
			WITH TYPES 304 AND 316	
			STAINLESS STEELS, CRNL S S	
			ALLOY,INCONEL 625, & INCOLOY 800 WITH SODIUM BONDING	
			IS DISCUSSED	
			WITH NA AND CLADDING MATER	22
(U,PU)N	HEAT CAPACITY			
	298K	1800K	CALORIMETER;(U.8PU.2)N	65
	723K	1473K	(SEE ABSTRACT)	21
				101
(U,PU)N	DENSITY			
			(SEE ABSTRACT)	719
(U,PU)N	DIFFUSION			
	1500K	1820K	N2 SELF DIFFUSION AS A FUNCTION OF N2 PRESSURE.	215
	1500K	1820K	N2	363
			REVIEW TO SUPPORT DESIGN	101

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)N	ELASTIC CONSTANTS			
	298K	1573K	AS A FUNCTION OF TEMP. & POROSITY	537
	298K	298K	AS A FUNCTION OF POROSITY FOR U0.85 PU0.15 C	206
(U,PU)N	ENTHALPY			
	298K	1800K	CALORIMETER; (U.8PU.2)N	65
	723K	1473K		21
(U,PU)N	FREE ENERGY OF FORMATION			
	723K	1473K		21
(U,PU)N	HOT HARDNESS			
	293K	1273K	FROM LITERATURE FOR U0.7 PU0.3 N	691
	298K	1273K	(U.7PU.3)N	32
	298K	1273K	REVIEW OF HOT HARDNESS DATA	686
	298K	1273K	FROM LITERATURE	688
			U0.85 PU0.15 N	544
			HOT HARDNESS	101
(U,PU)N	LATTICE PARAMETERS			
	298K	298K	MEASURED FOR U SUB 1-X PU SUB X N; O & C IMPURITIES	676
			REVIEW;FUNCTION OF COMP.	668
			(SEE ABSTRACT)	515
			AS A FUNCTION OF PU CONTENT	17
			(SEE ABSTRACT)	414
(U,PU)N	MELTING POINT			
	2773K	3073K	DECOMPOSITION & MELTING CURVES UNDER N2 FOR U0.8 PU 0.2 N.	720
			EFFECT OF CARBON & OXYGEN IMPURITIES ON MELTING BEHAVIOR.	509
(U,PU)N	MISCELLANEOUS			
			PERFORMANCE CAPABILITIES IN LMFBR.	714

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)N	MISCELLANEOUS			
			PREP, PROPERTIES, IRRAD BEHAV	567
			PROG REP, APPLICATIONS, PROPS,	568
			IRRAD BEHAVIOR	
			HIGH TEMP THERMO PROP	23
			FUEL PROPERTIES, PROGRESS REP	24
			PROPERTIES: IRRAD	359
(U,PU)N	PHASE EQUILIBRIUM			
	298K	2500K	MELTING BEHAVIOR	158
	723K	1473K		21
			EXPERIMENTAL	450
			LATTICE PARAMETER	719
			TERNARY EQUILIBRIA, CALC	563
			LATTICE PARAM; (U.81PU.19)N	553
			LATTICE PARAM; (U.8PU.2)N	552
			LATTICE PARAMETER	82
(U,PU)N	PREPARATION			
			(U.8PU.2)N	718
			(SEE ABSTRACT)	545
			(SEE ABSTRACT)	359
			LOW TEMP	82
			(SEE ABSTRACT)	719
			(U.8 PU.2)N	546
			(SEE ABSTRACT)	419
			FROM OXIDES	361
			(SEE ABSTRACT)	414
			(SEE ABSTRACT)	17
(U,PU)N	REVIEW			
			OF CHEMISTRY, STRUCTURE, PHASE	421
			RELATIONSHIPS, DENSITY, THERMO	
			DYNAMIC & THERMAL PROPERTIES	
			AND COMPATIBILITY.	
			GENERAL, PREP, PROP, IRRAD	615
			BEHAVIOR, COMPAT	
			OF COMPATIBILITY & RESIS-	19
			TANCE TO REACTOR RADIATION	
			(SEE ABSTRACT)	111
			PHYSICAL & MECHANICAL PROPS;	683
			MIXED CARBIDES COMPARED WITH	320
			MIXED NITRIDES REGARDING	
			THERMAL AND NEUTRONIC PROPER	
			TIES, COMPATIBILITY, FABRICA-	
			TION COST AND IRRADIATION	
			BEHAVIOR.	
			REVIEW OF PHYS PROPERTIES	620

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)N	REVIEW		OF MECHANICAL PROPERTIES	690
(U,PU)N	SINTERING			
			OF UO.8 PUO.2 N	356
			EFFECT OF C ON SINTERABILITY	358
			OF UO.8 PUO.2 N.	
(U,PU)N	YIELD STRESS			
			ESTIMATION	358
(U,PU)N	THERMAL CONDUCTIVITY			
	293K	2073K	EXPERIMENTAL FROM THERMAL DIFFUSIVITY	450
	373K	1873K	CALCULATED FOR UO.8 PUO.2 N	245
	473K	1873K	CALCULATED FOR UO.8 PUO.2 N	243
	473K	1873K	CALCULATED FOR UO.2 PUO.8 N	244
	400K	1600K	(U.8PU.2)N	63
	473K	1473K	HAS COMPILED AND ASSESSED THE LITERATURE.	715
	473K	1273K	CALCULATED	356
	573K	1273K	LASER PULSE; (U.8PU.2)N	545
			IRRAD	357
			STATUS REPORT	362
			(SEE ABSTRACT)	101
(U,PU)N	THERMAL DIFFUSIVITY			
	323K	2273K	ANGSTROM & COWAN METHODS	697
	373K	1873K	MEASURED FOR UO.8 PUO.2 N	245
	473K	1873K	MEASURED FOR UO.2 PUO.8 N	244
	473K	1873K		718
	378K	1848K	MEASURED FOR UO.8 PUO.2 N	243
	600K	1500K	LASER PULSE; (U.8PU.2)N	65
	573K	1373K	EXPERIMENTAL	360
	573K	1373K	AS A FUNCTION OF STOICHIOMETRY & U/PU RATIO FOR UO.8 PUO.2 N AND UO.5 PUO.5 N	361
	473K	1273K	MEASURED	356
(U,PU)N	THERMAL EXPANSION			
	400K	1800K	(U.8 PU.2)N	65
	293K	1448K	EXPERIMENTAL	360
	293K	1448K	EXPERIMENTAL	361
			REVIEW TO SUPPORT DESIGN	101
			STATUS REPORT	362

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)N	VAPOR PRESSURE			
	1400K	2400K	EFFUSION; (U.8PU.2)N	65
	1400K	2400K	(U.8PU.2)N	12
	1400K	2400K	(U.8 PU.2)N	67
	1523K	2300K	LANGMUIR; EFFUSION; (U.8PU.2)N	545
	1960K	2130K	MEASURED FOR U0.8 PU0.2 N ;	361
			ALSO FLUX RATE	
	2020K	2130K	EXPERIMENTAL	360
		2073K	THERMAL STABILITY	158
		1923K		82
			VAP BEHAVIOR PREDICTED	563
			DECOMPOSITION PRESSURE	414
			STATUS REPORT ON VOLATILITY	362
			COMPARED WITH UN & PUN	66
(U,PU)NO	PHASE EQUILIBRIUM			
			EXPERIMENTAL	450
(U,PU)2C3	COMPATIBILITY			
		1073K	(U.8PU.2)2C3/V ALLOYS	404
	1073K	1073K	(U.85,PU.15)2C3/304SS	307
			FE & NI BASE ALLOYS	7
(U,PU)2C3	FREE ENERGY OF FORMATION			
	723K	1023K	FROM LITERATURE	29
	723K	1023K	(U.8PU.2)2C3, FROM LITERATURE	26
(U,PU)2C3	LATTICE PARAMETERS			
			(SEE ABSTRACT)	16
(U,PU)2C3	PHASE EQUILIBRIUM			
	1873K	2773K	MELTING BEHAVIOR C/M=1.5-2	32
			PU/(U+PU)=0-1.	
	1773K	1973K	MICROPROBE	204
			DILATOMETER & X-RAY	195
			CALCULATION OF EQUILIBRIA	465
(U,PU)2C3	PREPARATION			
			(SEE ABSTRACT)	659
			(U.8 PU.2)2C3	656
			(SEE ABSTPACT)	419

	FROM	TO	COMMENTS	ABSTRACT
(U,PU)2C3	REVIEW		OF CHEMISTRY,STRUCTURE,PHASE RELATIONSHIPS,DENSITY,THERMO DYNAMIC & THERMAL PROPERTIES AND COMPATIBILITY.	421
(U,PU)2C3	GAS RELEASE AND SNELLING			
	1573K		UNDER VARICUS BURNUP	72
(U,PU)2C3	THERMAL EXPANSION			
	1073K	1973K	(U.65PU.35)2C3	30
(U,PU)2C3	VAPOR PRESSURE			
	900K	1200K	EMF; PU PRESSURES CALC	7
(U,PU)2N3	COMPATIBILITY			
	973K	1273K	304SS	12
PU	SOLUBILITY			
	973K	1273K	OF NB IN LIQUID PU	17
	973K	1223K	OF C IN LIQUID PU	119
	1023K	1223K	SOLUBILITY OF C IN PU	118
PUC	COMPATIBILITY			
	1273K	1673K	/MO,NB,SS,TA,V,ZR,W	543
	723K	1023K	/316SS NA-BONDED	441
			/NA,IRRADIATED FUEL BEHAVIOR	18
			/SS AND NI ALLOYS	582
			REVIEW	392
PUC	HEAT CAPACITY			
	298K	1927K	PUC.67; PUC.85; REVIEW	519
	400K	1300K	PUC.77	648
	400K	1300K	CALC FROM ENTHALPY	389
	4K	373K	PUC.81	606
			REVIEW	392

	FROM	TO	COMMENTS	ABSTRACT
PUC				
	DENSITY			
		298K	AS A FUNCTION OF C-CONTENT	543
			COMPARISON OF THEORETICAL &	390
			EXPERIMENTAL	388
			REVIEW	392
			EFFECT OF C/PU	515
			FOR PU-C ALLOYS AS A FUNC-	163
			TION OF C-CONTENT	
			CALCULATED	743
PUC				
	ELECTRICAL CONDUCTIVITY			
	1200K	1200K	RESISTIVITY & THERMOEL POWER	183
	298K	1093K	PUC1.0;PUC1-X	416
	323K	1073K	EXPERIMENTAL FOR PUC AND PUC	411
			0.87	
	298K	973K	MEASURED	387
	4K	300K	EFFECTS OF MAGNETIC TRANS	182
		298K	FOR PUC0.87, PUC1.0 & PUC	413
			SUB 1-X; COMPARED WITH	
			LITERATURE	
			REVIEW	292
			ELECTRICAL CONDUCTIVITY	490
			(SEE ABSTRACT)	549
			REVIEW; PUC(1-X)	240
			PUC.87	417
PUC				
	ENTHALPY			
	298K	2500K	REVIEW	161
	298K	1927K	PUC.67; PUC.85; REVIEW	519
	400K	1300K	PUC.77	648
	400K	1300K	DROP CALORIMETRY	389
	973K	1273K	ENTHALPY OF SOLUTION OF C IN	120
			PU(L) CALC FROM SOLUBILITIES	
			OF MIXING	308
			REVIEW	392
PUC				
	ENTROPY			
	298K	2500K	REVIEW	161
	298K	1927K	PUC.67; PUC.85; REVIEW	519
	400K	1300K	PUC.77	648
	400K	1300K	CALC FROM ENTHALPY	389
	298K	298K	PUC.87 CALC	51
	298K	298K	OF FORMATION	16
	298K	298K		385
	298K	298K	ESTIMATED FOR PUC0.77	319

	FROM	TO	COMMENTS	ABSTRACT
PUC	FREE ENERGY OF FORMATION			
	298K	2500K	REVIEW	161
	1000K	2000K	FOR PUC0.77 CALCULATED STD FREE ENERGY OF FORMATION TOO	319
	1380K	1930K	FROM LITERATURE	561
	298K	1927K	PUC.67; PUC.85; REVIEW	519
	1923K	1923K	CALC FROM VAP	279
	298K	1848K	CALC	32
	1450K	1948K	PUC.9; CALC FROM VAP, EMF	154
	298K	1800K	CALC PUC.87	30
		1662K	CALCULATED	372
	900K	1200K	PUC.9	7
	971K	1060K	EMF: PUC1-X	152
	723K	1023K	FROM LITERATURE	29
	723K	1023K	FROM LITERATURE	26
		986K	FROM EMF STUDIES	156
			PUC(1-X)	525
			FROM VAP	89
			DISTRIBUTION COEFFS	204
			ESTIMATING CALCULATIONS FOR CARBIDES OF PU	318
			CALCULATED	16
PUC	HOT HARDNESS			
	293K	1273K	FOR PUC0.93	691
	298K	1273K	FOR PUC0.931	688
	298K	1273K	FOR PUC0.93	687
	298K	1273K	PUC.93	32
	298K	1273K		30
		298K		543
	298K	298K	REVIEW FOR PUCX MEASURED	686
			REVIEW	390
				392
PUC	HEAT OF COMBUSTION			
	298K	298K	EXPERIMENTAL FOR PUC0.77 , ESTIMATED HEAT OF FORMATION	319
PUC	HEAT OF FORMATION			
	298K	2500K	REVIEW	161
	298K	1927K	PUC.67; PUC.85; REVIEW	519
	298K	1800K	CALC PUC.87	30
	400K	1300K	PUC.77	648
	298K	298K	PUC.87; SFCFM	531
	298K	298K	PUC.9; EFFUSION	462
	298K	298K	PUC.9, CALCRIM	461

	FROM	TO	COMMENTS	ABSTRACT
PUC	HEAT OF FORMATION			
	298K	298K	PUC.91;COMBUST CALORIM	449
	298K	298K	PUC.878;COMBUST CALORIM	333
	298K	298K	PUC.9;FROM VAP,EMF;SFORM	154
	298K	298K	PUC.859	8
	298K	298K	PUCO.87 CALC	51
	298K	298K	PUC.878	9
	298K	298K	PUC.878	10
	298K	298K	ESTIMATED FOR PUCO.77	319
	298K	298K	CALCULATED	16
	298K		CALC	28
	298K	298K	PUC.86 CALC	29
	298K		CALC	32
		298K	FROM 2ND & 3RD LAW	156
	29	8K	CALCULATED; 2ND & 3RD LAW	372
			(SEE ABSTRACT)	371
			(SEE ABSTRACT)	370
			EXPERIMENTAL FOR PUCO.77	318
			FOR TERNARY AND QUATERNARY	308
			SYST WITH M, M1 AND M2	
PUC	HEAT OF VAPORIZATION			
	1366K	1835K	MASS SPEC-EFFUSION; 2 PHASE	531
			PUC & PU2C3	
PUC	LATTICE PARAMETERS			
	73K	673K	DETERMINED FOR VARIOUS PU	110
			CARBIDES	
			AS A FUNCTION OF C-CONTENT	163
			NEUTRON DIFFRACTION DATA FOR	260
			PUC SUB 1-X.	
			TO DETERMINE ORDERING FOR	257
			PUCO.91;NEUTRON DIFFRACTION	
			REVIEW OF CRYSTAL STRUCTURE	415
			X-RAY DIFFRACTION	526
			AS A FUNCTION OF C-CONTENT	388
			(SEE ABSTRACT)	743
			FOR PUCO.88; FROM X-RAY	83
			POWDER DIFFRACTION STUDIES	
			REVIEW	664
			REVIEW; FUNCTION OF COMP	668
			EFFECT OF C/PU	515
			VALUE FROM LITERATURE	391
			REVIEW OF PU-C SYSTEM.	310
			FOR TERNARY AND QUATERNARY	308
			SYST WITH M, M1 AND M2	
			X-RAY	29
			X-RAY	28
			PUC-PU SYSTEM	77

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		1927K	VALUE REPORTED	543
			ALLOYS WITH TA,W,MO	391
				148
PUC	MISCELLANECUS			
	20K	298K	NEUTRON DIFFRACTION DATA FOR PUCO.91; MAGNETIC TRANS PROPERTIES	259
			EVALUATION OF HI TEMP THERMO PROPS	1
				220
PUC	PHASE EQUILIBRIUM			
	273K	2773K	DISCUSSION & REVIEW	443
	373K	2773K	PU-C SYSTEM, REVIEW	561
	273K	2673K	PU-PUC2/C	410
	873K	2573K	COMPLETE PHASE DIAGRAM	32
	1873K	2308K	TRANSITION TEMPERATURES	26
	1873K	2273K	MELT BEHAVIOR PUC(1+X)	30
		1933K		370
	773K	1773K	0-50% PHASE DIAGRAM FROM M PT XRAY, METALLOGRAPHIC	590
			PU-C-FE,CO,NI	496
			REVIEW	59
			(SEE ABSTRACT)	392
			METALLOGRAPHY & X-RAY DIFF.	371
			FROM DILATCMETRIC STUDIES	398
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			PU-C SYSTEM PHASE EQUILIBRIA	415
			PHASE EQUILIBRIA BY DTA AND X-RAY DIFFRACTION	525
			THERMAL APRFST TEMPERATURES	31
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			TERNARY AND QUATERNARY SYST	308
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			INVESTIGATED PU-FE-C SYSTEM	507
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			REVIEW OF PU-C SYSTEM.	328
			LATTICE PARAMETER	148
			REVIEW	602
			PU; PUC.23, PUC.51;	89
			PUC.72 TO 1.91	
			REVIEW; LATTICE PARAMETERS	648

	FROM	TO	COMMENTS	ABSTRACT
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	PHASE EQUILIBRIUM		(SEE ABSTRACT)	111
PUC				
	PREPARATION			
	1173K		FROM GRAPHITE, PU OR PU-H	217
			CARBOTHERMIC REDUCTION	526
			EFFECT OF NI ADDITION	582
			(SEE ABSTRACT)	390
			REVIEW	392
			(SEE ABSTRACT)	522
			(SEE ABSTRACT)	81
			(SEE ABSTRACT)	90
			SYNTHESIS AND FABRICATION OF	22
			PU-C.	
			PUC.86 BY ARC MELTING	26
			(SEE ABSTRACT)	419
			SYNTHESIS AND FABRICATION	18
			PUC(X) X=.98,1.32,1.41,1.65,	27
			2.1,2.2,4. EFFECT OF BINDERS	
PUC				
	REVIEW			
	298K	2500K	THERMO PROPS	161
			TH COND; PHASE DIAGRAMS	602
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			PARAMETER, CHEMICAL STABI-	
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			DENSITY, MELTING POINT, HEAT	
			OF FORMATION, VAPOR PRESSURE	
			AND THERMAL CONDUCTIVITY FOR	
			PU-C SYSTEM.	
			REVIEW AND ASSESSMENT OF	328
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			THERMODYNAMIC PROPERTIES OF THERMOCHEMICAL PROPERTIES	309 412
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			DENSITY, THERMODYNAMIC PROPS INCLUDES PHASE EQUILIBRIA, VAPORIZATION BEHAVIOR	644
PUC	SEEBECK COEFFICIENT		SEEBECK COEFF	490
PUC	ENTROPY OF FORMATION			
		298K	CALCULATED	372
	298K	298K	PUC.86 CALC	29
	298K		CALC	32
	298K		CALC	28
			(SEE ABSTRACT)	370
			(SEE ABSTRACT)	371
PUC	GAS RELEASE AND SWELLING		SWELLING & GAS RELEASE	550
PUC	THERMAL CONDUCTIVITY			
	773K	1773K	REVIEW	37
	473K	673K	EXPERIMENTAL FOR PUCO.87	411
	473K	673K	FOR PUCO.87	413
			REVIEW	418
			REVIEW	392
			REVIEW; PUC (1-X)	240
			(SEE ABSTRACT)	490
			PUC.87	417
			REVIEW	602
PUC	THERMAL DIFFUSIVITY			
	773K	1773K	LASER PULSE	491
	773K	1773K		7
			REVIEW	418

	FROM	TO	COMMENTS	ABSTRACT
PUC	THERMAL EXPANSION			
	298K	1273K		603
	298K	1273K	MEASURED AS A FUNCTION OF COMPOSITION	604
	323K	1273K		387
	298K	1173K	AS A FUNCTION OF C-CONTENT	524
	298K	1173K	41.1,43.2,44.9,45.4,45.8% C;	523
			DILATOMETER	
	293K	1173K	DILATOMETER	527
	373K	1073K	BY DILATOMETRY	582
	293K	1053K	BY X-RAY DIFFRACTION	539
	298K	723K	PUC.62, PUC.84 DISCUSSES ANOMALIES IN LOW TEMP TH EXP DURING HEATING & COOLING CYCLES	573
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PUC	VAPOR PRESSURE			
	1300K	2500K	EFFUSION; 2 PHASE WITH PU2C3	461
		2500K		81
		2200K	MASS SPEC	561
	1450K	2170K	MASS SPEC	32
		1933K		370
	1761K	1907K	TRANSP-2PHASE WITH PU2C3	279
	1450K	1848K	PUC.9; MASS SPEC-EFFUSION	154
	1450K	1848K	DECOMPOSITION PRESSURE	372
	1773K	1838K	TRANSPIRATION; PUC.9	538
	1823K		MECHANISM FOR DECOMP	562
	1533K	1799K	PUC.85-PUC1.34 MASS SPEC	29
		1773K		148
			FOR 30A/O, 50A/O AND 65A/O CARBON CONTENT IN PU-C SYST.	16
			EXP: MASS SPEC	26
			MASS SPEC	28
			PUC(1+X) MASS SPEC	27
			REVIEW	392
PUCN	COMPATIBILITY			
	473K	593K	CORROSION RATES IN WATER & AIR	268
PUCN	DENSITY			
			(SEE ABSTRACT)	268

	FROM	TO	COMMENTS	ABSTRACT
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PUCN	LATTICE PARAMETERS		REVIEW; FUNCTION OF COMP.	668
PUCN	MELTING POINT		AS A FUNCTION OF N2 PRESSURE	268
PUCN	PHASE EQUILIBRIUM	298K	PU-N-C SYSTEM, BY X-RAY REVIEW OF PU-C-N SYSTEM & EQUILIBRIUM N2 PRESSURE (SEE ABSTRACT)	548 668 33
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	298K	2525K	REVIEW	519
PUC2	ENTHALPY			
	298K	2525K	REVIEW	519
	298K	2500K	REVIEW	161
PUC2	ENTROPY			
	298K	2525K	REVIEW	519
	298K	2500K	REVIEW	161
	298K	298K	CALC	51
	298K	298K		385
PUC2	FREE ENERGY OF FORMATION			
	298K	2525K	REVIEW	519
	298K	2500K	REVIEW	161
	2017K	2472K	FROM LITERATURE	561
	2273K	2273K	CALC FROM VAP	279
	1933K	2140K	CALC FROM VAP	154
	298K	2100K	CALC	32
		2053K	CALCULATED	372
	1600K	2000K	C2 EQUILIBRIUM	461
	298K	1850K	CALC PUC(2-X)	30
			REVIEW	386
			FROM VAP	89

	FROM	TO	COMMENTS	ABSTRACT
PUC2	HEAT OF FORMATION			
	298K	2525K	REVIEW	519
	298K	2500K	REVIEW	161
	298K	1850K	CALC PUC(2-X)	30
	298K		CALC	32
	298K	298K	CALC	51
	298K	298K	CALC FROM VAP; SFORM	154
		298K	CALCULATED; 2ND & 3RD LAW	372
PUC2	HEAT OF VAPORIZATION			
	1933K	2348K	MASS SPEC-EFFUSION	99
	298K	298K	2ND LAW SLOPE	497
PUC2	LATTICE PARAMETERS			
	2473K	2873K	XRAY EVIDENCE FOR PUC2 PHASE	159
	1983K	1983K	X-RAY DIFFRACTION DATA	275
PUC2	MELTING POINT			
	2505K			27
			EXPT	194
PUC2	PHASE EQUILIBRIUM			
	2000K		FROM VAP STUDIES	464
		1933K		370
	1933K		PU2C3-PUC2/C TRANSITION	27
			DTA; UC2-PUC2 SYSTEM	576
			TRANSFORMATION TO PU2C3 + C:	579
			CALCULATES HEAT OF TRANS &	
			COMPARES WITH UC VALUE	
			FORMATION TEMP FROM PU2C3 +C	194
			(SEE ABSTRACT)	371
			MELT BEHAVIOR	578
PUC2	REVIEW			
	298K	2500K	THERMO PROPS	161
			VAPORIZATION	386
			THERMOCHEM DATA	519
			OF CHEMISTRY, STRUCTURE, PHASE	421
			RELATIONSHIPS, DENSITY, THERMO	
			DYNAMIC & THERMAL PROPERTIES	
			AND COMPATIBILITY.	

	FROM	TO	COMMENTS	ABSTRACT
PUC2	ENTROPY OF FORMATION			
	298K	298K	CALCULATED CALC	372 32
PUC2	THERMAL EXPANSION			
	1933K	2273K	X RAY DIFFRACTION	32
	1933K	2273K	EXPERIMENTAL	258
	2023K	2273K		412
	2023K	2273K	X-RAY DIFFRACTION	27
PUC2	VAPOR PRESSURE			
	1300K	2500K	EFFUSION; 2PHASE WITH PU2C3-C	461
	1773K	2500K	REVIEW	648
	2017K	2472K	TRANSP-2PHASE WITH GRAPHITE	279
	2000K	2400K	EXPERIMENTAL	497
	1933K	2348K	MASS SPEC-EFFUSION	99
	1933K	2348K	2 PHASES: EITHER PU2C3 OR C	9
	1450K	2170K	MASS SPEC	32
	1745K	2140K	MASS SPEC	30
	1933K	2140K	MASS SPEC, EFFUSION	154
	1933K	2140K	DECOMPOSITION PRESSURE	372
		1933K		370
			EXP: MASS SPEC	26
			REVIEW	386
PUN	COMPATIBILITY			
		1998K	CR	553
	1073K	1973K	TERNARY DIAGRAM WITH CR	551
	1093K	1923K	REFRACT METALS, STEEL	546
		1573K	/MO, W, TA	543
	1273K	1473K	316SS; NI ALLOYS; MOLY	545
		1473K	WITH MO	356
	613K	1373K	O2, N2, NA, LI	546
	973K	1273K	REACTION RATES WITH AEC- GRADE HELIUM	201
		1273K	/FE ALLOYS, INCONEL, REFRACT METALS	542
	1173K	1173K	/SS, EFFECT OF O2	68
			CALCULATION; WITH FE, CR, V, NB, ZR ETC.	358
			WITH VARIOUS CLADDING MATER.	361
			304SS; 316SS; V-ALLOYS	11
PUN	HEAT CAPACITY			
	298K	3000K	REVIEW & ESTIMATED	631

	FROM	TO	COMMENTS	ABSTRACT
PUN	HEAT CAPACITY			
	298K	2843K	REVIEW	519
	298K	2400K	EST	12
PUN	DENSITY			
	523K	1673K	CALCULATED	201
		298K		543
			AS A FUNCTION OF PRESSING & SINTERING CONDITIONS	17
			CALCULATED	743
			(SEE ABSTRACT)	515
PUN	ELECTRICAL CONDUCTIVITY			
	4K	300K	EFFECTS OF MAGNETIC TRANS	182
PUN	ENTHALPY			
	298K	3000K	REVIEW & ESTIMATED	631
	298K	2843K	REVIEW	519
	298K	2400K	EST	12
PUN	ENTROPY			
	298K	3000K	REVIEW & ESTIMATED	631
	298K	2843K	REVIEW	519
	298K	2400K	EST	12
PUN	FREE ENERGY OF FORMATION			
	298K	2843K	REVIEW	519
		1000K	REVIEW	683
	913K		FROM EMF STUDY	150
	695K	716K	EMF	151
	713K	713K	FROM EMF STUDIES.	16
	700K	700K	EMF	155
	700K	700K	EMF	152
		700K	BY EMF MEASUREMENTS	414
	298K		FROM EMF STUDY	153
PUN	HOT HARDNESS			
	293K	1273K	FROM LITERATURE	691
	298K	1273K	REVIEW	696
	298K	1273K		32
	323K	1273K	FROM LITERATURE	688
		298K		543

	FROM	TO	COMMENTS	ABSTRACT
PUN	HEAT OF FORMATION			
	298K	2843K	REVIEW	519
	298K	298K	EFFUSION	463
	298K	298K	MASS SPEC-EFFUSION;SFORM	368
	298K	298K	MASS SPEC-EFFUSION	369
	298K	298K	COMBUST CALORIM	332
	298K	298K	CALCULATION	630
	298K	298K	EMF	152
	298K	298K		8
		298K	CALC	631
	298K		FROM EMF STUDY	153
	298K		FROM EMF STUDY	150
	298K		CALCULATED	361
	298K		CALC	29
PUN	LATTICE PARAMETERS			
	1173K	1923K		515
	73K	673K	DETERMINED	110
			REVIEW, ALSO PUN/O IMPURITY	631
			DISSOLVED C2.	475
			REVIEW	664
			(SEE ABSTRACT)	743
			(SEE ABSTRACT)	676
			POWDER	27
			VALUE FROM LITERATURE	391
			(SEE ABSTRACT)	16
PUN	MELTING POINT			
	2773K	3073K	MELTED UNDER N2 PRESSURES OF 1 TO 70 ATM.	720
		3023K		543
		2843K	REVIEW	631
			REVIEW	664
PUN	MISCELLANEOUS			
			OXIDATION DATA IN FLOWING N2 ,CO2 & DRY AIR (SEE ABSTRACT)	544 65
PUN	PHASE EQUILIBRIUM			
	298K	2500K	MELTING BEHAVIOR	158
	1073K	1973K	TERNARY DIAGRAM WITH CR	551
			LATTICE PARAM	552
			(SEE ABSTRACT)	111

	FROM	TO	COMMENTS	ABSTRACT
PUN	PREPARATION			
			(SEE ABSTRACT)	81
			(SEE ABSTRACT)	417
			(SEE ABSTRACT)	546
			(SEE ABSTRACT)	530
			(SEE ABSTRACT)	416
			SYNTHESIS IN N2 ATMOSPHERE	475
			WITH O2 AS IMPURITY.	
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			(SEE ABSTRACT)	419
PUN	REVIEW			
			OF THERMOCHEMICAL PROPERTIES	412
			OF CHEMISTRY, STRUCTURE, PHASE	421
			RELATIONSHIPS, DENSITY, THERMO	
			DYNAMIC & THERMAL PROPERTIES	
			AND COMPATIBILITY.	
			OF PHYSICAL & MECHANICAL	19
			PROPERTIES, COMPATIBILITY AND	
			RESISTANCE TO REACTOR RADIA-	
			TION	
			(SEE ABSTRACT)	111
			THERMOCHEM DATA	519
			THERMO PROPS: PHASE DIAGRAMS	572
			CHEM & PHYS PROPS	210
			"REACTOR MATERIALS" (1964)	40
			CRITICAL REVIEW OF VARIOUS	733
			PROPERTIES OF PU-N SYSTEM.	
			OF MECHANICAL PROPERTIES	690
			PHASE RELATIONSHIP, LATTICE	646
			PARAMETER, CHEMICAL STABI-	
			LITY, HARDNESS, RESISTIVITY,	
			THERMODYNAMIC PROPERTIES AND	
			VAPORIZATION FOR PU-N SYSTEM	
PUN	ENTROPY OF FORMATION			
	298K		FROM EMF STUDY	153
	298K		FROM EMF STUDY	150
	298K		CALC	29
PUN	SINTERING			
	1873K		EFFECT OF C2	16

	FROM	TO	COMMENTS	ABSTRACT
PUN	SOLUBILITY			
			N2 SOLUBILITY IN PUN	200
			SOLUBILITY OF O2	475
PUN	THERMAL CONDUCTIVITY			
	523K	1673K	CALCULATED	201
	573K	1273K	LASER PULSE	545
PUN	THERMAL DIFFUSIVITY			
	523K	1673K	EXPERIMENTAL	201
	473K	1173K	EXPERIMENTAL	361
PUN	THERMAL EXPANSION			
	293K	1273K	PUN.9, BY X-RAY	571
	299K	1273K	DILATOMETER	546
	323K	1273K		397
	293K	1173K		515
			(SEE ABSTRACT)	543
PUN	VAPOR PRESSURE			
	298K	3000K	REVIEW & ESTIMATED	631
	2290K	2770K		530
		2500K		81
	1400K	2400K		12
	1523K	2300K	LANGMUIR; EFFUSION	545
	1931K	2249K	MASS SPEC	29
	1885K	2130K	MEASURED	361
		2073K	THERMAL STABILITY	158
	1658K	1976K	MASS SPEC-EFFUSION	368
	1658K	1976K	EXP: MASS SPEC	26
	1658K	1976K	MASS SPEC	27
	1600K	1900K	MEASURED LOSS OF WEIGHT	358
	1523K	1823K	LANGMUIR	546
	1523K	1823K	VOLATILITY IN VACUUM. ALSO	200
			CALCULATED ACTIVATION ENERGY	
			FOR VAPORIZATION.	
	1426K	1658K	MASS SPEC-EFFUSION	369
			EFFUSION	463
			COMPARED WITH UN	66
			N2 PRESSURE IN EQUILIBRIUM	668
			DECOMPOSITION PRESSURE	414

	FROM	TO	COMMENTS	ABSTRACT
PU2C3	HEAT CAPACITY			
	298K	2323K	REVIEW	519
	298K	2200K	EST	154
	298K	2200K	CALC	32
	298K	2000K	CALORIM	461
	35K	300K	EXPTL	198
PU2C3	DENSITY			
	EFFECT OF C/PU			515
PU2C3	ELECTRICAL CONDUCTIVITY			
	298K	1093K		416
	4K	300K	EFFECTS OF MAGNETIC TRANS	182
PU2C3	ENTHALPY			
	298K	2500K	REVIEW	161
	298K	2323K	REVIEW	519
	298K	2200K	EST	154
	298K	2200K	CALC	32
	298K	2000K	CALC FROM VAP & CALORIM	461
	298K	298K	CALC FROM CP	198
PU2C3	ENTROPY			
	298K	2500K	REVIEW	161
	298K	2323K	REVIEW	519
	298K	2200K	EST	154
	298K	2200K	CALC	32
	298K	2000K	CALC FROM VAP & CALORIM	461
	298K	298K	CALC FROM CP	198
	298K	298K	MASS SPEC-EFFUSION SFORM	99
	298K	298K	CALC	51
	298K	298K	APPROXIMATION	16
	298K	298K		385
	298K	298K	ESTIMATION	319
PU2C3	FREE ENERGY OF FORMATION			
	298K	2500K	REVIEW	161
	298K	2323K	REVIEW	519
	1540K	2023K	FROM LITERATURE	561
	1000K	2000K	CALCULATED STD FREE ENERGY OF FORMATION TOO	319
	1873K	2000K	CO EQUILIBRIUM	461
	1668K	1933K	CALC FROM VAP, ENF	154

	FROM	TO	COMMENTS	ABSTRACT
PU2C3	FREE ENERGY OF FORMATION			
	1923K	1923K	CALC FROM VAP	279
	298K	1900K	CALC	30
		1842K	CALCULATED	372
	900K	1200K		7
	974K	1091K	EMF	152
	910K	1048K	CALC FROM EMF DATA	32
	723K	1023K	FROM LITERATURE	29
	723K	1023K	FROM LITERATURE	26
	917K	1016K	BY EMF TECHNIQUES	31
		986K	FROM EMF STUDIES	156
	298K	298K	CALC	9
			FROM VAP	89
			CALCULATED	16
PU2C3	HOT HARDNESS			
	293K	1273K	FOR PUC1.454	691
	298K	1273K	FOR PUC1.454	688
	298K	1273K		32
PU2C3	HEAT OF FORMATION			
	298K	2500K	REVIEW	161
	298K	2323K	REVIEW	519
	298K	1900K	CALC	30
	298K	298K	CALC	29
	298K		CALC	32
	298K	298K	PUC(1.467) COMBUSTION CALOR	334
	298K		CALC	28
	298K	298K	CALC	51
	298K	298K	CALC FROM VAP, EMF; SFORM	154
	298K	298K	MASS SPEC-EFFUSION	99
	298K	298K	SFORM	531
	298K	298K	COMBUST CALORIM	449
	298K	298K	CALORIM	461
	298K	298K	EFFUSION	462
	298K	298K	PUC1.466	10
	298K	298K	CALC	9
	298K	298K	APPROXIMATION	16
	298K	298K	ESTIMATION	319
		298K	2ND & 3RD LAW	156
		298K	CALCULATED; 3RD LAW	372
			(SEE ABSTRACT)	371
			(SEE ABSTRACT)	370
PU2C3	HEAT OF VAPORIZATION			
	1579K	2299K	MASS SPEC-EFFUSION	99
	1691K	1988K	MASS SPEC-EFFUSION; 2 PHASE PU2C3 & C	531

	FROM	TO	COMMENTS	ABSTRACT
PU2C3	LATTICE PARAMETERS			
			(SEE ABSTRACT)	16
			EFFECT OF C/PU	515
			X-RAY	28
			NEUTRON DIFFRACTION	23
			NEUTRON DIFFRACTION	18
			X-RAY	29
			TO DETERMINE ORDERING FOR PU2C3; NEUTRON DIFFRACTION	257
			(SEE ABSTRACT)	388
			(SEE ABSTRACT)	163
			NEUTRON DIFFRACTION DATA	260
			(SEE ABSTRACT)	525
			STRUCTURAL ANALYSIS	412
			K-RAY DIFFRACTION	526
PU2C3	PHASE EQUILIBRIUM			
	2000K		FROM VAP STUDIES	464
	1933K	1933K	PU2 C3-PUC2/C TRANSITION	27
			MELT BEHAVIOR	370
			TRANSITION TO PUC2	578
				371
PU2C3	PREPARATION			
	2073K	2173K	FROM GRAPHITE & PU-DIOXIDE	217
			CARBOTHERMIC REDUCTION	526
			(SEE ABSTRACT)	419
			BY ARC MELTING	26
			(SEE ABSTRACT)	522
			(SEE ABSTRACT)	659
PU2C3	REVIEW			
	298K	2500K	THERMO PROPS	161
			THERMOCHEM DATA	519
			INCLUDES MELT PT, CRYSTAL STRUCTURE, LATTICE PARAMETERS	595
			DENSITY	
			OF THERMOCHEMICAL PROPERTIES	412
			OF CHEMISTRY, STRUCTURE, PHASE RELATIONSHIPS, DENSITY, THERMO DYNAMIC & THERMAL PROPERTIES AND COMPATIBILITY.	421
PU2C3	ENTROPY OF FORMATION			
	298K		CALCULATED	372

	FROM	TO	COMMENTS	ABSTRACT
PU2C3	ENTROPY OF FORMATION			
	298K		CALC	32
	298K	298K	CALC	29
	298K		CALC	28
			(SEE ABSTRACT)	370
			(SEE ABSTRACT)	371
PU2C3	THERMAL EXPANSION			
	273K	1973K	X RAY DIFFRACTION	32
	293K	1873K		412
	298K	1873K	EXPERIMENTAL	258
	1073K	1873K		29
	1073K	1873K	X-RAY DIFFRACTION	27
	293K	1273K	BY X-RAY	571
	293K	1053K	BY X-RAY DIFFRACTION	539
			(SEE ABSTRACT)	515
PU2C3	VAPOR PRESSURE			
	1300K	2500K	EFFUSION; 2PHASE WITH PUC-C	461
	2255K	2455K	TRANSPIRATION	8
	1579K	2299K	MASS SPEC-EFFUSION	99
	1579K	2299K	2 PHASES: EITHER PUC2 OR C	9
	1450K	2170K	MASS SPEC	32
	1668K	2170K	DECOMPOSITION PRESSURE	372
	1745K	2140K	MASS SPEC	30
	1668K	1933K	MASS SPEC-EFFUSION	154
		1933K		370
	1745K	1928K	PUC1.5-PUC2.07 MASS SPEC	29
	1761K	1907K	TRANSP -2PHASE WITH PUC	279
			MASS SPEC	28
U	VAPOR PRESSURE			
	1800K	2400K	EFFECT OF CARBON ON VAP PRES	52
UC	COMPATIBILITY			
	1273K	2673K	INVESTIGATED RELATIVE COMPA- TIBILITY WITH W,TA,MO,ZIP- CALOY-2,AISI 304LSS,INCONEL, HASTELLOY-F,NIOBIUM AND ZIRCONIUM ALLOYS.	166
	1273K	2273K	PREDICTED THE REACTIVITY OF U-C WITH METAL CLADDINGS OF NB,TA,TI,W, AND ZR.	191
	1473K	2273K	WITH W,MO,TA & NB	722
	1473K	2273K	/W,MO,TH,NB	721
	1473K	2273K	UZRC/MO,TA,NB,W	721

UC

FROM	TO	COMMENTS	ABSTRACT
COMPATIBILITY			
	1978K	UC(1+X)/W,TA,MO,NB, & ALLOYS	473
	1873K	/V, U-V-C SYSTEM	627
	1873K	/CR, U-CR-C SYSTEM	628
923K	1323K	/SS,EFFECT OF TI,MO	492
	1273K	/NB-1W/O ZR	187
811K	1144K	TESTED UC WITH TYPE 304 AND 347 STAINLESS STEEL.	716
811K	1144K	TESTED U-C ALLOYS WITH TYPE 304 STAINLESS STEEL.	717
922K	1144K	TESTED HYPER & HYPOSTOICHIOMETRIC UC WITH TYPE 304 S S, NIOBIUM AND ZIRCONIUM ALLOYS	269
1103K	1103K	STAINLESS STEEL	294
	1093K	304SS; NB; ZIRC; BE	659
773K	1073K	/KCL-LICL-ZNCL2-ZN	587
	1073K	/316SS NA-BONDED	125
	1033K	UC PASTES/304SS	162
723K	1023K	/316SS NA-BONDED	441
823K	1023K	UC1.07/316SS, V-ALLOYS NA-BONDED	30
	1023K	UC(1+X)/304SS, NA-BONDED	512
	973K	/V ALLOYS	323
	923K	/SS,/NICKEL ALLOYS	178
	873K	/AL	14
	863K	/AL	15
		/CARBIDES OF MO,NB, TI,V,ZR, (SEE ABSTRACT)	605
		CALC OF C ACTIVITY BUFFERING	127
		AL,CR,FE,MO,NB,NI,TI,V,ZR,SS	173
		UC(1+X)/CLADDING,EFFECT OF FISSION PRODUCTS ON CLAD ATTACK	344
		RADIATION STABILITY OF HYPO & HYPERSTOICHIOMETRIC UC	305
		/TYPES 316,304 & 347 SS AND HASTELLOY-N	550
		REVIEW,/GASES,LIQUIDS,SOLIDS FROM X-721 TEST BETWEEN SAP SHEATHING & CARBIDE PELLETS.	284
		/AL,BE,SS,NI-ALLOYS,TI,V, CR,ZR,MO,NB,TA & W IS REVIEWED	145
		COMPARED IN-PILE COMPATIBILITY FOR UC1.05 WITH STAINLESS STEEL CLADDING.	451
		TESTED STABILIZED URANIUM CARBIDE WITH AUSTENITIC AND FERRITIC STAINLESS STEELS.	253
		316 SS	254
		TUNGSTEN; CALCULATED	209
		PERFORMED CORROSION TESTS	337
		TESTED COMPATIBILITY OF HYPO AND HYPERSTOICHIOMETRIC UC	696
			296
			221

	FROM	TO	COMMENTS	ABSTRACT
UC	COMPATIBILITY			
			WITH TYPE 304 SS, NB-1WT% ZR, 321, HASTELLOY, NICHROME 5, AND HIGH-CHROMIUM STEELS.	221
			STUDIED CHEMICAL INTERACTION BETWEEN U-C AND TYPE 304S S, ZIRCONIUM, AND NIOBIUM ALLOYS USED HYPO AND HYPER STOICHIOMETRIC U-CARBIDES.	157
			TESTED COMPATIBILITY WITH NB-1WT% ZR.	189
			TESTED TYPE 304 S S, 2.25% CR-1MO STEEL, NB, INCONEL-X, ZIRCALLOY-2, AND BE.	623
			ESTIMATED FROM FREE ENERGY OF FORMATION OF U, W, MO, TA, ZR AND TI CARBIDES FOR VARIOUS URANIUM CARBIDES.	63
UC	COMPRESSIBILITY			
	1273K	1273K	CERMET	634
	296K	296K	EXPERIMENTAL CALCULATION OF ISOTHERMAL COMPRESSIBILITY.	367
UC	HEAT CAPACITY			
	298K	2800K	CALCULATIONAL	429
	400K	2800K		54
	700K	2800K		56
	800K	2800K		57
		2800K	RAPID HEATING METHOD	55
	298K	2773K		298
	298K	2750K	CALCULATED	179
	1287K	2481K	EXPERIMENTAL CALCULATION FOR UO ₂	433
	300K	2400K	REVIEW	145
	273K	1477K	EXPERIMENTAL CALCULATION	278
	273K	1475K	EXPERIMENTAL CALCULATION FOR U-C ALLOYS	207
	273K	1473K	EXPERIMENTAL CALCULATION	276
	400K	1000K	MOLAR VALUES	487
	298K	873K	EXPERIMENTAL	488
	373K	673K	EXPERIMENTALLY OBTAINED MOLAR VALUES ALSO.	494
	398K	523K		114
	10K	450K		466
	5K	350K	EXPERIMENTAL	723
	5K	350K	EXP	725
	10K	350K		726
	11K	330K	EXPERIMENTAL	74
	298K	298K	EXPERIMENTAL	489

	FROM	TO	COMMENTS	ABSTRACT
UC	HEAT CAPACITY			
	298K		EXPERIMENTAL	493
	2K	85K		202
	2K	4K	CP OF UC AND UC-THC	274
			HIGH-TEMPERATURE DATA	641
			OF U-C	328
			LASL WORK	123
UC			ESTIMATION	385
			MAGNETIC & ELECTRONIC CONTRB	197
	TENSILE CREEP			
	1873K	2573K	UC WITH VARIABLE C-CONTENT	456
	1773K	2173K	EXPERIMENTALLY MEASURED	157
			COMPRESSIVE CREEP AND FLOW	
			STRESS FOR URANIUM CARBIDES.	
UC	1673K	2073K	UC AND UC BASED FUELS WITH	741
			W AND ZR.	
	1373K	1973K	REVIEW	205
	1673K	1973K	TENSILE CREEP	355
	298K	1873K	REVIEW	686
	1473K	1873K	SLIGHTLY HYPOSTOICHIOMETRIC	638
			UC.	
	1273K	1773K	DIFFERENT STOICHIOMETRIES &	514
			PURITIES.	
	1273K	1673K	VARIABLE C CONTENT	270
	1203K	1573K	FOR HYPO & HYPER STOICHI-	376
			METRIC UC1#X	
	1373K	1573K	AS A FUNCTION OF STOICHI-	235
			METRY	
	1573K		4000, 6000 PSI	28
	1173K	1373K	HYPOSTOICHIOMETRIC UC	377
	1173K	1273K	REVIEW AND ESTIMATES	133
	1273K		COMPARISON WITH (U,Pu)C	687
	1273K		COMPARISON WITH (U,Pu)C	698
	873K	1123K	ESTIMATED FROM BURN UP DATA	134
			EXPERIMENTAL DEVICE FOR	213
			IRRADIATION CREEP.	
			REVIEW OF LITERATURE DATA	608
			FOR UC1#X	
			REVIEW OF LITERATURE	621
UC	DEFORMATION RATES AND MECHANISMS			
	1273K	2273K	INVESTIGATED MECHANICAL PRO-	251
			PERTIES SUCH AS DEFORMATION	
UC			RATES UNDER COMPRESSION FOR	
			U-C SYSTEM.	
			STUDIED PLASTIC DEFORMATION	49
			AT HIGH TEMPERATURE.	

	FROM	TO	COMMENTS	ABSTRACT
UC	DENSITY			
	1773K	2173K	DEPENDENCE ON COMPACTING TEMPERATURE.	477
	1473K	1673K		7
	294K	673K	EFFECT OF LOW TEMP IRRADIATION ON DENSITY OF UC.	379
	294K	673K	EFFECT OF LOW TEMPERATURE IRRADIATION ON DENSITY OF URANIUM CARBIDE AND COMPARISON OF CHANGES IN DENSITY WITH CHANGES IN LATTICE PARAMETER.	378
			(SEE ABSTRACT)	296
			AS A FUNCTION OF PRESSURE, TEMP AND TIME OF TREATMENT WITH RESPECT TO THERMAL COMPRESSION.	476
			(SEE ABSTRACT)	338
UC	DIFFUSION			
	1753K	2823K	U-233 SELF DIFFUSION IN STOICHIOMETRIC ARC CAST MATERIAL AND SINGLE CRYSTALS.	469
	1973K	2573K	FOR $UC_{0.96}$ & $UC_{1.07}$	297
	2173K	2533K	U-233 DIFF IN UC	610
	2173K	2533K	U AND C DIFF IN $UC(1-x)$	610
	2223K	2503K	C-SELF-DIFFUSION FOR $UC_{1.38}$ AND $UC_{1.52}$ BY TRACER TECH.	458
	2243K	2458K	VOLUME DIFFUSION COEFFICIENT FOR POLYCRYSTALLINE MATERIAL ALSO GIVES SURFACE DIFFUSION COEFFICIENT.	457
	1073K	2373K	U-SELF-DIFFUSION FOR SINGLE CRYSTAL OF HYPOSTOICHIOMETRIC UC	439
	1473K	2373K	GAVE EQUATIONS FOR DIFFUSION OF C, AND U IN UC AND FOR CHEMICAL DIFFUSION OF C IN UC.	171
	2173K	2323K	C DIFFUSION	536
	1373K	2273K	U-DIFFUSION FOR UC WITH DIFFERENT C CONTENT	103
	1373K	2273K	CARBON DIFFUSION FOR UC WITH DIFFERENT C CONTENT.	103
	1473K	2273K	DESCRIBED THE RATE OF GROWTH OF MONOCARBIDE LAYER. ALSO GAVE EQUATIONS FOR DIFFUSION OF C AND U IN UC.	169
	1673K	2273K	CARBON DIFFUSION BY TRACER TECHNIQUE.	459

UC

	FROM	TO	COMMENTS	ABSTRACT
DIFFUSION				
	1723K	2273K	U-SELF DIFFUSION FOR NEARLY STOICHIOMETRIC & STABILIZED MATERIAL.	700
	1723K	2253K	U-SELF DIFFUSION FOR STOICHIOMETRIC MATERIAL.	701
	1873K	2253K	U AND C IN UC AND UC ₂	314
	1778K	2136K	U-DIFFUSION FOR STOICHIOMETRIC POLYCRYSTALS.	424
	1873K	1973K	SELF-DIFFUSION COEFF.	295
	1973K		U-SELF DIFFUSION RATE	199
	1539K	1957K	C-DIFFUSION FOR STOICHIOMETRIC POLYCRYSTALS.	424
	1338K	1772K	CARBON DIFFUSION COEFFICIENT	383
	1673K		CATION DIFFUSION COEFFICIENT FOR POLY AND SINGLE CRYSTALS	471
		1673K	APPARENT DIFFUSION COEFF	126
		1673K	VACANCY MECHANISM	614
		1273K	THEORETICAL CALCULATIONS BASED ON FISSIONING EFFECTS ON SELF DIFFUSION COEFF.	136
	1173K		FISSION-ENHANCED U-DIFFUSION COEFFICIENT	306
	330K	330K	DERIVED A RELATION BETWEEN ACTIVATION ENERGY FOR SELF-DIFFUSION & TEMPERATURE	535
			REVIEW OF LITERATURE DATA ON CATION-ANION DIFFUSION FOR UC1#X	608
			REVIEW OF DIFFUSION DATA	609
			SELF-DIFFUSION COEFF OF C IN UC; CALCULATED	673
			FROM X-721 TEST ABOUT MOBILITY OF URANIUM	451
			IN GRAPHITE,SILICON CARBIDE, BE & ZR	50

UC

ELECTRICAL CONDUCTIVITY

	1100K	2400K	EXPERIMENTAL	263
	1673K	2373K	AS A FUNCTION OF TEMPERATURE AND U CONTENT.	476
	1673K	2373K	DEPENDENCE OF UC+U ON U CONTENT & SINTERING TEMPERATURE	477
	273K	2073K	REVIEW	93
	1175K	2050K	EXPERIMENTAL	264
	293K	1873K	EFFECT OF IRRADIATION ON	596
	1373K	1373K	FOR BEFORE & AFTER ANNEALING CONDITIONS	50
	298K	1273K	EXPERIMENTAL	157
	298K	1273K	EXPERIMENTAL	189
	298K	1273K		712
	1273K		EXPERIMENTAL	282

	FROM	TO	COMMENTS	ABSTRACT
UC	ELECTRICAL CONDUCTIVITY			
	1200K	1200K	RESISTIVITY & THERMOEL POWER	183
	373K	1173K	EXPERIMENTAL	411
	1000K		ALSO SPECTRAL & TOTAL EMITTANCE	265
		873K		487
	293K	473K	MEASURED FOR MIXTURES OF UC PARTICLES AND GRAPHITE	694
	4K	300K	EFFECTS OF MAGNETIC TRANS	182
		298K	COMPARED WITH LITERATURE	413
	298K	298K		114
	290K			338
			EXPERIMENTAL	498
			REVIEW	240
			ELECTRICAL CONDUCTIVITY (SEE ABSTRACT)	490
			TO FIND OUT THE EFFECT OF RADIATION	549
				195
UC	ELASTIC CONSTANTS			
	298K	1623K	FOR HYPO AND HYPERSTOICHIOMETRIC POLYCRYSTALS	271
	298K	1573K	AS A FUNCTION OF TEMP. & POROSITY	537
	298K	1373K	EXPERIMENTALLY MEASURED THE MODULUS OF RUPTURE FOR URANIUM CARBIDES.	157
	293K	1273K	REVIEW	205
	298K	1273K	ELASTIC MODULI AND MODULUS OF RUPTURE.	675
	298K	1073K	EXPERIMENTALLY MEASURED YOUNGS MODULUS.	190
	80K	900K	FOR SINGLE & POLY CRYSTALS WITH VARIABLE C CONTENT.	597
	80K	900K	AS A FUNCTION OF STOICH	599
	5K	300K		255
	298K	298K	REVIEW & PRELIMINARY DATA YOUNGS MODULUS FOR DIFF C	686
	298K		AS A FUNCTION OF POROSITY, COMPARED WITH (U,P)C DATA	355
		298K		516
UC	ENTHALPY			
	298K	2800K	CALCULATIONAL	429
		2800K	FROM CP	55
	298K	2750K	CALCULATED	179
	1500K	2600K	CALCULATION	554
	298K	2500K	REVIEW	161
	1287K	2481K	EXPERIMENTAL FOR UCO.99	433
	298K	1700K	CU BLOCK DROP CALORIMETER	521
	273K	1477K	MEASURED	278

	FROM	TO	COMMENTS	ABSTRACT
UC	ENTHALPY			
	273K	1473K	EXPERIMENTAL	276
	273K	1473K	EXPERIMENTAL FOR U-C ALLOYS WITH O2 AND N2 AS IMPURITIES	207
	400K	1000K	EXPERIMENTAL CALCULATION	488
	400K	1000K	MOLAR VALUES	487
	5K	350K	CALC	725
	10K	330K	EXPERIMENTAL CALCULATION	74
	5K	300K	EXPERIMENTAL CALCULATION OF MIXING	723
				308
UC	ENTROPY			
	298K	2800K	CALCULATIONAL	429
		2800K	FROM CP	55
	298K	2750K	CALCULATED	179
	1500K	2600K	CALCULATION	554
	298K	2500K	REVIEW	161
	400K	1000K	EXPERIMENTAL CALCULATION	488
	400K	1000K	MOLAR VALUES	487
	5K	350K	CALC	725
	10K	350K		726
	10K	330K	EXPERIMENTAL CALCULATION	74
	5K	300K	EXPERIMENTAL CALCULATION	723
	298K	298K	ESTIMATION	319
	298K	298K		385
			EXPERIMENTAL CALCULATION	493
			EXPERIMENTAL CALCULATION FOR PARTIAL MOLAR QUANTITIES FOR THE SOLUTION AND VAPORIZATION OF CARBON.	681
			DERIVES AN ANALYTICAL EQUATION FOR U-C SYSTEM THEORETICALLY.	511
UC	PLASTIC FLOW			
	1773K	2173K	PLASTIC FLOW FOR UC WITH LESS THAN 4.83 WT.% C.	160
UC	FREE ENERGY OF FORMATION			
	298K	2800K	ESTIMATION AS FREE ENERGY	429
	1600K	2800K	CALCULATED FROM THEORETICAL EQUATIONS AS A FUNCTION OF TEMPERATURE AND COMPOSITION FOR UC SUB Y, Y=0.9 TO 1.9	510
	2283K	2503K	CALCULATED FREE ENERGY CHANGE FOR VAPORIZATION	706
	298K	2500K	REVIEW	161
	1000K	2500K	EXPERIMENTAL EXTRAPOLATION	63

	FROM	TO	COMMENTS	ABSTRACT
UC	FREE ENERGY OF FORMATION			
	2155K	2455K	EXPERIMENTAL CALCULATION FOR UC SUB X, X=0.98 TO 1.85	681
	2000K	2400K	STATISTICAL INTERACTION MODEL WAS APPLIED TO STORM'S DATA TO CALCULATE PARTIAL GIBB'S FREE ENERGY OF UC1#X. CALCULATIONS FOR U-C	70
	1273K	2273K		191
	1653K	2023K		339
	1000K	2000K	CALCULATED STD FREE ENERGY OF FORMATION TOO. FROM LITERATURE	319
	1405K	2000K	FROM PHASE EQUILIBRIA	561
		1973K		600
	1700K	1950K	CALC FROM VAP DATA	559
	1723K	1823K	CALCULATED FROM EXPTS	62
	973K	1223K	CALCULATED PARTIAL MOLAR FREE ENERGY FOR THC-UC SYST	534
	1000K	1200K	CALC	501
	1015K	1165K	EXPERIMENTAL	186
	1115K	1165K	EXPERIMENTAL	185
	1018K	1115K	REFERRED TO GRAPHITE + U(L)	583
	723K	1023K	FROM LITERATURE	29
	723K	1023K	FROM LITERATURE	26
		1023K	CALC FROM EMF DATA	165
	5K	300K	CALCULATED AS FREE ENERGY	723
	298K	298K	EST	10
			EFFECT OF C/U	261
			EXPERIMENTAL CALCULATION	493
			FROM HIGH-TEMP GALVANIC CELL	474
			DERIVES THEORETICAL EQUATION FOR FREE ENERGY AND INTERNAL ENERGY IN U-C SYSTEM	511
			ESTIMATING CALCULATIONS FOR CARBIDES OF U	318
			ESTIMATION OF STD EQUATION	693
UC	GRAIN GROWTH			
	1773K	2173K	GRAIN GROWTH FOR VARYING C CONTENT.	224
UC	HOT HARDNESS			
	1273K	1773K		596
	1253K	1693K	EXPERIMENTAL FOR U-C ALLOYS	207
	773K	1373K	EXPERIMENTAL	189
	298K	1273K	EXPERIMENTALLY STUDIED THE EFFECT OF CARBON CONTENT AND FABRICATION METHOD.	188
	298K	1273K	REVIEW & PRELIMINARY DATA	686
	298K	298K		114

	FROM	TO	COMMENTS	ABSTRACT
UC	HOT HARDNESS		COMPARED FOR HYPO AND HYPER-STOICHIOMETRIC UC (SEE ABSTRACT) MEASURED	284 476 477
UC	HEAT OF COMBUSTION		LASL WORK	123
UC	HEAT OF FORMATION			
	298K	2750K	CALCULATED	179
	298K	2500K	REVIEW	161
	2155K	2455K	EXPERIMENTAL CALCULATION FOR UC SUB X @ 298K; X=0.98-1.85	681
	1573K	1873K	MEASURED FROM THE EXCESS RESISTIVITY OBTAINED BY QUENCHING.	214
	298K	298K	ESTIMATION	427
	298K	298K		9
	298K	298K	ESTIMATION	319
	298K	298K		693
	298K	298K	CALCULATED FOR UC1.1	706
	298K	298K	FOR UC.996#.005 & UC1.032#.005 FROM HCOMBUSN.	642
	298K	298K	CALCULATED FOR UC1.1	705
	298K	298K	CALCULATED FOR UC1.1	707
	298K	298K	COMBUSTION CALORIMETRY	232
	273K		UC(1+X), EFFECT OF HSUBM OF U	555
			REVIEW OF LITERATURE	641
			REVIEW OF U-C SYSTEM	328
			FOR TERNARY AND QUATERNARY SYST WITH M, M1 AND M2	308
			EXPERIMENTAL CALCULATION	493
UC	HEAT OF SUBLIMATION			
	298K	298K	DERIVED FROM THE THERMOCHEMICAL DATA OF THE CARBIDES OF URANIUM.	216
	298K	298K	ASSESSED FROM VAPORIZATION MEASUREMENTS	168
			EXPERIMENTAL CALCULATION	626
			CALCULATED FOR U FROM UC DATA	705
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	298K	3000K	CALCULATIONAL	429
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	298K	1800K	MOLAR VALUES CALCULATED FOR UC1.9	452
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	200K	1500K	EXPERIMENTAL FOR UC1.9	453
	298K	1500K	CU BLOCK DROP CALORIMETER	521
	5K	350K	CALC	725
	10K	330K	EXPERIMENTAL CALCULATION FOR UC1.91	74
	5K	300K	EXPERIMENTAL CALCULATION FOR UC1.9	723
	298K	298K	EXPERIMENTAL CALCULATION FOR UC1.94	231
UC2	ENTROPY			
	298K	3000K	CALCULATIONAL	429
	2423K	2973K	VAPORIZATION TO U(G) + 2C(S)	513
	2623K	2973K	EXCESS CARBON	513
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	FROM	TO	COMMENTS	ABSTRACT
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	298K	2000K	ESTIMATED FOR UC1.86	428
	298K	1800K	MOLAR VALUES CALCULATED FOR UC1.9	452
	400K	1520K	EXPERIMENTAL CALCULATION FOR UC1.9	452
	5K	350K	CALC	725
	10K	350K		726
	10K	330K	EXPERIMENTAL CALCULATION FOR UC1.91	74
	5K	300K	CALCULATED FOR UC1.9	723
	298K	298K		385
	298K	298K	EXPERIMENTAL CALCULATION FOR UC1.94	231
	298K	298K	ESTIMATION	319
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	298K	298K	EXPERIMENTAL FOR UC1.86	319
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UC2	HEAT OF FORMATION			
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	298K	2750K	CALCULATED	179
	2448K	2731K	ESTIMATION	239
	298K	2500K	REVIEW	161
	298K	2500K	ESTIMATED	445
	2300K	2300K	EXPERIMENTAL CALCULATION	219
	298K	298K	ESTIMATION	319
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	298K	298K	INDIRECT EXPERIMENTAL DETER- MINATION FOR UC1.9	317
	298K	298K	REPORTED DIFFERENT LITERA- TURE VALUES.	452
	298K	298K	ESTIMATED FOR UC1.86	428
	298K	298K	ESTIMATION	427
	298K	298K	CALCULATIONAL	429
	298K	298K	CALC	444
			EXPERIMENTAL CALCULATION	493
			EXPERIMENTAL FOR UC1.86	318
UC2	HEAT OF SUBLIMATION			
	2300K	2300K	EXPERIMENTAL CALCULATION	219
			CALCULATED FOR U FROM UC2	554
UC2	HEAT OF VAPORIZATION			
	2623K	2973K	EXCESS CARBON	513
	2000K	2900K	ESTIMATED FROM VAPOR PRES	445
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	FROM	TO	COMMENTS	ABSTRACT
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	FROM	TO	COMMENTS	ABSTRACT
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	2000K	2900K	BY EFFUSION	444
	2060K	2820K	EXPERIMENTAL FOR UC1.9	219
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	2448K	2731K	EXPERIMENTAL	239
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	400K	2200K		54
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	298K	1700K	CU BLOCK DROP CALORIMETER	520
	298K	1700K	CALC	34
	523K	1673K		201
	273K	1473K		277
	273K	1423K		633
	273K	1422K	REVIEW	683
	298K	1273K		502
	298K	1000K	EXPERIMENTAL	671
	10K	450K	UNI.01	466
	5K	350K	EXP	725
	11K	320K	EXPERIMENTAL	184
	50K	298K	ADIABATIC CALORIMETRY	724
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			MATERIAL WITH O2	
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			FUNCTION OF N2 PRESSURE.	
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	298K	1473K	REVIEW	683
	298K	1273K	EXPERIMENTAL	222
	298K	1273K		712
	473K	1073K	QUART REPT 1961	354
	473K	1073K	QUART REPT 1961	353
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	4K	300K	EFFECTS OF MAGNETIC TRANS	182
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	298K	1693K		271
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		2200K	FROM CP	55
	2100K		CALCNS-2ND LAW	708
	298K	1700K	CU BLOCK DROP CALORIMETER	520
	298K	1700K	CALORIMETER	34
	273K	1473K		277
	387K	701K	EXPERIMENTAL	181
	5K	350K	CALC	725
	10K	320K	EXPERIMENTAL CALCULATION	184
		298K		327
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UN	ENTROPY			
		2200K	FROM CP	55
	2100K		CALCNS-2ND LAW	708
	5K	350K	CALC	725
	10K	320K	CALCULATED	184

	FROM	TO	COMMENTS	ABSTRACT
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UN				
	FREE ENERGY OF FORMATION			
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		1000K	COMPATIBILITY	683
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	293K	1673K	MEASURED	280
	1273K	1673K	MEASURED KNOOP AND VICKERS HARDNESS IN OPHN. FROM LITERATURE	222 691
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	323K	1273K	MEASURED	223
	298K	298K	MEASURED AS A FUNCTION OF SINTERING CONDITIONS. ALSO GAVE VALUES FOR HIGHER NITRIDES. CAST UN	227 351
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	298K		CALCULATED	520
	298K		DIRECTLY FROM ELEMENTS	262
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	298K	298K	CALCULATED	430
	298K	298K	CALC	34
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	298K		CALCD U METAL	520

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	2773K	3073K	DECOMPOSITION & MELTING	720
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	2753K			506
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SECTION II. AUTHOR AND ABSTRACT LISTING
ARRANGED ALPHABETICALLY BY FIRST AUTHOR

ABSTRACT 1

ANL-6516 (1961)

DEVELOPMENT OF CERAMIC FUEL AND HIGH ABSORBING MATERIALS

PROGRESS IS REPORTED IN STUDIES CONCERNING THE PROPERTIES OF PUC, PUC-UC SYSTEMS, FUELED GLASSES, AND POISON GLASSES. OTHER WORK IS REPORTED ON INVESTIGATIONS OF UO SUB 2, URANIUM OXIDE-LANTHANUM OXIDE SYSTEMS, URANIUM OXIDE-NEODYMIUM OXIDE SYSTEMS, URANIA-THORIA SYSTEMS, AND U-THORIUM SULFIDE SYSTEMS.

ABSTRACT 2

ANL-6868, P133 (1963)

DEVELOPMENT OF CERAMIC FUELS AND HIGH ABSORBING MATERIALS

THE DEVELOPMENT OF CERAMIC FUELS AND HIGH ABSORBING MATERIALS IS EVALUATED WITH RESPECT TO PREPARATION, PHASE STUDIES, STRUCTURE, THERMAL PROPERTIES, OXIDATION, REDUCTION AND REACTION.

ABSTRACT 3

ANL-7122 (1965)

LIQUID-METAL-COOLED REACTORS

A REVIEW IS PRESENTED OF THE OPERATIONS AND ANALYSES OF SEVERAL LIQUID-METAL-COOLED REACTORS, INCLUDING EBR-II, FARET, SEFOR, AND ZPR-3 AND -9. PHASE STUDIES AND IRRADIATION TESTING OF U-PU-ZR, U-PU-TI, U-PU FISSION, AND UC-PUC SYSTEMS ARE REPORTED. THE DISTRIBUTION COEFFICIENT OF U BETWEEN MGCL SUB 2 AND CU-MG ALLOY IS MEASURED. THE PERFORMANCE OF V-TI, SS 304, SS 316, HASTELLOY X, HASTELLOY X280, NB-ZR, NB-V, V, W, CARBON STEEL 1020, CHROMIUM STEEL 4130, SS 405, TA, V-TI-MO, AND V-CR-AL IN LIQUID-NA AND FUSED-CHLORIDE- LIQUID-METAL ENVIRONMENTS (THE LATTER CONSISTING IN AL-MG-MGCL SUB 2-KCL- NaCl) IS EVALUATED. THE WETTING OF THE SURFACES OF A VITREOUS C CRUCIBLE BY A FUSED-CHLORIDE- LIQUID-METAL SYSTEM CONSISTING OF CU-MG-MGCL SUB 2- KCL-NACL-U IS DETERMINED.

ABSTRACT 4

ANL-7299, P220

ACTINIDE CERAMIC COMPOUNDS

RESULTS OF INVESTIGATIONS ARE PRESENTED ON ANTIFERROMAGNETISM OF UP, DEFECT EQUILIBRIA OF PUO SUB 2, THERMODYNAMIC PROPERTIES OF PU CARBIDES, NEUTRON DIFFRACTION BY NPO SUB 2, AND MAGNETIC SUSCEPTIBILITIES OF ACTINIDE CARBIDES AND OXIDES.

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ABSTRACT 5

ANL-7310, P249
FAST REACTOR SAFETY

URANIUM CARBIDES-EQUATIONS OF STATE FOR, CONSTANTS FOR, LINEAR EXPANSION COEFFICIENTS FOR

ABSTRACT 6

ANL-7375, P95
MATERIALS CHEMISTRY AND THERMODYNAMICS

DEVELOPMENTS ARE REPORTED FOR STUDIES ON: THERMODYNAMICS OF URANIA; U-UD SUB 2 PHASE DIAGRAM; CONGRUENTLY VAPORIZING COMPOSITION OF UD SUB 2; FACTORS INFLUENCING THE COMPOSITIONAL (D/U) ANALYSIS OF UD SUB 2; HEAT OF FORMATION OF UD SUB 3(G); VAPORIZATION OF UP; MASS SPECTROMETRY OF RE-REO SUB 2-VAPOR AND REO SUB 2-REO SUB 3-VAPOR SYSTEMS; HIGH TEMPERATURE PU STUDIES; CHEMISTRY OF IRRADIATED CERAMIC FUEL; ELECTRON MICROPROBE STUDIES; DEMONSTRATION OF FLUIDIZED-BED PROCESS FOR PREPARATION OF (U,PU) C; REACTIVITY OF FLUIDIZED-BED CARBIDE WITH GLOVEBOX ATMOSPHERE; PRESSING AND SINTERING OF (U,PU)C IRRADIATION TEST FUEL; THERMODYNAMICS; LARGE-SCALE PREPARATION OF CARBIDES BY FLUIDIZED-BED TECHNIQUES; ENTHALPIES OF FORMATION OF THE SUB 4, CF SUB 4, PARE EARTH TRIFLUORIDES; AND URANIUM COMPOUNDS; THERMOCHEMISTRY OF PLUTONIUM COMPOUNDS; 1500 DEG C DROP CALORIMETER; ELECTRON-BEAM-HEATED CALORIMETRIC SYSTEM; AND LIQUID SODIUM COOLANT CHEMISTRY.

ABSTRACT 7

ANL-7417, P85
ELECTRONIC AND MAGNETIC STRUCTURES OF METALS AND ALLOYS

(U, PU) C AND (U,PU) SUB 2 C SUB 3 WERE TESTED WITH VARIOUS COMMERCIAL 800 DEG C FOR 1000 HRS WITH HYPER-STOICHIOMETRIC (U SUB 0.8 PU SUB 0.2)C. IRON AND NICKEL BASE ALLOYS. SIX VANADIUM BASE ALLOYS WERE ALSO TESTED AT DENSITY OF UC FROM 1200 TO 1400 DEG C WAS CORRELATED WITH EXPOSURE TIME DURING HOT PRESSING. THERMAL DIFFUSIVITIES OF UC, PUC, AND (U SUB 0.8 PU SUB 0.2) C WERE MEASURED FROM 500 TO 1500 DEG C. THE COMPARISON WAS ALSO MADE WITH THE AVAILABLE DATA IN THE LITERATURE. TO PROVIDE AN INDEPENDENT CHECK ON THE VAPORIZATION STUDIES OF PU-C, EMF MEASUREMENTS WERE MADE BETWEEN 900 AND 1200 DEG K. FROM THAT PARTIAL PRESSURES OF PU IN SESQUICARBIDE AND MONOCARBIDE WERE CALCULATED AS A FUNCTION OF TEMPERATURE. BETWEEN 900 TO 1200 DEG K, VALUES ARE GIVEN FOR THE FREE ENERGY OF FORMATION OF PU SUB 2 C SUB 3 AND PUC SUB 0.9. MAGNETIC SUSCEPTIBILITY OF PUC SUB X (X=0.779 TO 0.887) ARE ALSO REPORTED AS A FUNCTION OF TEMPERATURE.

ABSTRACT 8

ANL-7550 (1968)
RESEARCH HIGHLIGHTS , MAY 1968-DECEMBER 1968

FROM THE EXPERIMENTAL MEASUREMENTS OF THE RATES OF EFFUSION AT VARIOUS TEMPERATURES, THE VAPOR PRESSURE OF PU OVER PU SUB 2 C SUB 3 WAS CORRELATED WITH TEMPERATURE. PRELIMINARY PHASE DIAGRAM OF THE PLUTONIUM-

ABSTRACT 8 (CONT'D)

RICH PORTION OF THE PU-PUC SUB 2 SYSTEM AT HIGH TEMPERATURES IS ALSO GIVEN. EMPLOYING THE TRANSPIRATION TECHNIQUE THE CARBON ACTIVITY IS EXPRESSED AS A FUNCTION OF COMPOSITION AT TEMPERATURES OF 2255, 2355, AND 2455 DEG K. FROM THAT, THE FREE ENERGY OF FORMATION FOR UC SUB X ($X = 0.97$ TO 1.84) IS ESTIMATED AT 2255, 2355, AND 2455 DEG K FOR VARIOUS VALUES OF C/U. STANDARD ENTHALPY OF FORMATION FOR PUN AND PUC SUB 0.859 AT 298 DEG K ARE ALSO REPORTED.

ABSTRACT 9

ANL-7650 (1969)

CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS

MEASUREMENTS REGARDING VOLATILIZATION BEHAVIOR OF SOLID MIXTURES CONTAINING PU SUB 2 C SUB 3 + C, PU SUB 2 C SUB 3 + PUC SUB 2, AND PUC SUB 2 + C IN THE TEMPERATURE RANGES 1579 TO 1933 DEG K, 1933 TO 2299 DEG K, AND 1933 TO 2348 DEG K, RESPECTIVELY WERE MADE. EQUATIONS FOR THE VAPOR PRESSURES AS A FUNCTION OF TEMPERATURE WERE DERIVED. VALUES FOR STANDARD HEAT OF FORMATION AND ENTROPY OF FORMATION FOR PU SUB 2 C SUB 3 WERE CALCULATED AND COMPARED WITH THE LITERATURE VALUES. BETWEEN THE TEMPERATURE RANGE OF 2155 TO 2455 DEG K, THE ACTIVITY OF CARBON IN U-C SYSTEM WAS CORRELATED WITH THE COMPOSITION. FROM THIS, FREE ENERGIES AND HEATS OF FORMATION FOR UC AND UC SUB 2 WERE CALCULATED. STANDARD HEAT OF FORMATION FOR PUC SUB 0.878 WAS DETERMINED EXPERMENTALLY.

ABSTRACT 10

ANL-7775 (1970)

CHEMICAL ENGINEERING DIVISION

THE STANDARD FREE ENERGY OF FORMATION OF UC WAS ESTIMATED FROM THE HEAT OF FORMATION OF UC AND THE APPROPRIATE FREE ENERGY FUNCTIONS. ATTEMPTS WERE MADE TO ESTABLISH THE CONGRUENT VAPORIZING COMPOSITION OF URANIUM CARBIDE FROM 2255 TO 2455 DEG K. MEASUREMENTS WERE ALSO MADE TO STUDY EFFECT OF OXYGEN ON CARBON ACTIVITY AND TOTAL PRESSURE OF URANIUM-BEARING SPECIES IN U-C SYSTEM. FREE ENERGY OF FORMATION OF THE OXYCARBIDE WAS ESTIMATED FROM OXYGEN AND CARBON ACTIVITY VALUES. THE VAPORIZATION BEHAVIOR OF URANIUM CARBIDE CONTAINING OXYGEN AND NITROGEN AS CONTAMINANTS WAS ALSO INVESTIGATED. FROM EXPERIMENTAL WORK, STANDARD HEAT OF FORMATION OF PUC SUB 0.878 WAS CALCULATED. PRELIMINARY ESTIMATES WERE ALSO MADE FOR THE STANDARD HEATS OF FORMATION FOR PUC SUB 1.466 AND PUC SUB 1.5.

ABSTRACT 11

BMI-1857 SECT A

U-PU NITRIDE FUELS FOR LMFBR APPLICATIONS

STUDIES ARE DIRECTED TOWARD EVALUATION OF THE COMPATIBILITY OF (U SUB 0.8 PU SUB 0.2)N, UN, AND PUN WITH TYPE 316, AND 304 STAINLESS STEELS AND THREE OTHER SELECTED VANADIUM-BASE ALLOYS. TO ASCERTAIN THE INFLUENCE OF TEMPERATURE, TIME, AND GASEOUS ATMOSPHERE ON THE ABILITY OF LIQUID SODIUM TO WET NITRIDE FUELS AND CLADDING MATERIALS OF INTEREST TO LMFBR

ABSTRACT 11 (CONT'D)

APPLICATIONS, SESSILE-DROP MEASUREMENTS WERE PLANNED OVER THE TEMPERATURE RANGE OF 100 TO 700 DEG C.

ABSTRACT 12

**BMI-1868 SECT A
U-PU NITRIDE FUELS FOR LMFBR APPLICATIONS**

FROM THE EXPERIMENTAL WORK ON MIXED NITRIDES, THE THERMOCHEMICAL PROPERTIES OF PUN SUCH AS HEAT CAPACITY, ENTHALPY, FREE ENERGY, ENTROPY ETC ARE ESTIMATED IN THE TEMPERATURE RANGE OF 298 TO 2400 DEG K. VAPORIZATION BEHAVIOR OF UN, PUN, AND (U SUB 0.8 PU SUB 0.2)N IS ALSO GIVEN FOR THE TEMPERATURE RANGE OF 1400 TO 2400 DEG K. TYPE 304 STAINLESS STEEL WAS FOUND TO BE COMPATIBLE WITH MIXED NITRIDES, LOW DENSITY (U SUB 0.8 PU SUB 0.2)N, AND SESQUINITRIDES FOR 10,000 HR AT 700 DEG C AND FOR 1000 HR AT 1000 DEG C. TYPE 316 STAINLESS STEEL CLADDINGS NITRIDED DURING HEAT TREATMENTS WITH HYPERSTOICHIOMETRIC UN FUELS AT 700 AND 800 DEG C. THE CHANGES IN THE WETTING CHARACTERISTICS OF LIQUID SODIUM ON TYPE 304L STAINLESS STEEL, UN, AND (U,PU)N WERE DETERMINED AS A FUNCTION OF TEMPERATURE BY USE OF A SESSILE-DROP TECHNIQUE IN HELIUM ATMOSPHERE.

ABSTRACT 13

**GU-5279
FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM**

THE FOUR SODIUM-BONDED FUEL RODS IRRADIATED AT 25 KW/FT IN A THERMAL REACTOR TO 16.1×10^{20} FISS/CM²³ (46.100 MWD/T) WERE EXAMINED METALLOGRAPHICALLY AT LASL. NO FUEL-CLAD REACTION WAS OBSERVED BETWEEN TYPE 316 SS AND INCOLOY-800 CONTAINING HIGH DENSITY SINGLE PHASE FUEL. DARK ETCHING ZONES WERE OBSERVED ON THE CLAD ID OF TYPE 316 AND INCOLOY-800 TO DEPTHS OF 0.006 IN. AND 0.009 IN., RESPECTIVELY, CONTAINING HIGH DENSITY, TWO-PHASE FUEL. THE EXAMINATION OF THE HELIUM AND SODIUM-BONDED MIXED CARBIDES IRRADIATED FOR SHORT PERIODS OF TIME AT 45 KW/FT CONFIRMED THEIR GOOD PERFORMANCE. THE RESULTS OF THE HELIUM-BONDED EXPERIMENTS INDICATE THAT ONE COULD DESIGN A FUEL ROD CONTAINING MIXED CARBIDES WITH A LARGE ANNULAR HELIUM GAP WITHOUT HEAT TRANSFER PROBLEMS. THE SODIUM-BONDED EXPERIMENTS INDICATE THAT AT VERY HIGH HEAT FLUX AND LINEAR POWER, VOIDS IN SODIUM BONDS ARE NOT AS CRITICAL AS HAD BEEN PREVIOUSLY THOUGHT AND THAT A FUEL ROD CAN SURVIVE A COMPLETE LOSS OF SODIUM BOND WITHOUT FAILURE FOR A SUFFICIENTLY LONG TIME TO PERMIT REACTOR SHUTDOWN.

ABSTRACT 14

**IDO-17037 (1964)
ANNUAL PROGRAM REPORT ON REACTOR FUELS AND MATERIALS DEVELOPMENT FOR FY 1964**

EXPERIMENTS WERE CONDUCTED TO STUDY REACTION OF ALUMINIUM WITH UC AND UN. FROM THE RESULTS, IT WAS EVIDENT THAT THE UC AND UN FUEL PARTICLES IN AL MATRIX WERE COMPLETELY REACTED IN AS-FABRICATED CONDITIONS.

ABSTRACT 15

100-17154 (1965)

ANNUAL REPORT ON REACTOR FUELS AND MATERIALS DEVELOPMENT FOR FY 1965.

MEASUREMENTS WERE MADE OF PERCENTAGE CHANGE IN VOLUME OF UN FUEL CORES WHEN IRRADIATED TO VARIOUS EXPOSURES AND COMPATIBILITY OF UC AND UN FUELS WITH ALUMINIUM AT 590 DEG C.

ABSTRACT 16

LA-3370 (1965)

QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING JULY 31 1965 (1965)

PROGRESS ON CONSTRUCTION OF THE FAST REACTOR CORE TEST FACILITY IS REPORTED. DESCRIPTIONS ARE INCLUDED CONCERNING CONSTRUCTION OF THE BUILDING AND ASSOCIATED SERVICES, INSTALLATION OF A 20-MW NA COOLANT SYSTEM, INSTALLATION OF A CONTROL ROOM, AND CONSTRUCTION OF THE REACTOR. INFORMATION IS ALSO INCLUDED ON DESIGN OF A MOLTEN PU BURN-UP EXPERIMENT AND FUEL TESTING IN THE OMEGA WEST REACTOR. DATA ARE INCLUDED FROM ACCELERATED FUEL CORROSION TESTS, MASS TRANSFER OF TA IN MOLTEN FUEL ALLOYS, AND PREPARATION OF UCL SUB 3-KCL-NACL FOR BLANKET STUDIES. EFFORTS DEVOTED TO RESEARCH ON NA PURITY, VENTING FISSION GASES IN NA COOLANT, AND NA-FUEL EQUILIBRIA ARE DISCUSSED. RESEARCH IS SUMMARIZED ON PROPERTIES OF PU CARBIDES, U SUB 2 C SUB 3 -PU SUB 2 C SUB 3 SYSTEMS, PU NITRIDES, AND PU-SC ALLOYS. PROGRESS ON CONSTRUCTION AND COMPONENT TESTING IN THE UHTREX PROGRAMME IS SUMMARIZED, ALONG WITH RESEARCH ON PLASMA THERMOCOUPLES AND HEAT PIPES.

ABSTRACT 17

LA-3431-MS P44 (1965)

PU-U NITRIDE SOLID SOLUTIONS

SOLID SOLUTIONS OF UN AND PUN WERE PREPARED AND LATTICE CONSTANTS WERE MEASURED. THERMAL CONDUCTIVITY OF (UO₈PUO₂)C WAS MEASURED IN THE TEMPERATURE RANGE OF 300 TO 660 DEG C. THE RESULTS OF PRESSING AND SINTERING OF PUN POWDER IN DRY NITROGEN ARE ALSO GIVEN. THE SOLUBILITY OF NB IN LIQUID PLUTONIUM WAS MEASURED IN THE TEMPERATURE RANGE OF 700 DEG C TO 1000 DEG C.

ABSTRACT 18

LA-3607-MS (1966)

QUARTERLY STATUS REPORT ON THE ADVANCED FUEL PROGRAM

RESULTS OF INVESTIGATIONS CONCERNED WITH THE INTERACTIONS OF PU-BASED FUELS WITH NA, THE RELEASE AND DISTRIBUTION OF FISSION PRODUCTS FROM IRRADIATED FUEL TO NA, AND METHODS OF ALTERING THE FISSION-PRODUCT DISTRIBUTION ARE REPORTED. DATA ON THE SOLUBILITY OF O SUB 2 IN NA AT 124 TO 300 DEG C ARE TABULATED. ACTIVITIES IN A STUDY TO DEFINE AND MEASURE PARAMETERS FOR COLD TRAP DESIGN WERE DEVOTED TO DESIGN OF A NA TEST LOOP. SYNTHESIS AND FABRICATION DATA AND INFORMATION ON PUO SUB 2, PU CARBIDES, AND PU NITRIDES ARE INCLUDED. RESULTS OF PHASE STUDIES OF PU-C, AND U-PU-C SYSTEMS USING DIFFERENTIAL THERMAL ANALYSES ARE PRESENTED. STUDIES

ABSTRACT 18 (CONT'D)

OF SELF-IRRADIATION DAMAGE IN PU CERAMICS REVEAL THAT THE LATTICE PARAMETERS OF NORMAL ISOTOPIC COMPOSITION PU CERAMICS INCREASE AT A STEADY RATE. A PRELIMINARY DETERMINATION OF THE CRYSTALLOGRAPHIC ATOMIC POSITION FOR PU SUB 2 C SUB 3 USING NEUTRON DIFFRACTION WAS COMPLETED. PROGRESS IS REPORTED ON THE USE OF EMF CELLS AND VAPORIZATION STUDIES TO DETERMINE THERMODYNAMIC PROPERTIES OF CERAMIC FUELS. TECHNIQUES USING HIGH-TEMPERATURE CALORIMETRY AND THERMAL CONDUCTIVITY ARE DESCRIBED FOR DETERMINATION OF THE THERMODYNAMIC PROPERTIES OF PU CERAMIC FUELS. PLANS FOR TESTING THE COMPATABILITY OF PUC-UC, AND PUN-UN FUELS WITH CANDIDATE CLADDING MATERIALS ARE OUTLINED. COMPUTER PROGRAMS ARE BEING DEVELOPED FOR APPLICATION TO REACTOR KINETICS PROBLEMS, AND A BURNUP PROGRAM, DTFBUR, TO SURVEY LIFE HISTORIES OF PU-FUELED FAST REACTORS WAS COMPLETED. PROGRESS IS REPORTED IN DEVELOPMENT OF EVALUATION METHODS FOR NEUTRON CROSS SECTIONS USED IN REACTOR CALCULATIONS. DESIGN WORK ON A HIGHTEMPERATURE RESIDUAL GAS ANALYZER FOR NA SYSTEM COVER GAS IS REPORTED.

ABSTRACT 19

LA-3646

THE USE OF (U,PU)N FUEL WITH A SODIUM BOND: A SUMMARY OF EXISTING DATA

THE PERTINENT LITERATURE IS REVIEWED FOR AN EXPERIMENTAL STUDY OF THE NUCLEAR FUEL (URANIUM, PLUTONIUM) MONONITRIDE BONDED WITH SODIUM TO A SUITABLE CLAD. SECTIONS ON THE FUEL'S PHYSICAL PROPERTIES, MECHANICAL PROPERTIES, COMPATIBILITY, AND RESISTANCE TO REACTOR RADIATION ARE FOLLOWED BY A DISCUSSION ON OUTSTANDING PROBLEMS THAT STILL EXIST.

ABSTRACT 20

LA-3686-MS (1967)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM

DEVELOPMENTS ARE REPORTED FOR STUDIES ON: RELEASE, DISTRIBUTION, AND REMOVAL OF FISSION PRODUCTS IN NA COOLANT SYSTEMS; MEASUREMENT OF IMPURITIES AND DEVELOPMENT OF QUALITY CONTROL TECHNIQUES FOR HIGH TEMPERATURE SODIUM COOLANT SYSTEMS; KINETICS OF NA COLD TRAPS; CERAMIC PU FUEL MATERIALS; COMPATIBILITY OF NA-BONDED (U,PU)C AND (U,PU)N FUELS WITH CLADDING MATERIALS; REACTOR NUCLEAR ANALYSIS METHODS AND CONCEPT EVALUATIONS; TESTING AND EVALUATION OF NEUTRON CROSS SECTIONS FOR REACTOR CALCULATIONS; AND ADVANCED MEASUREMENT AND ANALYSIS TECHNOLOGY.

ABSTRACT 21

LA-3745-MS (1967)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM LASL

THE EXPERIMENTAL PROGRAM IS CONCERNED WITH THE EFFECTS OF LONG-TIME CONTACT BETWEEN TRACE-IRRADIATED, PU-CONTAINING FUELS AND 500 DEG TO 700 DEG C NA. A HIGH-PURITY TERNARY ALLOY OF PU, CO, AND CE WITH A MELTING POINT NEAR 435 DEG C IS USED AS A SOURCE OF FISSION PRODUCTS FOR THE TRANSPORT AND DISTRIBUTION IN THE NA LOOP EXPERIMENT. THE RANGES OF CONTAMINATION LEVELS FOUND IN NA AND ON STAINLESS STEEL SPECIMENS FOR

ABSTRACT 21 (CONT'D)

SR-90, RU-106, SB-125, CS-137, CE-144, EU-155, AND PU-239 ARE SUMMARIZED. SODIUM-COOLANT CHEMISTRY ASSOCIATED WITH THE CONTROL OF CHEMICAL REACTIONS OCCURRING IN THE NA COOLANT IS INVESTIGATED FOR THE LMFBR PROGRAM. THE SOLUBILITY OF O₂ IN NA USING THE VACUUM-DISTILLATION ANALYTICAL TECHNIQUE HAS BEEN EVALUATED OVER THE TEMPERATURE RANGE OF 125 DEG TO 300 DEG C. THE ANALYTICAL LOOP NO. 1 HAS BEEN MODIFIED AND ANALYTICAL LOOP NO. 2 IS BEING COMPLETED. THE NA SYSTEM FOR THE COLD TRAP CHARACTERIZATION TEST HAS BEEN COMPLETED. EXPERIMENTS DETERMINED THE EFFECT OF COOLING RATE OF A PLUGGING ORIFICE ON THE INDICATED PLUGGING TEMPERATURE. PHASE EQUILIBRIA AND GENERAL PROPERTIES, SPECIFIC THERMODYNAMIC PROPERTIES, FREE ENERGY OF FORMATION IN THE 450 TO 1200 DEG C TEMPERATURE RANGE, AND HEAT CAPACITY AND HEAT OF TRANSITION ARE PROPERTIES BEING INVESTIGATED FOR PU FUEL MATERIALS. THE INTERACTIONS AMONG SINGLE-PHASE MIXED U-PUC, A NA BOND AND POTENTIAL CLADDING MATERIALS ARE STUDIED AND A LITERATURE SURVEY COMPLETED. FOUR ISOTHERMAL NA LOOPS HAVE BEEN COMPLETED. TESTING WAS CARRIED OUT AND THE O₂ ANALYSES OF NA TABULATED. A STUDY OF NITRIDE FUEL IS BEING CONDUCTED. AN APPARATUS WAS CONSTRUCTED FOR MEASURING THE PRESSURE DEVELOPED BY A NITRIDE MATERIAL OR FUEL PELLET ON HEATING TO 900 DEG C. A SYSTEM FOR LOADING CERAMIC FUEL PELLETS AND NA INTO TEST CAPSULES IS COMPLETE AND TESTING IS IN PROGRESS. WORK ON NUMERICAL METHODS FOR THE TREATMENT OF NEUTRON AND Y-RAY TRANSPORT PROBLEMS HAS INCLUDED IMPROVEMENTS IN CODES FOR INPUT-OUTPUT DATA PREPARATION, COMPLETION OF A CODE IN WHICH THE METHOD OF CONTINUOUS ANALYTIC CONTINUATION IS APPLIED TO REACTOR KINETIC PROBLEMS, A COMPARISON OF EXPERIMENTAL AND CALCULATED DATA FOR FISSION PRODUCT DECAY IN ²³⁹PU FAST FISSION FOR APPLICATION TO HEAT DEPOSITION IN FAST REACTOR SHIELDS, THE PREPARATION OF A TRANSPORT THEORY BURNUP PROGRAM, AND STUDIES OF COMPUTER PROGRAMS FOR MULTIMODE REACTOR KINETICS AND SPACE-TIME-DEPENDENT MULTIGROUP NEUTRON TRANSPORT. WORK HAS PROCEEDED ON THE MEASUREMENT OF GASEOUS DIFFUSION RATES IN METALS, THE CORRELATION OF NONDESTRUCTIVE TEST WITH LIQUID METAL COOLANT LEAKS, AND Y-RAY SCANNING TECHNIQUES.

ABSTRACT 22

LA-3820 (1967)

QUARTERLY STATUS REPORT ON THE ADVANCED PLUTONIUM FUELS PROGRAM JULY 1-SEPTEMBER 30, 1967

THE RELEASE AND DISTRIBUTION OF FUEL AND FISSION PRODUCTS IN SODIUM SYSTEMS WERE STUDIED USING BOTH SEALED CAPSULES AND FORCED-CONNECTION SODIUM LOOPS. THE SOLUBILITY OF OXYGEN IN SODIUM USING THE VACUUM-DISTILLATION ANALYTICAL TECHNIQUE WAS DETERMINED OVER THE TEMPERATURE RANGE OF 125 TO 300 DEG C. EXPERIMENTAL FACILITIES TO BE USED IN THE DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE MEASUREMENT OF IMPURITIES IN SODIUM AND A SODIUM LOOP TO STUDY THE PERFORMANCE CHARACTERISTICS OF DIFFERENT DESIGNS OF COLD TRAPS WERE CONSTRUCTED. SEVERAL TESTS WERE CONDUCTED TO DETERMINE THE RATES OF CHANGE OF OXYGEN CONCENTRATION IN THE SODIUM LOOP FOLLOWING RAPID CHANGES IN THE COLD-TRAP TEMPERATURE. STUDIES WERE CONTINUED ON THE SYNTHESIS, FABRICATION, AND DETERMINATION OF HIGH TEMPERATURE PROPERTIES OF PLUTONIUM AND URANIUM CARBIDE AND OXIDE FUEL MATERIALS. RESULTS IN THE PROGRAM TO DETERMINE THE INTERACTIONS OF (U,PU)C AND (U,PU)N FUELS WITH SODIUM AND POTENTIAL CLADDING MATERIALS IN ORDER TO ACHIEVE A SATISFACTORY SODIUM-BONDED FUEL ELEMENT ARE PRESENTED. PROGRESS IS REPORTED ON THE NUCLEAR ANALYSIS AND

ABSTRACT 22 (CONT'D)

EVALUATION OF VARIOUS FAST BREEDER CONCEPTS AND PROPOSALS AND ON THE DEVELOPMENT OF EVALUATED CROSS-SECTION DATA AND PROCESSING CODES. THE DEVELOPMENT OF EQUIPMENT AND METHODS TO BE USED IN THE EXAMINATION AND COMPARISON OF NEUTRON

ABSTRACT 23

LA-3880-MS (1967)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

SODIUM:FISSION PRODUCT DISTRIBUTION IN, FROM PLUTONIUM CARBIDE-URANIUM CARBIDE FUEL; ANALYSIS FOR IMPURITIES, DEVELOPMENT OF TECHNIQUES FOR; QUALITY CONTROL IN, PERFORMANCE OF COLD TRAPS FOR; CORROSIVE EFFECTS ON FUEL CLADDING MATERIALS AT 650 DEG C. OXYGEN:SOLUBILITY IN SODIUM AT 125 TO 300 DEG C; REMOVAL FROM SODIUM, PERFORMANCE OF COLD TRAPS FOR; DETERMINATION IN GERMANIUM BY HELIUM-3 ACTIVATION TECHNIQUE. REACTOR FUELS:PREPARATION OF CERAMIC PLUTONIUM; PROPERTIES OF CERAMIC PLUTONIUM, DETERMINATION OF HIGH TEMPERATURE; COMPATIBILITY OF SODIUM-BONDED CARBIDE AND NITRIDE, WITH CLADDING MATERIALS; RADIATION EFFECTS ON FAST, DETERMINATION OF NEUTRON. PLUTONIUM CARBIDES:PUC-UC, PREPARATION BY HYDROGEN REDUCTION METHOD; PUC-UC, HIGH TEMPERATURE PROPERTIES OF; CRYSTAL STRUCTURE OF ROOM TEMPERATURE PU SUB 2 C SUB 3, NEUTRON DIFFRACTION DETERMINATION OF; PUC-UC, COMPATIBILITY OF SODIUM BONDED, WITH CLADDING MATERIALS. PLUTONIUM NITRIDES:THERMODYNAMIC PROPERTIES MEASUREMENTS ON PUN; PUN-UN, COMPATIBILITY OF SODIUM-BONDED, WITH CLADDING MATERIALS. STAINLESS STEEL:CORROSION OF TYPE 316, BY SODIUM; ANALYSIS OF CARBURIZED, FOR CARBON BY HELIUM-3 ACTIVATION TECHNIQUE. PLUTONIUM OXIDES:PUO SUB 2, PUO SUB 2-UO SUB 2, PREPARATION AND HIGH TEMPERATURE PROPERTIES OF. REACTOR FUEL ELEMENTS:HEAT TRANSFER PROPERTIES OF SODIUM-BONDED, EFFECTS OF BOND DEFECTS ON.

ABSTRACT 24

LA-3933-MS (1968)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

RESEARCH AND DEVELOPMENT PROGRESS IS SUMMARIZED ON SODIUM TECHNOLOGY, CERAMIC PU FUEL MATERIALS, AND COMPATIBILITY OF NA BONDED PU-U ALLOYS AND PU-U NITRIDES WITH CLADDING MATERIALS. RESEARCH ON REACTOR PHYSICS IS ALSO REPORTED ALONG WITH RESULTS OF FAST REACTOR FUEL EXAMINATION, AND RESULTS OF INVESTIGATIONS DEVOTED TO ADVANCED SYSTEMS.

ABSTRACT 25

LA-3993 (1968)

ADVANCED PLUTONIUM FUELS PROGRAM

SODIUM- BONDING COMPATIBILITY OF,COMPATIBILITY OF TYPE 316 STAINLESS STEEL-CLADDING WITH PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) AND PLUTONIUM NITRIDE (PUN)-URANIUM NITRIDE (UN) USING PLUTONIUM CARBIDES-PUC-UC, FABRICATION OF PELLET-SHAPED, EFFECTS TECHNIQUES ON QUALITY, PUC-UC, THERMAL PROPERTIES OF ANALYSIS AT 1600 TO 2500 DEG C OFF MELTING BEHAVIOR OF, ANALYSIS UP TO 1660 DEG C CF; PUC-UC, COMPATIBILITY

ABSTRACT 25 (CONT'D)

OF WITH TYPE 316 STAINLESS STEEL-CLADDING OF SODIUM BONDED, EVALUATION OF; PUC-UC, RADIATION EFFECTS ON EBR-2 DRIVER FUEL ELEMENTS, ANALYSIS OF NEUTRON PLUTONIUM NITRIDES, URANIUM NITRIDES-PUN-UN, COMPATIBILITY WITH TYPE 316 STAINLESS STEEL-CLADDING OF SODIUM BONDED, EVALUATION OF STAINLESS STEEL-CLADDING OF TYPE 316, COMPATIBILITY WITH PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) AND PLUTONIUM NITRIDE(PUN)- URANIUM NITRIDE (UN) OF SODIUM BONDED REACTOR FUEL ELEMENTS-RADIATION EFFECTS ON EBR-2 PLUTONIUM CARBIDE (PUC)- URANIUM CARBIDE (UC), ANALYSIS OF NEUTRON NEUTRONS-EFFECTS ON PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) EBR-2 FUEL ELEMENTS, ANALYSIS OF URANIUM CARBIDES-PUC-UC, RADIATION EFFECTS ON EBR-2 DRIVER FUEL ELEMENTS, ANALYSIS OF NEUTRON

ABSTRACT 26

LA-4073-MS (1968)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM , LASL

TRANSITION TEMPERATURES IN (U,PU) C SUB 2 AND PU-C SYSTEM WERE STUDIED. LITERATURE SURVEY ON VAPORIZATION BEHAVIOR OF PU-C SYSTEM WAS COMPLETED. THE LITERATURE SEARCH WAS ALSO MADE ON STABILITIES OF METAL CARBIDES FROM WHICH THE DATA FOR THE FREE ENERGY OF FORMATION FOR VARIOUS FUEL AND CLAD CARBIDES WAS COLLECTED AND EVALUATED. EXPERIMENTS WERE ALSO MADE TO STUDY THE COMPATIBILITY OF MIXED CARBIDE WITH TYPE 316 STAINLESS STEEL AND V-15 TI- 7 1/2 CR. ALLOY.

ABSTRACT 27

LA-4114-MS (1963)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM LASL

THERMAL CONDUCTIVITY OF (U,PU)C WAS MEASURED FROM 44 TO 404 DEG C. MEASUREMENTS WERE ALSO MADE TO DETERMINE COMPRESSIVE CREEP OF MIXED CARBIDES AND LATTICE PARAMETERS FOR PU-C AND PU-N SYSTEMS. VAPORIZATION BEHAVIORS OF PU-N AND PU-C SYSTEMS WERE STUDIED; FROM THIS, HEAT AND ENTROPY OF FORMATION OF PUN WERE DETERMINED. CALCULATIONS WERE ALSO PERFORMED TO OBTAIN RELATIVE THERMODYNAMIC COMPATIBILITIES OF FUEL CARBIDE WITH TYPE 316 STAINLESS STEEL, VANADIUM, CHROMIUM , AND IRON.

ABSTRACT 28

LA-4193-MS (1969)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

THERMAL CONDURTIVITY OF (U,PU) C WAS MEASURED FROM 118 TO 1001 DEG C. MEASUREMENTS WERE ALSO MADE FOR THE COMPRESSIVE CREEP OF UC AND LATTICE DIMENSIONS OF PU-C SYSTEM. PHASE DIAGRAM OF U-PU-C WAS ALSO STUDIED. FROM THE VAPORIZATION STUDY, STANDARD HEAT AND ENTROPY OF FORMATION FOR PUC SUB 0.87 AND PUC SUB 1.5 WERE DETERMINED. CALCULATIONS WERE ALSO MADE OF THE THERMODYNAMIC EQUILIBRIUM CONSANTS FOR REACTION OF FUEL CARBIDE WITH SODIUM OXIDE AND RESULTANT TRANSFER OF CARBON FROM FUEL TO CHROMIUM. ATTEMPTS WERE ALSO MADE TO STUDY COMPATIBILITY OF UC SUB 1.04 WITH TYPE 316 L STAINLESS STEEL.

ABSTRACT 29

LA-4284-MS (1969)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

THERMAL CONDUCTIVITY OF MIXED CARBIDE SAMPLES OF VARYING DENSITY WAS MEASURED FROM 44 TO 1016 DEG C. MEASUREMENTS WERE MADE OF COMPRESSIVE CREEP FOR UC, UC SUB 2 AND MIXED CARBIDES. EFFECT OF PRESSING PRESSURE AND SINTERING CONDITIONS ON (U,PU) C PELLETS WAS ALSO STUDIED. PHASE DIAGRAM AND MELTING BEHAVIOR OF U-PU-C SYSTEM WAS STUDIED. LATTICE DIMENSIONS OF PU-C AND PU-N SYSTEMS WERE DETERMINED. ATTEMPTS WERE STARTED TO STUDY VAPORIZATION BEHAVIOR OF PU-N AND PU-C. WORK WAS DONE TO EVALUATE COMPATIBILITY OF U-PU-C WITH TYPE 316 STAINLESS STEEL AND V-15 TI- 7 1/2 CR ALLOY. FROM THE LITERATURE, VALUES FOR THE FREE ENERGY OF FORMATION FOR FUEL CARBIDES AND POTENTIAL CLAD CARBIDES WERE COLLECTED AND EVALUATED.

ABSTRACT 30

LA-4307-MS (1969)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

PHASE DIAGRAM AND MELTING BEHAVIOR OF PU-C AND U-PU-C SYSTEMS WERE STUDIED. FROM THE STUDY OF VAPORIZATION BEHAVIOR OF PU-C SYSTEM, STANDARD HEAT OF FORMATION OF PUC SUB 1.5 AND PUC SUB 0.87 WERE DETERMINED. MEASUREMENTS WERE MADE OF HOT HARDNESS OF MIXED CARBIDE. COMPATIBILITY STUDIES WERE MADE FOR SODIUM-BONDED, SINGLE PHASE MIXED CARBIDE WITH TYPE 316 STAINLESS STEEL AND V-15 CR-5 TI ALLOY AT 750 DEG C FOR 4000 HRS. ALSO, THE REACTION OF SODIUM-BONDED UC SUB 1.07 AND UC SUB 1.43 WITH TYPE 316 STAINLESS STEEL WAS STUDIED.

ABSTRACT 31

LA-4376-MS (1969)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM

CONTINUING WORK ON THE CHARACTERIZATION OF PLUTONIUM FUEL MATERIALS IS DISCUSSED. PROGRESS IN HIGH TEMPERATURE X-RAY DIFFRACTION AND DTA STUDIES OF U-PU-C PHASE RELATIONSHIPS, AND THERMODYNAMIC PROPERTIES OF PLUTONIUM COMPOUNDS BY ELECTROMOTIVE FORCE TECHNIQUES IS REPORTED.

ABSTRACT 32

LA-4494-MS (1970)

QUARTERLY STATUS REPORT ON THE ADVANCED FUELS PROGRAM, LASL

PHASE DIAGRAM AND MELTING BEHAVIOR OF PU-C AND U-PU-C SYSTEMS WERE STUDIED. ELECTROCHEMICAL MEASUREMENTS WERE MADE TO DETERMINE FREE ENERGY OF FORMATION OF PU-N AND PU-C SYSTEMS. VAPORIZATION BEHAVIOR OF PU-C SYSTEM WAS STUDIED FROM 1450 TO 2170 DEG K. ENTHALPHY, ENTROPY AND SPECIFIC HEAT OF PUC SUB 1.5 WERE ESTIMATED FROM 298 TO 2200 DEG K. STANDARD HEAT AND ENTROPY OF FORMATION FOR VARIOUS PU CARBIDES WERE ESTIMATED. THERMAL CONDUCTIVITY OF A SAMPLE CONTAINING U,PU,C,N, AND O WAS MEASURED FROM 119 TO 835 DEG C. ELECTRICAL RESISTIVITIES OF MIXED CARBIDE SAMPLE WERE MEASURED FROM 2.3 TO 970 DEG C. HOT HARDNESS, COMPRESSIVE CREEP AND ELASTIC CONSTANTS FOR VARIOUS FUELS WERE

ABSTRACT 32 (CONT'D)

DETERMINED. COMPATIBILITY STUDIES OF U-PU-C IN TYPE 316 STAINLESS STEEL AND VANADIUM ALLOY CONTAINERS AT 750 DEG C FOR 1000 TO 8000 HRS WERE CONDUCTED.

ABSTRACT 33

LAMS-2815 (1962)

QUARTERLY STATUS REPORT ON LMPRE PROGRAM FOR PERIOD ENDING NOV. 20, 1962

THE OPERATION OF LAMPRE I IS SUMMARIZED. THE RESULTS OF THE EXAMINATION OF A DEFECTIVE FUEL CAPSULE AND THE NA COOLANT ARE GIVEN. THE STATUS OF THE CORE CALCULATION PROGRAM FOR THE TRANSPORT-THEORY DESCRIPTION OF CORE CHARACTERISTICS IS DESCRIBED. THE PREPARATION OF PU-CO-CE ALLOYS IS REPORTED. THE REACTIONS OF MOLTEN CO-CE ALLOYS WITH TA ARE STUDIED. INTERGRANULAR ATTACK WAS OBSERVED IN THE EXPOSURE OF TAC, NBC, AND ZRC CRUCIBLES TO U-MN ALLOY AT 1100 DEG C. DATA ARE GIVEN ON THE ZETA PHASE, MONOCARBIDE, AND SESQUICARBIDE IN THE PU-C PHASE DIAGRAMS, AND ON THE OTHER PU SYSTEMS: PU-C-N, PU-C-O, PU-IN, PU-N, AND PU-RARE EARTH. THE STATUS OF THE CORE TEST FACILITY (PHASE A AND B) IS OUTLINED.

ABSTRACT 34

ORNL-4770 (1971)

METALS AND CERAMICS DIVISION, ANNUAL PROGRESS REPORT

COMPILED THE AVAILABLE DATA ON COMPATIBILITY EXPERIMENTS TO DETERMINE WHETHER COMPATIBILITY PROBLEMS EXIST BETWEEN THE NITRIDES AND CANDIDATE CLADDINGS. EXPERIMENTALLY DETERMINED THE HIGH TEMPERATURE ENTHALPY OF UN FROM 298 TO 1700 DEG K BY A COPPER BLOCK DROP CALORIMETER. COMBINING THIS WITH THE AVAILABLE LITERATURE, A TABLE OF THERMODYNAMIC FUNCTIONS FOR UN IS CONSTRUCTED. THE PROPERTIES DEALT WITH ARE HEAT CAPACITY, HEAT OF FORMATION AND HEAT OF VAPORIZATION.

ABSTRACT 35

REACTOR MATER 10, 203 (1967-68)

FUEL AND FERTILE MATERIALS

UNALLOYED URANIUM AND ALPHA- AND GAMMA-PHASE URANIUM ALLOYS ARE DISCUSSED. PLUTONIUM AND THORIUM DEVELOPMENT AS NUCLEAR FUELS IS SUMMARIZED. THE PROPERTIES AND BEHAVIOR OF DISPERSIONS, URANIUM AND THORIUM OXIDES, AND CARBIDE AND NITRIDE FUELS ARE REVIEWED. THE OXIDATION OF URANIUM DIOXIDE BY STEAM AND IRRADIATION EFFECTS IN FUEL MATERIALS ARE OUTLINED. A LISTING OF 66 REFERENCES IS INCLUDED.

ABSTRACT 36

REACTOR MATER 11, 81 (1968)
FUEL AND FERTILE MATERIALS

MECHANICAL PROPERTIES AND PHASE STUDIES ARE PRESENTED FOR UNALLOYED URANIUM α -PHASE URANIUM ALLOYS, ϵ -PHASE URANIUM ALLOYS, AND γ -PHASE URANIUM ALLOYS. PHASE STUDIES FOR THE PU-U-ZR SYSTEM ARE PRESENTED. TERNARY PHASE DIAGRAM STUDIES FOR THE O-PU-U SYSTEM ARE PRESENTED. IRRADIATION EFFECTS ON ZIRCALOY-2 CLAD TH-U-ZR FUEL ELEMENTS ARE DESCRIBED. THERMAL AND MECHANICAL PROPERTIES OF CERAMIC FUELS ARE PRESENTED. MECHANICAL AND THERMAL PROPERTIES AS WELL AS FABRICATION TECHNIQUES FOR URANIUM AND THORIUM OXIDES AND URANIUM CARBIDES, NITRIDES, PHOSPHIDES, AND SULFIDES ARE DESCRIBED. THE STEAM OXIDATION REACTIONS OF UO₂ SUB 2 ARE DESCRIBED. IRRADIATION EFFECTS ON MECHANICAL AND THERMAL PROPERTIES OF METALS AND CERAMICS ARE PRESENTED. 61 REFERENCES ARE INCLUDED.

ABSTRACT 37

REACTOR MATER 11, 145 (1968)
FUEL AND FERTILE MATERIALS

THE DIFFUSION OF U IN TI AND FE IS DESCRIBED. CREEP-RUPTURE MECHANISMS OF U ARE ANALYZED. PHASE DIAGRAMS FOR RU-U, RH-U, AND IR-U ARE PRESENTED. MECHANICAL AND PHYSICAL PROPERTIES OF HIGH-PURITY CAST U ARE LISTED. TENSILE PROPERTIES OF MO-U ARE PRESENTED. THE SOLUBILITY OF PU IN FE IS ANALYZED. THE THERMAL DIFFUSIVITIES OF UC, PUC-UC, AND PUC FROM 500 TO 1500 DEG ARE LISTED. THE THERMAL CONDUCTIVITIES OF VARYING STOICHIOMETRY UO₂ SUB 2 AND PUO₂ SUB 2- UO₂ SUB 2 ARE PRESENTED. LATTICE DIFFUSION COEFFICIENTS OF PU IN SINTERED THO₂ SUB 2 AND THO₂ SUB 2-UO₂ SUB 2 ARE DESCRIBED. THE GENERAL PHASE DIAGRAMS FOR C-N-U SYSTEMS AT 1500 TO 1800 DEG C AND N- TH-U SYSTEMS AT 1000 DEG C ARE PRESENTED. 66 REFERENCES ARE INCLUDED.

ABSTRACT 38

REACTOR MATER 14, 35 (1964)
FUEL AND FERTILE MATERIALS

RESEARCH ON UNALLOYED URANIUM, ALPHA-PHASE URANIUM ALLOYS, GAMMA-PHASE URANIUM ALLOYS, PLUTONIUM, PLUTONIUM COMPOUNDS, THORIUM, DISPERSION FUELS, CERMET FUELS, COATED-PARTICLE FUEL MATERIALS, URANIUM OXIDES, URANIUM CARBIDES, URANIUM NITRIDES, URANIUM-SULFIDES, FUEL-WATER REACTIONS, AND IRRADIATION EFFECTS IN FUEL MATERIALS IS REVIEWED.

ABSTRACT 39

REACTOR MATER 7, 149 (1964)
FUEL AND FERTILE MATERIALS

RESEARCH AND DEVELOPMENT PROGRESS ON URANIUM, URANIUM ALLOYS, URANIUM DIOXIDE, URANIUM CARBIDES, URANIUM(IV-VI) OXIDES, URANIUM COMPOUNDS, PLUTONIUM, PLUTONIUM ALLOYS, PLUTONIUM COMPOUNDS, PLUTONIUM DIOXIDE, PLUTONIUM CARBIDES, THORIUM, THORIUM ALLOYS, THORIUM CARBIDES, DISPERSION FUELS, CERMET FUELS, COATED-PARTICLE FUEL MATERIAL, REFRACTORY FUEL,

ABSTRACT 39 (CONT'D)

COATINGS, RADIATION EFFECTS ON FUEL MATERIALS, CORROSION MECHANISMS, AND FERTILE MATERIALS IS REVIEWED.

ABSTRACT 40

REACTOR MATER 7, 81 (1964)
FUEL AND FERTILE MATERIALS

RESEARCH AND DEVELOPMENT PROGRESS ON URANIUM, URANIUM ALLOYS, URANIUM DIOXIDE, URANIUM CARBIDES, URANIUM NITRIDES, URANIUM SYSTEMS, PLUTONIUM, PLUTONIUM DIOXIDE, PLUTONIUM ALLOYS, PLUTONIUM SYSTEMS, THORIUM, THORIUM ALLOYS, PLUTONIUM CARBIDES, PLUTONIUM NITRIDES, DISPERSION FUELS, CERMET FUELS, COATED-PARTICLE FUEL MATERIALS, REFRACTORY FUELS, COATINGS, RADIATION EFFECTS ON FUEL MATERIALS, CORROSION MECHANISMS, AND FERTILE MATERIALS IS REVIEWED.

ABSTRACT 41

REACTOR MATER 7,211 (1964-65)
FUEL AND FERTILE MATERIALS

RESEARCH PROGRESS IS REPORTED ON URANIUM METAL AND ALLOYS, PLUTONIUM, THORIUM METAL-CERAMIC FUELS, COATED-PARTICLE FUEL MATERIALS, URANIUM OXIDES, URANIUM AND THORIUM CARBIDES, URANIUM AND THORIUM NITRIDES, URANIUM AND THORIUM SULFIDES, FUEL-WATER REACTIONS, AND BASIC STUDIES OF IRRADIATION EFFECTS IN FUEL MATERIALS.

ABSTRACT 42

REACTOR MATER 8,57 (1965)
FUEL AND FERTILE MATERIALS.

RECENT RESEARCH DEVELOPMENTS ARE REVIEWED FOR URANIUM AND ITS ALLOYS, PLUTONIUM AND ITS ALLOYS, THORIUM AND ITS ALLOYS, METAL-CERAMIC FUELS, COATED-PARTICLE FUEL MATERIALS, URANIUM OXIDES, URANIUM AND THORIUM CARBIDES, URANIUM AND THORIUM NITRIDES, URANIUM CORROSION, AND RADIATION EFFECTS ON URANIUM AND URANIUM CARBIDE.

ABSTRACT 43

UCRL-50004-67-1 (1967)
ADVANCED SPACE NUCLEAR POWER PROGRAM PROG REP # 6 JAN MARCH 1967

REPORTS STATUS OF WORK ON N SUB 2 DIFFUSION IN UN. ANNEALING TEMPERATURES UP TO 1970 DEG C HAVE BEEN OBTAINED. D SUB N SUB 2 = 9.8×10^{-11} CM**2/SEC.

ABSTRACT 44

UNC-5033 (1962)
FUEL CYCLE DEVELOPMENT PROGRAM

THE PROGRESS IN DEVELOPING LOW COST URANIUM OXIDE AND CARBIDE FUELS BY LOWERING THE COST OF FABRICATION PROCESSES IS REPORTED. THREE FULL SCALE FUEL RODS CONTAINING URANIUM DIOXIDE PELLETS SINTERED BY THE LOW TEMPERATURE PROCESS WERE FABRICATED AND FORWARDED TO THE VBWR FOR IRRADIATION. THE 5% ENRICHED PELLETS WERE OBTAINED BY SINTERING AT 1150 DEG C IN NITROGEN TO PRODUCE DENSITIES OF 95 TO 96% OF THEORETICAL. FINAL MEASUREMENTS OF THERMAL EXPANSION OF TRIPLICATE SPECIMENS REPRESENTING 4.4 WT. % CARBON SINTERED URANIUM CARBIDE AND 4.8 WT. % CARBON CAST URANIUM CARBIDE WERE MADE. THE AVERAGE COEFFICIENTS OF LINEAR THERMAL EXPANSION OVER THE RANGE FROM ROOM TEMPERATURE TO 1000 DEG C WERE 11.8×10^{-6} AND 11.0×10^{-6} /DEG C, RESPECTIVELY. AVERAGE COEFFICIENTS FOR SINGLE SPECIMENS REPRESENTING 4.8 WT. % CARBON SINTERED MATERIAL AND 5.2 WT. % CARBON CAST URANIUM CARBIDE WERE FOUND TO BE 10.9×10^{-6} AND 11.5×10^{-6} /DEG C, RESPECTIVELY.

ABSTRACT 45

UNC-5217 (1968)
FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM

THE STATUS OF THE UC-PUC PELLET ROD IRRADIATIONS IN EBR-II IS SUMMARIZED. MIXED-CARBIDE ANNULAR PELLET IRRADIATION CAPSULE ASSEMBLIES ARE DESCRIBED, AND THE SPECIMENS PREPARED FOR FISSION GAS RELEASE TESTING ARE TABULATED. SODIUM-BONDED CARBIDE FUEL IRRADIATION CAPSULE DESIGN IS SHOWN. HIGH-DENSITY UC, UC-PUC, AND UO SUB 2 PUC SUB 2 SPECIMENS WERE FABRICATED, AND THE KINETIC AND THERMODYNAMIC COMPATIBILITY OF MIXED-CARBIDE FUEL WITH STAINLESS STEEL-CLADDING WAS EVALUATED.

ABSTRACT 46

USEM-U-1109 (1964)
INVESTIGATION OF THE SYSTEM URANIUM CARBIDE-URANIUM NITRIDE-URANIUM OXIDE

CONSIDERABLE PROGRESS WAS MADE IN THE DEVELOPMENT OF TECHNIQUES FOR HANDLING THE PYROPHORIC POWDERS AND BODIES AND IN THE HIGH TEMPERATURE SINTERING, DECOMPOSITION PRESSURE MEASUREMENT, AND BODY EVALUATION. PRELIMINARY EXAMINATION OF COMPOSITIONS OF THE THREE BINARY SYSTEMS UC-UN, UC-UN AND UN-UO WERE CONDUCTED.

ABSTRACT 47

WCAP-3791-2 (1967)
URANIUM PLUTONIUM CARBIDE DEVELOPMENT

DEVELOPMENTS IN THE DESIGN AND CHARACTERIZATION OF A (U, PU) C FUEL ELEMENT THAT IS SUITABLE FOR APPLICATION IN A COMMERCIAL, LIQUID METAL-COOLED, FAST BREEDER REACTOR ARE REPORTED. METHODS FOR FE AND CR SUB 23 C SUB 6 STABILIZATION OF HYPOSTOICHIOMETRIC UC WERE IDENTIFIED, AND STABILIZED AND UNSTABILIZED (U,PU)C PELLETS WERE FABRICATED, CHARACTERIZED AND TESTED. A DETAILED SURVEY OF STAINLESS STEEL PROPERTIES CONCLUDED WITH THE CURRENT SELECTION OF TYPE 316 AS REFERENCE FUEL

ABSTRACT 47 (CONT'D)

CLADDING MATERIAL AND TYPE 304 AS ALTERNATE. THE COMPATIBILITY OF V ALLOYS WITH CARBIDE AND OXIDE FUELS WAS INVESTIGATED. CONCEPTUAL DESIGN OF TEST CAPSULES WAS ALSO BEGUN. A PRELIMINARY DEMONSTRATION OF FUEL ELEMENT NA BONDING BY A BOTTOM FILLING TECHNIQUE WAS COMPLETED.

ABSTRACT 48

ACCARY A

LA-TR-64-30 (1964)

SOLUBILITY OF URANIUM IN URANIUM MONOCARBIDE

THE SOLUBILITY OF URANIUM IN UC WAS FOUND TO REACH A MAXIMUM (2 AT.%) AT 1700±30 DEG C. IT IS VERY SLIGHT FOR TEMPERATURES LOWER THAN 500 DEG C AND IN THE REGION OF 2200 DEG C. NO EVIDENCE WAS FOUND FOR THE SOLUBILITY OF CARBON IN UC.

ABSTRACT 49

ACCARY A

MEETING ON NUCLEAR AND ENGINEERING CERAMICS HARWELL (1965)

HIGH TEMPERATURE MECHANICAL BEHAVIOUR AND FORMING OF URANIUM-CARBON ALLOYS AROUND UC COMPOSITION

THE HIGH TEMPERATURE MECHANICAL BEHAVIOR OF URANIUM CARBON ALLOYS AROUND THE UC COMPOSITION HAS BEEN STUDIED. MECHANICAL BEHAVIOR IS STRONGLY DEPENDENT ON TOTAL CARBON CONTENT. PLASTIC DEFORMATION OF ALLOYS AT HIGH TEMPERATURE WAS OBSERVED AND DIE FORMING, CARRIED OUT AT 2280-2300 DEG C, WAS FOUND POSSIBLE. DIE FORMING COULD ALSO BE CARRIED OUT FOR URANIUM DICARBIDE, THORIUM DICARBIDE AND (TH,UC) SUB 2 ALLOYS. X-RAY EXAMINATION OF EXTRUDED UC RODS SHOWED THE EXISTENCE OF A PREFERENTIAL TEXTURE.

ABSTRACT 50

ACCARY A

NUCLEAR FUEL ELEMENTS P257 (1959)

DEVELOPMENT OF CERAMIC FUELS IN FRANCE

THE EVOLUTION UNDER HEAT TREATMENT OF UC WAS FOLLOWED BY MEASUREMENT OF ELECTRICAL RESISTIVITY. CURVES OF ELECTRICAL CONDUCTIVITY OF UC ARE GIVEN AT 1100 DEG C FOR BEFORE AND AFTER ANNEALING CONDITIONS. CURVES ARE ALSO GIVEN FOR DILATOMETRIC CYCLE INVOLVING HEATING FROM ROOM TEMPERATURE TO 1140 DEG C AT A RATE OF 100 DEG C PER HOUR AND COOLING BACK TO ROOM TEMPERATURE AT THE SAME RATE. REPORTED THERMAL CONDUCTIVITY OF UC FROM 119 DEG C TO 236 DEG C. INITIATED THE EFFORT TO STUDY DIFFUSION OF UC WITH CLADDING MATERIALS SUCH AS GRAPHITE, SILICON CARBIDE, BE AND ZR.

ABSTRACT 51

ACHACINSKI V V

LA-TR-71-22 (1971)

HEAT OF FORMATION AND ENTROPY OF FORMATION OF PLUTONIUM CARBIDE

A CERTAIN CONNECTION HAS BEEN FOUND BETWEEN THE HEAT OF FORMATION OF CARBIDES AND THE HEAT OF EVAPORATION AND MELTING TEMPERATURE OF THE METALS WITHIN A GIVEN GROUP, WITH SIMILAR CHEMICAL PROPERTIES, WHICH FORM THESE CARBIDES. ON THE BASIS OF THIS CONNECTION, THE HEATS OF FORMATION ΔH SUB 298 DEG HAVE BEEN CALCULATED FOR PUC SUB 0.87, PU SUB 2 C SUB 3 AND PUC SUB 2. THE RESULTING VALUES WERE COMPARED WITH AVAILABLE EXPERIMENTAL DATA. THE MOST PROBABLE ENTROPY VALUES S SUB 298 DEG OF THE PLUTONIUM CARBIDES IS GIVEN.

ABSTRACT 52

ACKERMAN R J

J. PHYS. CHEM. 73, 769 (1969)

THE VAPOR PRESSURE OF LIQUID URANIUM; EFFECTS OF DISSOLVED TANTALUM, PHOSPHOROUS, SULFUR, CARBON, AND OXYGEN.

THE VAPORIZATION BEHAVIOR OF LIQUID URANIUM SATURATED WITH TANTALUM, PHOSPHORUS, SULFUR, AND CARBON HAS BEEN STUDIED BY MASS EFFUSION AND MASS SPECTROMETRIC TECHNIQUES IN THE TEMPERATURE RANGE 1800-2400 DEG K. THE RESULTS, COMBINED WITH THOSE PREVIOUSLY REPORTED FOR URANIUM SATURATED WITH OXYGEN, SHOW THAT THE ACTIVITY COEFFICIENT OF URANIUM DECREASES WITH INCREASING ELECTRONEGATIVITY OF THE DISSOLVED COMPONENT, VARYING FROM NEARLY UNITY IN THE CASE OF TANTALUM AND PHOSPHORUS TO APPROXIMATELY 0.2 FOR OXYGEN. THE VAPOR PRESSURE OF LIQUID URANIUM IS GIVEN BY THE EQUATION $\log P(\text{ATM}) = (5.71 \pm 0.17) - (25,230 \pm 370)/T$, AND THE HEAT OF SUBLIMATION, ΔH DEG SUB 298, IS 126.3 ± 1.0 KCAL/MOL. AT HIGH TEMPERATURES URANIUM MONOPHOSPHIDE AND URANIUM MONOSULFIDE ARE CONVERTED TO THE TWO-PHASE SYSTEMS $U_P(S)+U(l)$ AND $U_S(S) + U(l)$.

ABSTRACT 53

ADAMS D W

NASA-TM-X-2493 (1972)

SHOCK AND VIBRATION TESTS OF URANIUM MONONITRIDE FUEL PELLETS FOR A SPACE-POWER NUCLEAR REACTOR

SHOCK AND VIBRATION TESTS WERE CONDUCTED ON CYLINDRICALLY ROUND DEPLETED, URANIUM MONONITRIDE (UN) FUEL PELLETS. THE STRUCTURAL CAPABILITIES OF THE PELLETS WERE DETERMINED UNDER PRESSURE TO SHOCK AND VIBRATION LOADING WHICH A NUCLEAR REACTOR MAY ENCOUNTER DURING LAUNCHING INTO SPACE. VARIOUS COMBINATIONS OF DIAMETRAL AND AXIAL CLEARANCES BETWEEN THE PELLETS AND THEIR ENCLOSING STRUCTURES WERE TESTED. THE RESULTS OF THESE TESTS INDICATE THAT FOR PRESENT FABRICATION OF UN PELLETS, A DIAMETRAL CLEARANCE OF 0.254 MILLIMETER AND ON AXIAL CLEARANCE OF 1.125 MILLIMETER ARE TOLERABLE WHEN SUBJECTED TO LAUNCH-INDUCED LOADS.

ABSTRACT 54

AFFORTIT C

CEA-CNF-1146,16 (1968)

SPECIFIC HEAT OF UC, UO SUB 2 AND UN

HAS PRESENTED SPECIFIC HEATS OF UN UP TO 2200 DEG K AND OF UC UP TO 2800 DEG K.

ABSTRACT 55

AFFORTIT C

CEA-R-4266 (1972)

CONTRIBUTION TO THE STUDY OF THE SPECIFIC HEAT OF ACTINIDE COMPOUNDS

BY RAPID HEATING METHOD, DETERMINED THE SPECIFIC HEATS OF UC, U SUB 2 C SUB 3, AND UN. THERMODYNAMIC FUNCTIONS SUCH AS ENTHALPY AND ENTROPY ARE GIVEN FOR UN UP TO 2200 DEG K, FOR UC UP TO 2800 DEG K, AND FOR U SUB 2 C SUB 3 UP TO 2000 DEG K.

ABSTRACT 56

AFFORTIT C

HIGH TEMP HIGH PRESS 1, 27 (1969); RFP-TRANS-67

SPECIFIC HEAT OF UN, UC, AND UO SUB 2.

THE SPECIFIC HEAT OF SINTERED SPECIMENS OF UN, UC AND UO SUB 2 HAS BEEN MEASURED UP TO TEMPERATURES CLOSE TO THEIR MELTING POINTS. A STEEP INCREASE OF THE SPECIFIC HEAT OF UC AND UO SUB 2 WHEN APPROACHING THEIR POINTS HAS BEEN RECORDED.

ABSTRACT 57

AFFORTIT C

J NUCL MATER 34,105 (1970)

SPECIFIC HEAT OF UC AND UN

THE EQUATIONS (OBTAINED BY THE METHOD OF LEAST SQUARES) WHICH BEST REPRESENT THE EXPERIMENTAL RESULTS FOR HEAT CAPACITY OF UN AND UC ARE GIVEN (CP IN KCAL/MOLE/DEG K) UN: $CP = 10.2 + 4.2 \cdot 10^{-3} T$ (1000 DEG K < T < 2000 DEG K); UC: $CP = 11.2 + 3.45 \cdot 10^{-3} T + (4.6 \cdot 10^{-10} / T^{10}) \exp(-60000/RT)$ (800 DEG K < T < 2800 DEG K)

ABSTRACT 58

AINSLEY R

CARBIDES IN NUCLEAR ENERGY P240 (1964)

SOME ASPECTS OF THE PREPARATION OF URANIUM AND PLUTONIUM CARBIDES FROM OXIDES

RESULTS ARE PRESENTED RELATING TO THE PREPARATION OF U-C AND (UPU)-C BY THE REDUCTION OF OXIDES WITH CARBON. UNDER CERTAIN CONDITIONS THE PRESENCE OF PLUTONIUM CAN MODIFY THE MECHANISM OF THE REACTION, (UPU)O SUB 2 AND (UPU) SUB 2 C SUB 3 BEING FORMED AS INTERMEDIATES. ANOTHER FEATURE OF INTEREST IS THE TENDENCY OF A PLUTONIUM SPECIES TO VOLATILISE FROM (UPU)-C AT HIGH TEMPERATURE. AN UPPER LIMIT FOR THE VAPOR PRESSURE IS GIVEN BY $\log P \text{ (ATM)} = 5.47 - (23,000)/T \text{ DEG K}$

ABSTRACT 59

AKIMOTO Y

COMPATIBILITY OF CARBIDE FUELS WITH METALLIC MATERIALS:6,CHEMISTRY OF THE MULTI-COMPOUND SYSTEM OF U-PU CARBIDES WITH METALS, P346 (1969)
COMPATIBILITY OF CARBIDE FUELS WITH METALLIC MATERIALS:6,CHEMISTRY OF THE MULTI-COMPOUND SYSTEM OF U-PU CARBIDES WITH METALS

THE PHASE RELATIONS OF FE,CO, AND NI WITH C AND THE ACTINIDES ARE REPORTED, DATA ARE PRESENTED ON ME-C,U-ME,PU-ME,U- ME-C,PU-ME-C, AND U-ME SUB 1 - ME SUB 2 - C GROUPS, EUTECTIC POINT, SOLUBILITY, THERMODYNAMIC QUOTIENT, LATTICE CONSTANT, CRYSTAL STRUCTURE, STABLE TEMPERATURE REGION, AND THE BINARY AND TERNARY PHASE DIAGRAM OF METASTABLE COMPOUNDS AND INTERMETALLIC COMPOUNDS WERE EXAMINED. THESE ELEMENTS DO NOT FORM STABLE CARBIDES AND DISSOLVE THE SUBSTANTIAL QUANTITY OF CARBON AT HIGH TEMPERATURE, THE DIFFUSION RATE OF CARBON IN THESE ELEMENTS IS REMARKABLY HIGHER THAN THAT IN CERAMIC COMPOUNDS, SUCH AS UC. IN TYPE 304 STAINLESS STEEL IN CONTACT WITH CARBON-SATURATED NA AND NA WITH HYPERSTOICHIOMETRIC UC, THE RELATION BETWEEN CARBON CONTENT X AND TIME IS REPRESENTED BY $X^{2/3} = Kt$. AS THE FREE ENERGY DIFFERENCE BETWEEN THE SYSTEM OF REACTION AND THE SYSTEM OF FORMATION IS NOT SO LARGE IN THE PRACTICAL TEMPERATURE REGION, THE COMPATIBILITY OF IRON GROUP ELEMENTS WITH U-PUC CAN TEND IN EITHER WAY OF PROPRIETY, GOVERNED BY THE COMPOSITION OF FUEL AND COVERING MATERIAL. THE COMPATIBILITY OF VARIOUS STAINLESS STEELS WITH U-PUC AND THAT OF NI-BASE ALLOYS WITH U-PUC ARE TABULATED. THE INFORMATION ON THE BUFFERING OF UC WITH METAL AND COMPOUNDS IS ALSO SUMMARIZED.

ABSTRACT 60

ALCOCK C B

CARBIDES IN NUCL ENERGY 1, 330 (1964)

ANALYSIS OF DATA PERTAINING TO THE VAPORIZATION OF URANIUM CARBIDES

A PRESSURE-COMPOSITION DIAGRAM FOR THE U-C BINARY SYSTEM HAS BEEN CONSTRUCTED WHICH CAN RECONCILE THE CALORIMETRIC AND FREE-EVAPORATION DATA FOR THIS SYSTEM. IT IS NECESSARY TO POSTULATE A LARGE CONTRIBUTION FROM UC SUB 2(G) TO THE VAPORIZATION SCHEME IN ORDER TO DO THIS. MASS SPECTROMETRY AND X-RAY DIFFRACTION RESULTS OBTAINED FROM SINTERED AND ARC CAST SAMPLES ARE REPORTED. THESE SUGGEST THAT UC SUB 2(G) IS A MINOR SPECIES IN THE VAPORIZATION OF URANIUM CARBIDES, AND THAT THE FREE EVAPORATION PROCESS IS NOT AT EQUILIBRIUM; HENCE THE RESULTS SHOULD NOT BE DIRECTLY COMPARED WITH THERMODYNAMIC DATA.

ABSTRACT 61

ALCOCK C B

IND SPEC REP SER 13, 257 (1964); NUCL MET AIME 10, 257 (1964)

A COMPARISON OF THE CALCULATED AND OBSERVED VAPORIZATION BEHAVIOR OF THE URANIUM DICARBIDE PHASE

TWO PREVIOUS MEASUREMENTS OF THE PARTIAL PRESSURE OF URANIUM IN EQUILIBRIUM WITH URANIUM DICARBIDE WERE ESSENTIALLY, IN AGREEMENT, BUT DISAGREED WITH THE CALORIMETRIC MEASUREMENTS OF THE HEAT AND ENTROPY OF FORMATION BY FACTORS AS LARGE AS FORTY. ONE STUDY ALSO SUGGESTED THAT THE DICARBIDE LOSES CARBON PREFERENTIALLY TO LEAVE A RESIDUE OF MONOCARBIDE, WHICH SUPPOSEDLY VAPORIZES CONGRUENTLY. ALL OF THESE OBSERVATIONS CAN BE BROUGHT INTO AGREEMENT PROVIDED THAT THE PRINCIPAL GASEOUS SPECIES ABOVE UC SUB 1.8 IS GASEOUS DICARBIDE. ALTHOUGH THE EXISTENCE OF THE GASEOUS UC SUB 2 WAS ESTABLISHED PREVIOUSLY IN A MASS SPECTROMETRIC STUDY, ITS CONCENTRATION WAS SOMEWHAT UNCERTAINLY KNOWN BECAUSE OF THE POSSIBILITY

ABSTRACT 61 (CONT'D)

OF ITS FRAGMENTATION BY THE IONIZING ELECTRONS. TO INVESTIGARE MORE THOROUGHLY THE CONCENTRATION, A MASS SPECTROMETRIC INVESTIGATION WAS EFFECTED. IT WAS FOUND IN THIS STUDY THAT THE GASEOUS DICARBIDE WAS, IN FACT, RELATIVELY UNIMPORTANT, BUT THAT THE MOST INTENSE AND PERSISTENT GASEOUS SPECIES WAS CARBON MONOXIDE. IN ADDITION IT WAS FOUND BY X-RAY EXAMINATION OF SURFACES OF DICARBIDE FROM WHICH VAPORIZATION HAD OCCURRED THAT CARBON WAS PRECIPITATED ON THE SURFACE. THEREFORE IT WAS CONCLUDED THAT THE VAPORIZATION OF URANIUM DICARBIDE IS A COMPLEX NON-EQUILIBRIUM PROCESS IN WHICH CARBON IS LOST PREFERENTIALLY VIA CARBON MONOXIDE AND DIFFUSION OF URANIUM TO THE SURFACE IS SUFFICIENTLY SLOW TO BE DECISIVE.

ABSTRACT 62

ALCOCK C B

THERMO NUCL MATER, P563 (1962)

STUDY OF URANIUM BORIDES AND CARBIDES BY MEANS OF THE KNUDSEN EFFUSION TECHNIQUE

THE FREE ENERGIES OF FORMATION OF THE BORIDES UB SUB 2, UB SUB 4, AND UB SUB 12, AND THE CARBIDES UC AND UC SUB 2 WERE OBTAINED FROM A SERIES OF EXPERIMENTS BASED ON KNUDSENS EFFUSION TECHNIQUE FOR THE MEASUREMENT OF VAPOR PRESSURES. FROM THESE MEASUREMENTS, VALUES COULD BE OBTAINED FOR THE URANIUM ACTIVITIES ACROSS THE WHOLE COMPOSITION RANGE IN THE ALLOYS, AND BY MAKING THE ASSUMPTION THAT THE COMPOUNDS DO NOT DEPART SUBSTANTIALLY FROM THE STOICHIOMETRIC COMPOSITION, INTEGRAL FREE ENERGY OF FORMATION DIAGRAMS FOR THE U-B AND U-C SYSTEMS WERE OBTAINED AT SEVERAL TEMPERATURES. THE FOLLOWING TWO-TERM FREE ENERGY EQUATIONS FOR THE FORMATION OF ONE MOLE OF COMPOUND FROM LIQUID URANIUM AND SOLID CARBON OR BORON WERE OBTAINED: UC $\Delta G = -25\,200 + 3.6\,T$ CAL/MOLE OF COMPOUND. UC SUB 2 $\Delta G = -32\,600 + 3.6\,T$ CAL/MOLE OF COMPOUND. UB SUB 2 $\Delta G = -39\,300 + 3.0\,T$ CAL/MOLE OF COMPOUND. UB SUB 4 $\Delta G = -60\,400 + 4.4\,T$ CAL/MOLE OF COMPOUND. UB SUB 12 $\Delta G = -106\,000 + 10.5\,T$ CAL/MOLE OF COMPOUND. BY COMBINING THESE RESULTS WITH EARLIER WORK, THE SEQUENCE OF STABILITIES BORIDES > CARBIDES > SILICIDES > ALUMINIDES WAS ESTABLISHED FOR URANIUM COMPOUNDS. NO EVIDENCE WAS FOUND FOR THE FORMATION OF EXTENSIVE SOLID SOLUTIONS BETWEEN THE PHASES WHICH WERE STUDIED IN THESE EXPERIMENTS, NOR WAS THE PRESENCE OF A PHASE U SUB 2 C SUB 3 MARKEDLY MORE STABLE THAN A UC-UC SUB 2 MIXTURE INDICATED BY THESE RESULTS.

ABSTRACT 63

ALEXANDER C A

CARBIDES IN NUCL ENERGY, HARWELL A14 (1963)

THERMODYNAMICS FOR COMPATIBILITY STUDIES OF METAL-CLAD URANIUM CARBIDE

THERMOCHEMICAL DATA FOR THE CARBIDES OF MOLYBDENUM, NIOBIUM, TANTALUM, TITANIUM, TUNGSTEN, URANIUM, HAFNIUM, AND ZIRCONIUM HAVE BEEN CRITICALLY REVIEWED AND THE FREE ENERGY OF FORMATION AS A FUNCTION OF TEMPERATURE HAS BEEN CALCULATED FOR THESE CARBIDES. IN ADDITION, EFFUSION DATA HAVE BEEN OBTAINED FOR THE URANIUM CARBIDES UC, U SUB 2 C SUB 3, AND UC SUB 2 AT TEMPERATURES TO 2500 DEG K. FREE ENERGY EQUATIONS CALCULATED AS A FUNCTION OF TEMPERATURE ARE IN GOOD AGREEMENT WITH HIGH TEMPERATURE HEAT CONTENT DATA, CALORIMETRIC VALUES FOR ΔH SUB 298, ΔS SUB 298, AND PHASE DIAGRAMS REPORTED IN THE LITERATURE. HOWEVER, THE EFFUSION DATA DO NOT AGREE WITH MOST OTHER EFFUSION DATA REPORTED IN THE LITERATURE. ON THE BASIS OF THESE DATA, METAL CLADDINGS OF NIOBIUM, TANTALUM, TITANIUM,

ABSTRACT 63 (CONT'D)

ZIRCONIUM, AND HAFNIUM WOULD BE EXPECTED TO REACT WITH URANIUM CARBIDES IN THE TEMPERATURE RANGE OF 1000 TO 2000 DEG C. DATA ARE INSUFFICIENT TO PREDICT THE BEHAVIOR OF MOLYBDENUM, BUT TUNGSTEN SHOULD NOT REACT EXTENSIVELY WITH STOICHIOMETRIC UC BELOW 1700 DEG C. THE MONOCARBIDE, UC, IS THE MOST STABLE OF THE URANIUM CARBIDES IN CONTACT WITH THE METALS LISTED, AND U SUB 2 C SUB 3 AND UC SUB 2 WOULD BE EXPECTED TO REACT WITH ALL THE METALS OVER THE ENTIRE TEMPERATURE RANGE OF 1000 TO 2000 DEG C. A DETAILED DISCUSSION OF THE METHOD USED TO PREDICT COMPATIBILITY ON THE BASIS OF THERMOCHEMICAL AND DIFFUSION DATA IS GIVEN FOR NIOBIUM AND U SUB 2 C SUB 3.

ABSTRACT 64

ALEXANDER C A

J NUCL MATER 31, 13 (1969)

VOLATILIZATION CHARACTERISTICS OF URANIUM MONONITRIDE

EXPERIMENTS HAVE BEEN PERFORMED BY TRANSPIRATION, VACUUM MICROBALANCE, EFFUSATE COLLECTION, AND MASS SPECTROMETRY TO DETERMINE MASS TRANSPORT IN URANIUM MONONITRIDE. IT IS SHOWN THAT UNDER EQUILIBRIUM CONDITIONS URANIUM MONONITRIDE WILL PREFERENTIALLY LOSE NITROGEN, AND MOLTEN URANIUM WILL BE A PRODUCT AT ALL TEMPERATURES ABOVE THE MELTING POINT OF URANIUM. UNDER DYNAMIC VACUUM CONDITIONS, HOWEVER, NITROGEN VAPORIZATION IS MARKEDLY CURTAILED PROBABLY AS A RESULT OF THE SLOW RATE OF DIFFUSION OF NITROGEN THROUGH URANIUM MONONITRIDE. UNDER DYNAMIC CONDITIONS, IT IS POSSIBLE TO VAPORIZE UN WITHOUT THE ACCUMULATION OF MOLTEN URANIUM ON THE SURFACE. THE TRANSPIRATION DETERMINATIONS OF VAPORIZATION OF UN HAVE BEEN UTILIZED IN A THERMODYNAMIC CYCLE TO ESTABLISH A VALUE OF 126 KCAL/MOLE AS THE STANDARD HEAT OF VAPORIZATION OF URANIUM. THIS VALUE WAS FURTHER SUBSTANTIATED BY EFFUSATE COLLECTION WHICH YIELDED A VALUE OF 126.5 KCAL/MOLE FOR THE HEAT OF VAPORIZATION OF URANIUM. IT IS INDICATED THAT THE UN HOMOGENEITY RANGE EXTENDS TO UN SUB 0.97 AT 1600 DEG C AND APPROACHES UN SUB 0.96 AT 1700 SUB C. ACROSS THE PORTION OF THE HOMOGENEITY RANGE OF UN THAT WAS EXAMINED THE ACTIVITY OF URANIUM CHANGES BY A FACTOR OF ABOUT A THOUSAND AT THESE TEMPERATURES.

ABSTRACT 65

ALEXANDER C A

NUCL MET , MET SOC AIME 17,95 (1970)

THERMOPHYSICAL PROPERTIES OF (U,PU)N

THERMOCHEMICAL AND THERMOPHYSICAL DETERMINATIONS HAVE BEEN PERFORMED ON UN, PUN, AND U SUB 0.8 PU SUB 0.2 N. FOR THE MOST PART IT HAS BEEN ESTABLISHED THAT THE PROPERTIES OF U SUB 0.8 PU SUB 0.2 N ARE INTERMEDIATE BETWEEN THAT OF UN AND PUN. HEAT CAPACITY SEEMS TO BE NEAR-LINEAR FUNCTION OF COMPOSITION AND THE THERMOCHEMICAL DETERMINATIONS INDICATE THAT UN AND PUN FORM A NEAR IDEAL SOLUTION. THE IDEAL SOLUTION CONCEPT DOES NOT APPLY TO THE INDIVIDUAL ELEMENTS PLUTONIUM AND URANIUM, HOWEVER. THE METAL/NITROGEN RATIO SEEMS GOVERNED BY THE PLUTONIUM WHILE MASS TRANSPORT IS GOVERNED PREDOMINANTLY BY DIFFUSION OF PLUTONIUM THROUGH A SURFACE LAYER OF URANIUM NITRIDE.

ABSTRACT 66

ALEXANDER C A

TRANS AM NUCL SOC 11, 522 (1968)

THERMODYNAMICS AND MASS TRANSPORT IN THE PU-U-N SYSTEM

COMPARED VAPORIZATION CHARACTERISTICS OF UN AND PUN. REPORTED VALUES OF NITROGEN FLUX FROM STOICHIOMETRIC UN UNDER DYNAMIC AND STEADY STATE CONDITIONS. THE (U_{0.8} PU _{0.2})N COMPOSITION EXHIBITED THE VAPORIZATION CHARACTERISTICS SIMILAR TO BOTH UN AND PUN.

ABSTRACT 67

ALEXANDER C A

TRANS AMER NUCL SOC 12, 581 (1969)

VAPORIZATION OF NITRIDE AND CARBIDE FUELS

VAPORIZATION RATES FOR U SUB 0.8 PU SUB 0.2 C SUB 0.97, U SUB 0.8 PU SUB 0.2 N SUB 0.98, AND U SUB 0.8 PU SUB 0.2 O SUB 1.98 ARE EXPRESSED AS A FUNCTION OF TEMPERATURE. THE RATES FOR UN AND U SUB 0.8 PU SUB 0.2 N ARE GIVEN IN TABULATED FORM, COVERING THE TEMPERATURE RANGE OF 1400 TO 2400 DEG K.

ABSTRACT 68

ALLBUTT M

AERE-R-5466 (1967)

SOME OBSERVATIONS ON THE COMPATIBILITY OF URANIUM AND PLUTONIUM NITRIDES WITH SEVERAL STAINLESS STEEL ALLOYS

PREVIOUS OBSERVATIONS OF THE COMPATIBILITY OF UN WITH METALS ARE REVIEWED. IT IS SHOWN ON THERMODYNAMIC GROUNDS THAT, DUE TO THE INFLUENCE OF OXYGEN IMPURITIES, UN WILL BEHAVE IN PRACTICE AS A UN-U SUB 2 N SUB 3 MIXTURE WHILE THE NITRIDING POTENTIAL OF PUN WILL BE GREATER THAN THAT OF THE PURE COMPOUND. AT 900 DEG C STAINLESS STEEL IN CONTACT WITH UN FOR 250 HOURS AND ABOVE DEVELOPS A REACTION ZONE OF UP TO 10 MICRONS THICKNESS FEATURES IDENTIFIED WITHIN THE REACTION ZONE INCLUDE METAL EX-FOLIATION, PRECIPITATION OF UO SUB 2, AND GRAIN BOUNDARY HARDENING. WITH THE EXCEPTION OF UO SUB 2 PRECIPITATION THESE FEATURES ARE PRODUCED BY NITROGEN ALONE UNDER THE PRESSURE OF THE UN-U SUB 2 N SUB 3 EQUILIBRIUM. FROM TESTS USING PUN IT IS INFERRED THAT THE BEHAVIOR OF UN/PUN SOLID SOLUTIONS WILL RESEMBLE THAT OF A UN/U SUB 2 N SUB 3 MIXTURE. (AUTH)

ABSTRACT 69

ALLBUTT M

J NUCL MATER 24,1 (1967)

CHEMICAL ASPECTS OF NITRIDE PHOSPHIDE AND SULPHIDE FUELS

THE SEMI-METALLIC COMPOUNDS UN, UP AND US HAVE BEEN CONSIDERED, ALONG WITH UC, AS POSSIBLE NUCLEAR FUELS. ALTHOUGH ALL FOUR COMPOUNDS ARE SUPERFICIALLY SIMILAR, AS REGARDS THEIR PHYSICAL AND METALLURGICAL PROPERTIES, THEIR NUCLEAR AND CHEMICAL PROPERTIES ARE QUITE VARIABLE. THIS PAPER PRESENTS THE RESULTS OF AN EXTENDED INVESTIGATION INTO THE CHEMISTRY OF THE NITRIDES, PHOSPHIDES AND SULPHIDES OF URANIUM AND THE NITRIDES AND SULPHIDES OF PLUTONIUM. THE TOPICS REVIEWED INCLUDE CRYSTAL CHEMISTRY, PREPARATION AND FABRICATION OF THE NaCl TYPE PHASES, THERMODYNAMIC STABILITY AND STOICHIOMETRY, THE FORMATION OF SOLID SOLUTIONS, OXIDATION AND HYDROLYSIS, COMPATIBILITY WITH METALS AND

ABSTRACT 69 (CONT'D)

CHEMICAL EFFECTS OF IRRADIATION. THE COMPARATIVE MERITS AND LIMITATIONS OF THESE COMPOUNDS AS NUCLEAR FUELS ARE DISCUSSED FROM A CHEMICAL STANDPOINT.

ABSTRACT 70

ALLIBERT M

STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES ABOVE 2000 DEG K
P259

INTERPRETATION OF THERMODYNAMIC PROPERTIES OF NONSTOICHIOMETRIC PHASES

FROM INTERNATIONAL COLLOQUIUM ON THE STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES ABOVE 2000K; ODEILLO, FRANCE (27 SEP 1971). A STATISTICAL INTERACTION MODEL APPLICABLE TO MANY DIFFERENT TYPES OF SOLID SOLUTIONS AND ESPECIALLY TO NONSTOICHIOMETRIC COMPOUNDS WAS ESTABLISHED. WHEN THE STRUCTURAL STUDY DEFINES THE NATURE OF THE DEFECTS RESPONSIBLE FOR THE NONSTOICHIOMETRY, THIS MODEL LEADS TO SIMPLE EXPRESSIONS FOR THE THERMODYNAMIC FUNCTIONS AND THE NUMBER OF DEFECTS PRESENT. THIS MODEL WAS APPLIED TO STORMS' DATA FOR THE PARTIAL GIBBS FREE ENERGY OF THE UC SUB 1.4X PHASE BETWEEN 2000 AND 2400 DEG K. THE SIMPLEST FORM OF THE MODEL ALLOWS INTERPOLATIONS AND EXTRAPOLATIONS OF THERMODYNAMIC FUNCTIONS TO BE MADE. IN THIS WAY CERTAIN PHASE BOUNDARIES, E.G. THE NUMBER OF DEFECTS CORRESPONDING TO ANY GIVEN CONCENTRATION, CAN BE CALCULATED.

ABSTRACT 71

ANDERSEN J C

TRANS AM NUCL SOC 11 , 521 (1968)

A REPRODUCIBLE PROCESS FOR THE PREPARATION OF LOW - AND HIGH - DENSITY, SINGLE - PHASE U-PU-CARBIDE PELLETS

DEVELOPED A REPRODUCIBLE PROCESS TO PREPARE 84 AND 93 % OF THEORETICAL DENSITY, SINGLE-PHASE (U SUB 0.85 PU SUB 0.15) C PELLETS WITHOUT SINTERING AID. THE EFFECT OF EQUIVALENT CARBON CONTENT (ECC) ON PELLET STRUCTURE IS SHOWN. RELATIONSHIP OF COLD-FORMING PRESSURE AND SINTERING TEMPERATURE ON PELLET DENSITY AND DIAMETER ARE ALSO DESCRIBED.

ABSTRACT 72

ANDERSON J

GU-5288 (1972)

UNRESTRAINED SWELLING AND FISSION GAS RELEASE OF FAST REACTOR FUELS

RESULTS OF THE UNRESTRAINED SWELLING TESTS WERE: (1) THE MIXED CARBIDES SWELLED AT A $\Delta V/V$ OF APPROX 2.4% PER 10^{20} FISSIONS/CM³ AT 1300 DEG C. IN COMPARISON, THE RESTRAINED SWELLING RATE OF CARBIDES AT TYPICAL LMFBR TEMPERATURE GRADIENTS HAS BEEN FOUND TO RANGE BETWEEN 0.6 AND 0.9 % $\Delta V/V$ PER 10^{20} FISSIONS/CM³. (2) AT A TEMPERATURE OF 1300 DEG C, THE UNRESTRAINED SWELLING RATE OF THE MIXED CARBIDE IS APPROX 1.6 TIMES AS GREAT AS THAT OF THE MIXED OXIDES. THE TESTS CONFIRM THAT UNRESTRAINED SWELLING RATES OF BOTH OXIDES AND CARBIDES ARE CONSIDERABLY HIGHER THAN SWELLING RATES OF FUELS RESTRAINED BY CLADDING. RESULTS OF THE FISSION GAS RELEASE TESTS SHOW THAT AT 1300 DEG C AN AVERAGE RELEASE OF 18% OF THEORETICAL WAS RECORDED FOR THE 84% OF THEORETICALLY DENSE MONOCARBIDE, WHILE FUEL MATERIALS WITH DENSITIES OF $\approx$ 90% RELEASED LESS THAN 8% OF THEORETICAL AT THE SAME OPERATING TEMPERATURE.

ABSTRACT 73

ANDERSON R N

NUCL TECH 13, 29 (1972)

APPLICATION OF NITRIDE-FORMING REACTIONS TO REPROCESSING OF SPENT NUCLEAR FUELS

THE THERMODYNAMICS AND KINETICS OF NITROGEN-NITRIDE REACTIONS IN LIQUID URANIUM-TIN ALLOYS HAVE BEEN INVESTIGATED EXPERIMENTALLY. IN THE PRESENCE OF DISSOLVED METAL IMPURITIES IN THE ALLOYS, THE NITROGEN HAS BEEN FOUND TO REACT WITH THE URANIUM, TO FORM UN WHICH CAN, UNDER PROPER CONDITIONS, BE PRECIPITATED AS A PURE PHASE FROM THE MELT, LEAVING IMPURITIES BEHIND. THUS, THE CONCEPT OF NITRIDE PRECIPITATION OFFERS A POSSIBLE METALLURGICAL SEPARATION METHOD APPLICABLE TO THE REPROCESSING OF SPENT FAST REACTOR FUELS. BASED ON LABORATORY STUDIES FOR URANIUM AND THE EXTRAPOLATED BEHAVIOR FOR PLUTONIUM, IT APPEARS POSSIBLE TO ATTAIN 99% URANIUM RECOVERY AND 98% PLUTONIUM RECOVERY, WITH DECONTAMINATION FACTORS OF 10^{**6}

ABSTRACT 74

ANDON R J L

TRANS FARADAY SOC 60, 1030 (1964)

THERMODYNAMIC PROPERTIES OF URANIUM COMPOUNDS I LOW-TEMPERATURE HEAT CAPACITY AND ENTROPY OF THREE URANIUM CARBIDES

THE HEAT CAPACITIES OF UC, U SUB 2 C SUB 8, AND UC SUB 1.91 ARE DETERMINED IN AN ADIABATIC CALORIMETER FROM 11 TO 330 DEG K. FROM THESE THE MOLAR THERMODYNAMIC PROPERTIES ARE CALCULATED AND COMPARED WITH THE LITERATURE.

ABSTRACT 75

ANDRIEVSKII P A

ATOMNAYA ENERGIYA 26,494 (1969)

EVAPORATION OF URANIUM CARBIDE NITRIDE AND CARBONITRIDES

A NUMBER OF PAPERS HAVE DEALT WITH THE EVAPORATION OF URANIUM CARBIDE : ANALYSIS REVEALS THAT THE AGREEMENT BETWEEN THE DATA OF VARIOUS AUTHORS IS UNSATISFACTORY. THE DISCREPANCY BETWEEN THE ABSOLUTE VALUES OF THE VAPOR PRESSURE SOMETIMES REACHES TWO TO FOUR ORDERS OF MAGNITUDE, AND THIS IS NOT DUE ONLY TO THE DIFFERENT METHODS OF INVESTIGATION. IN PARTICULAR, STORMS DREW ATTENTION TO THE MARKED EFFECT OF THE CARBON CONTENT ON THE VAPOR PRESSURE OF URANIUM ABOVE THE CARBIDE. THERE ARE REFERENCES TO THE POSSIBLE INFLUENCE OF THE MATERIAL OF THE KNUDSEN CHAMBER ON THE RESULTS OF THE VAPOR-PRESSURE MEASUREMENTS. IN THE FURTHERANCE OF OUR PREVIOUS WORK (OF WHICH THE RESULTS SEEMED STRANGE AFTER THE PUBLICATION OF THE EXPERIMENTAL DATA IN). WE UNDERTOOK AN INVESTIGATION OF THE EVAPORATION OF URANIUM CARBIDES OF VARIOUS COMPOSITIONS, TOGETHER WITH THE NITRIDE AND CARBONITRIDES. FOR THE LATTER TWO, INFORMATION ON THE VAPOR PRESSURE OF URANIUM IS LIMITED, AND CAN, PERHAPS, BE SUMMARIZED FOR UN BY THE FOLLOWING EXPRESSION: $LG(PU) \approx 8.09 - (2.605 \cdot 10^{**4})/T$

ABSTRACT 76

ANDRIEVSKII R A

LA-4211-TR (1967)

CALCULATION OF INTERACTION ENERGIES AND CONFIGURATIONAL AND EXCESS ENTROPIES IN SOLUTIONS OF TRANSITION METAL CARBIDES

THE INTEGRAL AND PARTIAL CONFIGURATIONAL ENTROPIES FOR SOLID SOLUTIONS OF CARBIDES ARE COMPUTED. THE MAGNETIC SUSCEPTIBILITY, ELECTRONIC HEAT CAPACITY, ORDERING, AND CHARACTERISTIC TEMPERATURE IN SYSTEMS OF CARBIDES OF TRANSITION METALS IN GROUPS IV THROUGH VI ARE EXAMINED AND ANALYZED, AND SHOW THAT NONCONFIGURATIONAL (ELECTRONIC, MAGNETIC, AND VIBRATIONAL) CONTRIBUTIONS TO ENTROPY MAY BE IGNORED FOR SOLUTIONS FORMED BY CARBIDES OF METALS OF A SINGLE GROUP IN THE PERIODIC SYSTEM, OR FOR DILUTE CARBIDE SOLUTIONS. THE EXCESS ENTROPIES ARE DISCUSSED IN CONNECTION WITH HEATS OF MIXING AND ENTROPIES OF FORMATION IN CARBIDE SYSTEMS.

ABSTRACT 77

ANSELIN F

CARBIDES IN NUCLEAR ENERGY P113 (1964)

ON THE SYSTEM (U, PU) (CND) AS APPLIED TO SINTERED CARBIDES, CARBONITRIDES AND OXYCARBIDES.

IT IS KNOWN THAT THE PREPARATION OF COMPLETELY SINGLE PHASE UC IS A DIFFICULT PROBLEM, THE SLIGHTEST DEVIATION FROM THE STOICHIOMETRIC RATIO RESULTING IN THE FORMATION OF A SECOND PHASE, EITHER URANIUM METAL OR ONE OF THE HIGHER CARBIDES. THIS PROBLEM IS NOW CONSIDERED IN THE MORE GENERAL CONTEXT OF A MONOCARBIDE PHASE OF THE TYPE $M(C_{xN_{yO_z}})$ WHERE M INDICATES ANY U-PU COMPOSITION AND Y AND Z ARE THE ATOMIC FRACTIONS OF CARBON REPLACED BY NITROGEN AND OXYGEN RESPECTIVELY. THIS PHASE CAN BE CONSIDERED AS A TERNARY SOLID SOLUTION OF MC-MN-MO.

ABSTRACT 78

ANSELIN F

CEA-R-2762 (1965)

REACTION OF NICKEL WITH URANIUM MONONITRIDE

THE UN-NI SYSTEM WAS INVESTIGATED IN SOLID PHASE BY DIFFUSION COUPLES UN-NI OR BY MIXED POWDERS WHICH WERE PRESSED AND SINTERED. STUDIES WERE CARRIED OUT BY MICROGRAPHY, X RAYS AND MICRONALYSIS WITH A CASTAING MICROPROBE. UN-NI COMPATIBILITY IS QUITE GOOD UP TO 600 DEG C; BEYOND THIS TEMPERATURE, DIFFUSION ZONES CORRESPONDING TO UN₁ SUB 5 AND U SUB 2 N SUB 3 APPEAR IN THE COUPLES. ONE OF THE REACTIONS, $3UN + 5NI = U SUB 2 N SUB 3 + UN SUB 5$ OR $UN + 5 NI = UN SUB 5 + 1/2 N SUB 2$, TAKES PLACE FROM 700 DEG C ACCORDING TO NITROGEN PRESSURE INVOLVED. FOR TEMPERATURES BETWEEN 800 AND 1000 DEG C, NICKEL SOLUBILITY IN URANIUM NITRIDE IS 1500 # 500 PPM BY WEIGHT.

ABSTRACT 79

ANSELIN F

CEA-R-2845 (1965)

ETUDE DU DIAGRAMME TERNAIRE URANIUM-CARBON-NICKEL

THE U-C-NI TERNARY DIAGRAM PRESENTS, IN ADDITION TO THE INTERMETALLIC COMPOUNDS OF U-NI AND URANIUM CARBIDES, TWO MIXED CARBIDES UC SUB 2 NI AND U SUB 2 C SUB 3 NI. THE FIRST CARBIDE IS DECOMPOSED FROM 1400 DEG C; THE SECOND IS STABLE UP TO 1800 DEG C.

ABSTRACT 80

ANSELIN F

CEA-R-2961 (1966)

DISSOCIATION PRESSURE OF URANIUM MONOCARBIDE, BY THE KNUDSEN EFFUSION METHOD, BETWEEN 2250 AND 2500 DEG K.

THE VAPOR TENSIONS OF UC AND UC SUB 1.10 WERE MEASURED BY THE KNUDSEN EFFUSION METHOD. THE SPECIMENS PLACED IN A W CELL WERE HEATED TO A UNIFORM TEMPERATURE IN AN ELECTRONIC FURNACE. CHEMICAL ANALYSIS, X-RAY COUNTING, AND COUNTING OF THE FISSION FRAGMENTS OF U IN MICA WERE USED JOINTLY OR SEPARATELY. THE PRESSURE-TEMPERATURE GRAPH EXTRAPOLATIONS CONFIRM THAT THE DISSOCIATION PRESSURE OF THE CARBIDES OF COMPOSITION IN THE NEIGHBOURHOOD OF UC SUB 1.1 IS LOWER THAN THAT OF UC AT THE SAME TEMPERATURE; THE VAPORIZATION OF THE CARBIDE IS FOUND TO BE CONSISTENT WITH A COMPOSITION IN THE NEIGHBOURHOOD OF UC SUB (1.1)

ABSTRACT 81

ANSELIN F

COMPT REND ACAD SCI PARIS 255, 698 (1962)

VOLATILITY OF PUC AND PUN

U AND PU CARBIDES AND NITRIDES WERE PREPARED BY DIRECT REACTION OF THE POWDERED METALS WITH GRAPHITE AND N. CARBONITRIDES WERE OBTAINED BY SOLID-PHASE DIFFUSION OF THE CARBIDES AND NITRIDES. IN ALL CASES, SOLID HOMOGENEOUS SOLUTIONS WERE OBTAINED AT <1400 DEG . THE COMPOUNDS WERE BROUGHT TO THEIR FINAL UTILIZATION FORM BY VACUUM CALCINATION OF 1400-1600 DEG ; THE PELLETS FORMED WERE ABOUT 6 MM IN DIAMETER BY 10 MM IN HEIGHT AND HAD A DENSITY CLOSE TO THE THEORETICAL ONE. THEY CONSISTED OF ONE PHASE ACCORDING TO THE MICROGRAPHICAL AND X-RAY EXAMINATION. A STUDY WAS MADE OF THEIR HEAT STABILITY WHEN RAISING THE TEMPERATURE TO 2000 AND 2500 DEG (M.P.) IN CALCINATION KILNS OR HIGH-FREQUENCY SMALL FURNACES. THERE WAS A SIGNIFICANT VOLATILIZATION OF THE PU CARBIDES AND NITRIDE AT 1600 DEG AND IT WAS IMPORTANT AT 1800 DEG . U CARBIDE AND NITRIDE SHOWED ONLY A SLIGHT VOLATILIZATION AT THE SAME TEMPERATURES. PU CARBIDE, NITRIDE, AND CARBONITRIDE PROVED TOO VOLATILE TO BE SUITABLE FUELS FOR RAPID-NEUTRON REACTORS.

ABSTRACT 82

ANSELIN F

J NUCL MATER 10, 301 (1963)

STUDY OF URANIUM AND PLUTONIUM NITRIDES AND THEIR SOLID SOLUTIONS

THE DEVELOPMENT OF URANIUM AND PLUTONIUM NITRIDES OR THEIR SOLID SOLUTIONS AS A POSSIBLE FUEL ELEMENT FOR FAST BREEDER-REACTORS IS CONDITIONED BY POSSIBILITIES OF PRODUCTION OF THOSE COMPOUNDS ON A LARGE SCALE AND BY THE EVALUATION OF THEIR GENERAL PROPERTIES. A LOW TEMPERATURE PREPARATION METHOD OF URANIUM NITRIDES IS DESCRIBED. UNDER PRESSURE NITROGEN REACTS WITH MASSIVE-METALLIC URANIUM SAMPLES WHEN SUPERFICIALLY HYDRIDED. HIGHER NITRIDES SO PRODUCED HAVE A MEAN COMPOSITION RANGE UN SUB 1.75-UN SUB 1.77. URANIUM MONONITRIDE, UN, IS OBTAINED BY DISSOCIATION OF UN SUB 1.77 UNDER VACUUM AT 800 DEG C OR HIGHER TEMPERATURES. WITH PLUTONIUM FOR WHICH NO HIGHER NITRIDE EXISTS, MONONITRIDE IS DIRECTLY PREPARED BY METAL NITRATION. UNDER THE SAME CONDITIONS NO SOLID SOLUTIONS (UPU)N CAN BE PREPARED BY NITRATION OF U/PU ALLOYS; A MIXTURE OF (UN) SUB 1.77 AND (UPU)N IS OBTAINED. DENSITIES OF 87% OF THEORETICAL DENSITY ARE OBTAINED BY NATURAL SINTERING OF UN COMPACTS. SINTERING IMPROVEMENT AND GRAIN GROWTH ARE OBSERVED WHEN AN

ABSTRACT 82 (CONT'D)

URANIUM LIQUID PHASE IS PRESENT. LOW METALLIC ADDITIONS DO NOT IMPROVE THE SINTERING BEHAVIOR, BUT BODIES WITH 90% OF THEORETICAL DENSITY CAN BE OBTAINED WITH SMALL ADDITION OF OXIDES SUCH AS UO_2 , ZrO_2 . AFTER DIFFUSION IN SOLID STATE OF UN-PUN MIXTURE, THE SOLID SOLUTION OBTAINED CAN BE SINTERED TO 90% OF THEORETICAL DENSITY. THE DISSOCIATION OF UN AND PUN ABOVE 1650 DEG C AND THE STRONG VOLATILIZATION OF PUN AT HIGH TEMPERATURE ARE CHARACTERISTIC FEATURES OF THOSE COMPOUNDS. THE LATTICE PARAMETER OF (U,Pu)N SOLID SOLUTIONS PREPARED AT 900 DEG C INCREASES LINEARLY WITH PUN CONTENT, FOR SOLID SOLUTIONS ANNEALED AT HIGHER TEMPERATURE THE LATTICE PARAMETER FOLLOWS A LINEAR VARIATION WITH A DIFFERENT SLOPE. IN CONCLUSION GENERAL PROPERTIES OF NITRIDES AND CARBIDES AS POSSIBLE FUEL ELEMENTS ARE COMPARED.

ABSTRACT 83

ARNOLD G P

US/UK LIBBY-COCKCROFT NEWSLETTER ON PLUTONIUM FUELS (1965)
NEUTRON DIFFRACTION STUDY OF PUC SUB 0.86

A SAMPLE OF PUC SUB 0.86 CERMET IN AL WAS PREPARED FOR DIFFRACTION STUDIES IN THE TEMPERATURE RANGE 5 TO 295 DEG K. TARGET DENSITY WAS 0.5 G/CM³. AT ALL TEMPERATURES THE EXPECTED NaCl STRUCTURE WITH A SUB 0 = 4.96 Å WAS EXHIBITED (200 AND 220 PEAKS), TOGETHER WITH AL PEAKS FROM THE TARGET MATERIAL. THE X-RAY POWDER DIFFRACTION PATTERN OF THE PUC SUB 0.86 INDICATED THAT THE CARBIDE WAS SINGLE PHASE, WITH LATTICE CONSTANT A SUB 0 = 4.9680. THERE WAS NO INDICATION OF MAGNETIC ORDERING IN THE NEUTRON DIFFRACTION SAMPLE.

ABSTRACT 84

ASHREE K H G

J NUCL MATER 47, 323 (1973)

ON THE BAINITIC TRANSFORMATIONS IN URANIUM CARBIDES

IN VIEW OF THE HIGH-TEMPERATURE SOLID SOLUTION THAT EXISTS FROM THE APPROXIMATE COMPOSITION UC TO THE APPROXIMATE COMPOSITION UC SUB 2, A NEW NOMENCLATURE IS SUGGESTED FOR THE CARBIDE PHASES OF URANIUM. AS FAR AS THE URANIUM ATOMS ARE CONCERNED, THERE ARE VERY CLOSE RELATIONSHIPS BETWEEN THESE PHASES AND MODELS ARE EXAMINED FOR THE 'MILITARY TRANSFORMATIONS' THAT ARE BELIEVED TO OCCUR IN THEM. IT IS ASSUMED THAT THE CARBON DIFFUSION ALSO REQUIRED BY THESE TRANSFORMATIONS, INCLUDING THE INTERCHANGE OF SINGLE CARBON ATOMS TO DOUBLE CARBON ATOMS, IS EASY. THE BAINITIC TRANSFORMATIONS THUS DEDUCED ARE USED TO INTERPRET THE MICROSTRUCTURES REVEALED BY TRANSMISSION ELECTRON MICROSCOPY OF THREE URANIUM-CARBON ALLOYS.

ABSTRACT 85

ATOJI M

J CHEM PHYS 31, 332 (1959)

STRUCTURES OF CaC_2 AND UC_2 BY NEUTRON DIFFRACTION

THE C-C DISTANCES OF THE C SUB 2 GROUPS IN CALCIUM DICARBIDE AND URANIUM DICARBIDE HAVE BEEN DETERMINED BY THE POWDER NEUTRON DIFFRACTION METHOD. THE C-C DISTANCE IN CALCIUM DICARBIDE IS 1.20 ± 0.01 Å, EQUAL TO THE TRIPLE BOND C-C DISTANCE, BUT NOT 1.4 Å AS REPORTED PREVIOUSLY. URANIUM

ABSTRACT 85 (CONT'D)

DICARBIDE IS ISOSTRUCTURAL WITH CALCIUM DICARBIDE AND HAS THE C-C DISTANCE OF 1.34 ± 0.01 Å ESSENTIALLY THAT OF A C-C DOUBLE BOND. THE INTERATOMIC DISTANCES IN CALCIUM DICARBIDE, URANIUM DICARBIDE, LANTHANUM DICARBIDE, AND LANTHANUM SESQUICARBIDE ARE DISCUSSED IN CONNECTION WITH THE ELECTRONIC CONFIGURATION OF THE C SUB 2 GROUP.

ABSTRACT 86

ATOJI M

J CHEM PHYS 47, 1188 (1967)

NEUTRON-DIFFRACTION STUDY OF UC SUB 2 AT 300 DEG -5 DEG K

CRYSTAL STRUCTURE DATA OF UC SUB 2 WAS TAKEN FROM 300 DEG K TO 5 DEG K; AND WAS COMPARED WITH LITERATURE VALUES.

ABSTRACT 87

AUSTIN A E

ACTA CRYST 12, 159 (1959)

CARBON POSITIONS IN URANIUM CARBIDES

THE CARBON ATOM POSITIONS IN URANIUM CARBIDES HAVE BEEN DETERMINED FROM NEUTRON DIFFRACTION DATA. UC IS FACE-CENTERED CUBIC WITH SODIUM CHLORIDE STRUCTURE. U SUB 2 C SUB 3 IS BODY-CENTERED CUBIC WITH SPACE GROUP I-43D, AND CARBON ATOMS HAVE ONE PARAMETER OF 0.295 WITH CARBON-CARBON BOND DISTANCE OF 1.295 Å. UC SUB 2 IS TETRAGONAL WITH SPACE GROUP I4/MMM, AND THE CARBON ATOMS HAVE Z PARAMETER OF 0.388 WITH CARBON-CARBON BOND DISTANCE OF 1.34 Å. THE METAL-CARBON BONDING IS DISCUSSED.

ABSTRACT 88

BAGLEY K Q

PROCEEDINGS OF IAEA SYMP ON FUEL AND FUEL ELEMENTS FOR FAST REACTORS JULY 2-6, (1973)

FUEL ELEMENT BEHAVIOR UNDER IRRADIATION IN DFR

A TOTAL OF OVER 1000 STAINLESS STEEL OR NICKEL ALLOY CLAD (U,PU) OXIDE AND CARBIDE FUEL PINS HAVE NOW BEEN IRRADIATED IN THE DOUNREAY FAST REACTOR, THE MAXIMUM BURN-UP AND NEUTRON DOSE ACHIEVED BY SUBSTANTIAL NUMBERS OF PINS BEING APPROX= 11.2% OF HEAVY ATOMS AND APPROX= 9×10^{22} N.CM⁻² RESPECTIVELY. THESE PINS EFFECTIVELY REPRESENTED PIN DESIGN CONCEPTS PROPOSED FOR LARGE FAST REACTOR SYSTEMS AND WERE INTENDED TO INVESTIGATE THE INFLUENCE OF VARIATIONS IN SUCH PARAMETERS AS CROSS-SECTION, FUEL AND CLAD TYPE COMPOSITION AND CONDITION, FUEL-MASS RATING, MAXIMUM CLAD AND FUEL TEMPERATURE ON PIN PERFORMANCE, ENDURANCE LIMIT AND FAILURE CHARACTERISTICS. DATA ARE PRESENTED ON CLAD STRAIN DEVELOPMENT AS A FUNCTION OF BURN-UP AND NEUTRON DOSE FOR DIFFERENT CLAD AND FUEL TYPES, AND ON MICROSTRUCTURAL CHANGES IN FUEL AND CLAD. A SUBSTANTIAL NUMBER OF FUEL PINS INCORPORATING THE PARAMETERS OF THE PFR PIN DESIGN HAVE EXCEEDED 10% BURN-UP MAX. WITHOUT DEMONSTRATING A GENERIC FAILURE MECHANISM OF RELEVANCE TO POWER REACTORS. POST-FAILURE PHENOMENA HAVE THEREFORE BEEN STUDIED BY IRRADIATING NATURALLY OR ARTIFICIALLY DEFECTED PINS FOR EXTENDED PERIODS, AND THE CONTRIBUTION OF FUEL/COOLANT REACTIONS TO RUPTURE INITIATION OR PROPAGATION EXPLORED. OBSERVATIONS ON THE FREQUENCY AND NATURE OF CHEMICAL ATTACK ON THE INNER SURFACE OF THE CLADDING ARE MADE. A NUMBER OF SODIUM-BONDED CARBIDE PINS HAVE BEEN

ABSTRACT 88 (CONT'D)

EXAMINED AFTER IRRADIATION TO VARIOUS EXPOSURES IN DFR. A DESCRIPTION IS GIVEN OF SOME OF THE RESULTS OF THESE EXAMINATIONS. THE SCOPE AND OBJECTIVES OF THE EXPERIMENTAL FUELS IRRADIATION PROGRAM IN THE PFR ARE BRIEFLY REVIEWED.

ABSTRACT 89

BAKER R D

LA-4749-MS (1971)

QUARTERLY STATUS REPORT ON THE ADVANCED PLUTONIUM FUELS PROGRAM FOR THE PERIOD APRIL 1 TO JUNE 30, 1971 AND FIFTH ANNUAL REPORT

SELECTED COMPOSITIONS IN THE U-PU-C SYSTEM HAVE BEEN OBSERVED BY DTA AND METALLOGRAPHIC EXAMINATION TO DETERMINE THE PHASE BOUNDARIES OF THE SINGLE PHASE REGION NEAR U SUB 0.8 PU SUB 0.2 C IN THE TEMPERATURE RANGE OF 1400 TO 2100 DEG C. SAMPLES OF PU, PUC SUB 0.23, PUC SUB 0.51, AND PUC SUB 0.72 TO PUC SUB 1.91 WERE SIMILARLY INVESTIGATED TO REVISE PU-C PHASE DIAGRAM. WORK DONE ON CREEP RATES AND HOT HARDNESS OF MIXED CARBIDES IS ALSO REPORTED. VAPOR PRESSURES OF GASEOUS PLUTONIUM OVER VARIOUS TWO PHASE REGIONS IN PU-C SYSTEM ARE GIVEN FOR THE TEMPERATURE RANGES OF 1450 TO 1850 DEG K, 1668 TO 1927 DEG K, 1923 TO 2140 DEG K, AND 1933 TO 2170 DEG K. FREE ENERGY FOR FORMATION FOR PUC SUB 0.9, PUC SUB 1.5, AND PUC SUB 2 ARE GIVEN AS A FUNCTION OF TEMPERATURE. FROM THE DATA FOR U-C AND PU-C BINARY SYSTEMS, SOME CALCULATIONS AND SEMIQUANTITATIVE PREDICTIONS WERE ALSO MADE FOR U-PU-C SYSTEM.

ABSTRACT 90

BARGHUSEN J

REACTOR FUEL PROCESS 9, 51 (1965-66)

PRODUCTION OF URANIUM, THORIUM, AND PLUTONIUM AND THEIR COMPOUNDS

THE RECOVERY OF URANIUM FROM ORES BY HYDROMETALLURGICAL TECHNIQUES IS DESCRIBED. PRODUCTION OF UO SUB 3, CONVERSION OF UF SUB 6 TO UO SUB 2 AND U SUB 3 O SUB 8, REDUCTION OF HIGHER OXIDES TO UO SUB 2, REDUCTION OF UF SUB 4 BY CUT-CROWN MAGNESIUM, REDUCTION OF UO SUB 2 BY CALCIUM, ELECTROLYTIC PRODUCTION AND REFINING OF URANIUM, PREPARATION AND PROPERTIES OF PUO SUB 2, PRODUCTION AND PURIFICATION OF PLUTONIUM METAL, PRODUCTION AND PROPERTIES OF UC AND PUC, PREPARATION OF UN AND PUN, PREPARATION OF US AND PUS, AND PREPARATION OF UP AND PUP ARE DISCUSSED.

ABSTRACT 91

BARNER J D

PROCEEDINGS OF THE CONFERENCE ON FAST REACTOR FUEL ELEMENT TECHNOLOGY, 819-847, ANS, (1971) ; LA-4669 (1971)

BEHAVIOR OF SODIUM-BONDED (U,PU) C FUEL ELEMENTS AFTER MODERATE BURNUP

TWO SODIUM-BONDED, SINGLE-PHASE, (U SUB 0.8 PU SUB 0.2)C-FUELED, TYPE 316 STAINLESS-STEEL-CLAD FUEL ELEMENTS WERE IRRADIATED IN EBR-II AT HEATING RATES OF APPROX 30 KW/FT TO BURNUPS OF 3.7 AND 5.0 AT.%. NO CLADDING FAILURES OCCURRED AS A RESULT OF THE IRRADIATION. TOTAL FISSION GAS RELEASE FROM THE FUEL WAS LOW. THERMAL STRESSES IN THE FUEL RESULTED IN FUEL SPLITTING UPON INITIAL STARTUP AND GENERAL FUEL FRAGMENTATION AS FISSION PRODUCT RECOIL AND FAST-NEUTRON DAMAGE ACCUMULATED. NO NEW PHASES WERE OBSERVED IN THE FUEL AFTER IRRADIATION.

ABSTRACT 92

BATES J L

BNWL-SA-1494 (1967)

THERMAL CONDUCTIVITY OF URANIUM OXYCARBIDES

FROM 7TH ANNUAL CONFERENCE ON THERMAL CONDUCTIVITY, WASHINGTON, D.C. THE THERMAL DIFFUSIVITY OF URANIUM OXYCARBIDE WAS MEASURED AT 100 TO 1500 DEG C AS A FUNCTION OF OXYGEN CONCENTRATION AT 2 TO 17 AT. % OF THE ANIONS. THE THERMAL DIFFUSIVITY (α) OF THE OXYCARBIDES DECREASED AND THE SHAPE OF THE α -VERSUS-T CURVE CHANGED AS THE OXYGEN CONTENT INCREASED. OXYCARBIDES WITH THE LOWEST OXYGEN CONTENT SHOWED A DECREASE IN α AS THE TEMPERATURE INCREASED, WHEREAS THE OXYCARBIDES WITH THE HIGHEST OXYGEN CONTENT EXHIBITED A SLIGHT INCREASE IN α WITH AN INCREASE IN TEMPERATURE. THE THERMAL DIFFUSIVITIES OF ALL SPECIMENS, APPROACH A COMMON VALUE NEAR $0.05 \text{ CM}^2/\text{SEC}$ AT THE HIGHER TEMPERATURES. THE CALCULATED THERMAL CONDUCTIVITIES NEAR 1500 DEG C OF THE URANIUM OXYCARBIDES ARE APPROXIMATELY $0.18 \text{ WATTS/CM-DEG C}$, VERY NEAR THE REPORTED VALUES FOR NEARLY STOICHIOMETRIC AND SLIGHTLY HYPOSTOICHIOMETRIC UC. THE THERMAL CONDUCTIVITIES OF THE OXYCARBIDES CAN BE QUALITATIVELY SEPARATED INTO AN ELECTRONIC COMPONENT, OBEYING THE WIEDEMANN-FRANZ-LORENTZ LAW, AND A LATTICE COMPONENT, VARYING INVERSELY WITH TEMPERATURE. THE DECREASE IN THERMAL CONDUCTIVITY AT THE LOWER TEMPERATURES WITH INCREASING OXYGEN CONTENT RESULTS PRIMARILY FROM CHANGES IN THE LATTICE COMPONENT. SMALL DECREASES ALSO OCCUR IN THE ELECTRONIC COMPONENT OVER THE ENTIRE TEMPERATURE RANGE DUE TO INCREASES IN OXYGEN CONTENT.

ABSTRACT 93

BATES J L

BNWL-989 (1969)

THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF URANIUM OXYCARBIDE

THE THERMAL DIFFUSIVITY (α) OF URANIUM OXYCARBIDE WAS MEASURED FROM 100 TO 1500 DEG C AS A FUNCTION OF OXYGEN CONCENTRATION FROM 2 TO 17 AT.%. THERMAL DIFFUSIVITY DECREASED AS OXYGEN CONTENT INCREASED. OXYCARBIDES WITH THE LOWEST OXYGEN CONTENT SHOWED A DECREASE IN α AS TEMPERATURE INCREASED, WHEREAS OXYCARBIDES WITH THE HIGHEST OXYGEN CONTENTS EXHIBITED AN INCREASE IN α AS TEMPERATURE INCREASED. THERMAL DIFFUSIVITIES OF ALL SPECIMENS APPROACH A COMMON VALUE OF $0.05 \text{ CM}^2/\text{SEC}$ AT THE HIGH TEMPERATURES. CALCULATED THERMAL CONDUCTIVITIES NEAR 1500 DEG C ARE ABOUT 0.18 W/CM, DEG C , VERY NEAR THE REPORTED VALUES FOR NEARLY STOICHIOMETRIC AND SLIGHTLY HYPOSTOICHIOMETRIC UC. ELECTRICAL RESISTIVITY OF URANIUM OXYCARBIDES BETWEEN ROOM TEMPERATURE AND 1775 DEG K INCREASED AS OXYGEN CONCENTRATION INCREASED FROM 2 TO 16 AT.%. ELECTRONIC THERMAL CONDUCTIVITY IS PREDOMINANT ABOVE ABOUT 1200 DEG C; PHONON CONDUCTIVITY IS PREDOMINANT AT LOWER TEMPERATURES AND DECREASES WITH INCREASING OXYGEN CONTENT.

ABSTRACT 94

BATES J L

PROC 7TH CONF ON THERMAL CONDUCTIVITY, P477 (1967)

THERMAL CONDUCTIVITY OF URANIUM OXYCARBIDES

THE THERMAL DIFFUSIVITY OF URANIUM OXYCARBIDE WAS MEASURED FROM 100 TO 1500 DEG C AS A FUNCTION OF OXYGEN CONCENTRATION FROM 2 TO 17 AT. % OF THE ANIONS. THE THERMAL DIFFUSIVITY (α) OF THE OXYCARBIDES DECREASED AND THE SHAPE OF THE (α)-VERSUS-T CURVE CHANGED AS THE OXYGEN CONTENT INCREASED. OXYCARBIDES WITH THE LOWEST OXYGEN CONTENT SHOWED A DECREASE IN (α) AS

ABSTRACT 94 (CONT'D)

THE TEMPERATURE INCREASED, WHERE AS THE OXYCARBIDES WITH THE HIGHEST OXYGEN CONTENT EXHIBITED A SLIGHT INCREASE IN (2) WITH AN INCREASE IN TEMPERATURE THE THERMAL DIFFUSIVITIES OF ALL SPECIMENS APPROACH A COMMON VALUE NEAR $5 \times 10^{-6} \text{ M}^2/\text{SEC}$ AT THE HIGHER TEMPERATURES. THE CALCULATED THERMAL CONDUCTIVITIES NEAR 1500 DEG C OF THE URANIUM OXYCARBIDES ARE APPROXIMATELY 18 W/M, DEG., VERY NEAR THE REPORTED VALUES FOR NEARLY STOICHIOMETRIC AND SLIGHTLY HYPOSTOICHIOMETRIC UC. THE THERMAL CONDUCTIVITIES OF THE OXYCARBIDES CAN BE QUALITATIVELY SEPARATED INTO AN ELECTRONIC COMPONENT, OBEYING THE WIEDEMANN-FRANZ- LORENTZ LAW, AND A LATTICE COMPONENT, VARYING INVERSELY WITH TEMPERATURE. THE DECREASE IN THERMAL CONDUCTIVITY AT THE LOWER TEMPERATURES WITH INCREASING OXYGEN CONTENT RESULTS PRIMARILY FROM CHANGES IN THE LATTICE COMPONENT. SMALL DECREASES ALSO OCCUR IN THE ELECTRONIC COMPONENT OVER THE ENTIRE TEMPERATURE RANGE DUE TO INCREASES IN OXYGEN CONTENT.

ABSTRACT 95

BATEY W

CARBIDES IN NUCL ENERGY, HARWELL C12 (1963)

COMPATIBILITY OF (U,PU) CARBIDES WITH CLADDING MATERIALS

TO ASSIST IN THE SELECTION OF A SUITABLE FUEL AND CAN FOR A FAST REACTOR FUEL ELEMENT, WORK IS UNDERWAY AT DOUNREAY TO INVESTIGATE THE COMPATIBILITY OF A RANGE OF CLADDING MATERIALS WITH MIXED (U,PU) CARBIDES OF VARYING CARBON CONTENT. CARBIDE PELLETS OF KNOWN COMPOSITION ARE HEATED IN CONTACT WITH POLISHED END-PIECES OF THE CLADDING MATERIALS AT BOTH 800 DEG C AND 650 DEG C (IN SOME INSTANCES) IN AN ARGON ATMOSPHERE. OTHER TESTS HAVE BEEN CARRIED OUT AT 800 DEG C WITH A SODIUM BOND BETWEEN THE FUEL AND THE CAN. PRELIMINARY RESULTS AFTER TEST PERIODS OF 700 AND 2100 H SHOW REACTION BETWEEN 316L STAINLESS STEEL, NIMONIC 80A, AND NIMONIC PE16 WITH HYPERSTOICHIOMETRIC (U,PU) CARBIDE PELLETS BUT NO REACTION WITH MOLYBDENUM. THERE IS NO EVIDENCE OF REACTION BETWEEN THESE FOUR MATERIALS AND STOICHIOMETRIC MIXED (U,PU) CARBIDE PELLETS.

ABSTRACT 96

BATEY W

PLUTONIUM 1965, P888

THE COMPATIBILITY OF TYPE 316L STAINLESS STEEL WITH MIXED URANIUM-PLUTONIUM CARBIDES

THE COMPATIBILITY OF STAINLESS STEEL WITH MIXED (U,PU) CARBIDES OF VARYING C CONTENT WAS EXAMINED AT 650 AND 800 DEG C FOR PERIODS OF TIME UP TO ONE YEAR. SOME SLIGHT C TRANSFER WAS OBSERVED, BUT SHOULD NOT AFFECT THE MECHANICAL PROPERTIES OF THE STEEL. IN THE PRESENCE OF A NA TRANSFER MEDIUM, HOWEVER, THE EXTENT OF C TRANSFER IS ENHANCED CONSIDERABLY.

ABSTRACT 97

BATEY W

TRG REP 1038 (D) (1965)

THE COMPATIBILITY OF MIXED OXIDES AND CARBIDES WITH REFRACTORY METALS

THE COMPATIBILITY OF MIXED (U,15%PU) OXIDES AND CARBIDES WITH THE REFRACTORY METALS MOLYBDENUM, NIOBIUM, TANTALUM AND TUNGSTEN, HAS BEEN STUDIED IN SHORT-TERM TESTS ON THE LEITZ HOT-STAGE MICROSCOPE IN THE TEMPERATURE RANGE 1300-2100 DEG C. OF THESE REFRACTORY METALS, TUNGSTEN APPEARS TO BE SUPERIOR TO THE OTHERS, BEING COMPATIBLE UP TO, AND PROBABLY BEYOND, TEMPERATURES OF 1700-1800 DEG C.

ABSTRACT 98

BATEY W

TRG REPORT 1R35 (D)

THE COMPATIBILITY OF NIMONIC ALLOYS WITH MIXED (U,PU) CARBIDES

COMPATIBILITY TEST BETWEEN MIXED (U,15% PU) CARBIDES OF VARYING CARBON CONTENT AND THE NIMONIC ALLOYS 80A AND PE16 HAVE BEEN CARRIED OUT IN THE TEMPERATURE RANGE 650 TO 800 DEG C FOR PERIODS OF UP TO ONE YEAR. CARBURIZATION OF THE NIMONICS WAS OBSERVED TO OCCUR AT THE LOW END OF THE TEMPERATURE RANGE BUT AT A LOW LEVEL. REACTION INVOLVING PIT FORMATION IN THE NIMONICS, HOWEVER, OCCURRED TO SOME EXTENT IN ALL THE TESTS WITH ONE EXCEPTION, THAT COMPRISING NIMONIC PE16 AT 650 DEG C WHEN ONLY CARBON TRANSFER WAS OBSERVED. THE REACTION APPEARS TO BE INDEPENDENT OF CARBIDE COMPOSITION WITHIN A RELATIVELY WIDE RANGE AND THE DEPTH OF PENETRATION OF THE REACTION ZONE AND CONCOMITANT PITS AT 800 DEG C SUGGESTS AN OPERATIONAL LIMIT OF ABOUT 750 DEG C AT THE NIMONIC/CARBIDE INTERFACE IN ANY FUEL PIN.

ABSTRACT 99

BATTLES J E

HIGH TEMP SCI 2, 80 (1970)

A MASS SPECTROMETRIC STUDY OF THE VOLATILIZATION BEHAVIOR IN THE PU-C SYSTEM

THE VOLATILIZATION BEHAVIOR OF THE UNIVARIANT SOLID SYSTEMS PU SUB 2 C SUB 3 + C, PUC SUB 2 + C, AND PU SUB 2 C SUB 3 +PUC SUB 2 HAS BEEN INVESTIGATED BY COMBINED MASS-LOSS AND MASS SPECTROMETRIC KNUDSEN EFFUSION STUDIES. THE VAPOR PHASE IN EQUILIBRIUM WITH EACH UNIVARIANT SYSTEM IS THE SAME, PRIMARILY PU(G) WITH ONLY A MINOR AMOUNT (<0.1%) OF PUC SUB 2 (G) OBSERVED OVER THE SOLID SYSTEM PUC SUB 2 + C. MASS SPECTROMETRIC DATA ARE COMBINED WITH THE MASS-LOSS EFFUSION DATA TO YIELD THE FOLLOWING EQUATIONS FOR THE VAPOR PRESSURE. FOR THE REACTION: 1/2 PU SUB 2 C SUB 3 (S) = PU(G) + 3/2C(S), $\log P(\text{ATM}) = (4.510 \pm 0.140) - ((21,330 \pm 240)/T)$ (1579-1933 DEG K) $\Delta H_{\text{SUB T DEG}} = 97.59 \pm 1.08 \text{ KCAL/MOL PU(G)}$. FOR THE REACTION 2 PU SUB 2 C SUB 3(S) = PU(G) + 3PUC SUB 2 (S), $\log P(\text{ATM}) = (6.910 \pm 0.140) - ((25,940 \pm 240)/T)$ (1933-2299 DEG K), WITH $\Delta H_{\text{SUB T DEG}} = 118.72 \pm 1.10 \text{ KCAL/MOL PU(G)}$. FOR THE REACTION PUC SUB 2 (S) = PU(G) + 2C(S), $\log P(\text{ATM}) = (3.450 \pm 0.090) - ((19,290 \pm 120)/T)$ (1933-2348 DEG K), $\Delta H_{\text{SUB T}} = 88.29 \pm 0.55 \text{ KCAL/MOL PU(G)}$. THE ENTHALPY AND ENTROPY OF FORMATION OF PUC SUB 1.5(S) FROM THE ELEMENTS WERE EVALUATED AT THE REFERENCE TEMPERATURE 298 DEG K BY COMBINING VAPOR PRESSURE DATA WITH H SUB T DEG - H SUB 298 DEG AND S SUB T DEG - S SUB 298 DEG DATA. THE VALUES ARE $\Delta H_{\text{SUB F, 298 DEG}} = -16.14 \pm 1.10 \text{ KCAL/MOL}$ AND $\Delta S_{\text{SUB F, 298 DEG}} = + 5.09 \pm 0.60 \text{ EU}$.

ABSTRACT 100

BAJER A A

FAST REACTOR FUEL ELEMENT TECHNOLOGY, NEW ORLEANS TOPICAL, (1971)
MIXED-NITRIDE FUEL IRRADIATION PERFORMANCE

MIXED-NITRIDE FUEL IRRADIATION BEHAVIOR IS REVIEWED WITH EMPHASIS ON RECENT RESULTS OBTAINED FOR 24 SPECIMENS IRRADIATED IN THE ETR AND FOR A SINGLE, MIXED-NITRIDE FUEL PIN IRRADIATED IN THE EBR-II. THE THERMAL IRRADIATIONS INCLUDE SPECIMENS WITH HELIUM- AND SODIUM-BONDED FUEL IRRADIATED TO BURNUPS IN EXCESS OF 150,000 MWD/MTM AT PIN POWER HEAT RATINGS UP TO 49.8 KW/FT. EFFECTS OF FUEL TEMPERATURE AND THE PRESENCE OF OXYGEN-STABILIZED U SUB 2 N SUB 3 ON FUEL PERFORMANCE AND SWELLING BEHAVIOR AND OF FUEL POROSITY AND BURNUP ON FISSION GAS RELEASE BEHAVIOR ARE DESCRIBED. THE PIN IRRADIATED IN EBR-II CONTAINED MIXED-NITRIDE FUEL HELIUM-BONDED TO TYPE 304 STAINLESS-STEEL CLADDING AND ACHIEVED A FUEL BURNUP OF 32,100 MWD/MTM AT A PEAK LINEAR POWER OF 24.8 KW/FT. A CLADDING DIAMETER CHANGE OF ABOUT 1/2 MIL (<0.2%) IS ASSIGNABLE TO CLADDING DEFORMATION BY THE SWELLING FUEL. THE PRESENCE OF U SUB 2 N SUB 3, IN THE ABSENCE OF HIGH OXYGEN CONTENTS, DID NOT AFFECT FUEL IRRADIATION PERFORMANCE. EXCELLENT COMPATIBILITY IS EXHIBITED BETWEEN STAINLESS-STEEL CLADDING AND SINGLE-PHASE MIXED-NITRIDE FUEL. CLADDING IN CONTACT WITH FUEL CONTAINING THE U SUB 2 N SUB 3 PHASE EXHIBITED A REACTION LAYER INDICATIVE OF NITROGEN PENETRATION.

ABSTRACT 101

BAUER A A

REACTOR TECHNOL 15,87 (1972)

NITRIDE FUELS PROPERTIES AND POTENTIALS

INTEREST IN NITRIDE FUELS CENTERS PRINCIPALLY ON THE USE OF (U,PU)N IN FAST BREEDER REACTORS. A REVIEW OF NITRIDE FUEL PROPERTIES IS PRESENTED INCLUDING PROPERTIES AND IRRADIATION BEHAVIOR OF UN, WHOSE MAJOR POTENTIAL APPLICATION IS AS A SPACE REACTOR FUEL. INFORMATION ON UN AS PRESENTED HERE SERVES PRINCIPALLY AS BACKGROUND TO, AND TO SUPPLEMENT, DATA ON MIXED-NITRIDE, (U,PU)N, FUELS. ALTHOUGH THE MIXED NITRIDE HAVE RECEIVED LESS CONCENTRATED STUDY, A SUFFICIENT TECHNOLOGY BASE APPEARS TO EXIST THAT WILL PERMIT AN EVALUATION OF MIXED NITRIDES AS LIQUID-METAL-COOLED FAST BREEDER REACTOR FUELS. THE PROPERTIES OF (U,PU)N RELATED TO ITS IRRADIATION PERFORMANCE, SAFETY CHARACTERISTICS, AND FUEL-CYCLE COSTS ARE REVIEWED. FUEL-PIN DESIGN IS DISCUSSED, AND FUEL-PERFORMANCE POTENTIAL AND LIMITATIONS ARE OUTLINED. EMPHASIS IS PLACED ON POTENTIAL ADVANTAGES RESULTING FROM THE USE OF (U,PU)N TO FUEL AN ADVANCED LIQUID-METAL-COOLED FAST BREEDER REACTOR.

ABSTRACT 102

BEHL W K

J ELECTROCHEM SOC 113, 376 (1966)

STANDARD MOLAR FREE ENERGY OF FORMATION OF URANIUM DICARBIDE AND URANIUM SESQUICARBIDE BY ELECTROMOTIVE FORCE MEASUREMENTS

THE FREE ENERGIES OF FORMATION OF UC SUB 2 AND U SUB 2 C SUB 3 WERE DETERMINED BY MEANS OF THE FOLLOWING SOLID STATE GALVANIC CELLS OPERATED BETWEEN 700 AND 900 DEG C: U, UF SUB 3(S) | CAF SUB 2(S) || UF SUB 3, UC SUB 2, C AND U, UF SUB 3(S) | CAF SUB 2(S) || UF SUB 3, U SUB 2 C SUB 3, C. ALTHOUGH UC SUB 2 IS IN METASTABLE EQUILIBRIUM WITH CARBON IN CELL A, RESULTS ARE SIGNIFICANT. EXPERIMENTAL DETAILS ARE PRESENTED AND RESULTS ARE COMPARED WITH VALUES OBTAINED BY OTHER TECHNIQUES.

ABSTRACT 103

BENTLE G G

AI-AEC-12726 (1968)

SELF-DIFFUSION OF U AND C IN UC

DIFFUSION COEFFICIENTS OF CARBON AND URANIUM IN URANIUM CARBIDE (4.4 TO 4.9 WT% C) WERE MEASURED BY TRACER AND SECTIONING TECHNIQUES ON SPECIMENS ANNEALED AT 1100 TO 2000 DEG C. CARBON DIFFUSION WAS FASTER THAN URANIUM DIFFUSION BY TWO OR THREE ORDERS OF MAGNITUDE. THERE WAS A SMALL DEPENDENCE ON COMPOSITION; HIGHER CARBON CAUSED SOME INCREASE IN CARBON DIFFUSION AND A DECREASE IN URANIUM DIFFUSION. THE SPECIMENS VARIED IN GRAIN SIZE BUT NO SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN THE COARSE-GRAINED AND FINE-GRAINED SPECIMENS. BREAKS OCCURRED IN THE ARRHENIUS CURVES AT ABOUT 1500 DEG C; THE LOWER ACTIVATION ENERGIES BELOW 1500 DEG C WERE ATTRIBUTED TO SHORT-CIRCUITING BY GRAIN BOUNDARY OR SUB-GRAIN BOUNDARY TRANSPORT IN THE LOW-TEMPERATURE REGION. FIVE STUDIES OF SELF-DIFFUSION IN UC ARE REVIEWED AND COMPARED WITH THE PRESENT RESULTS.

ABSTRACT 104

BENZ R

HIGH TEMP SCI 1, 342 (1969)

UC-UC SUB 2 PHASE BOUNDARIES

THE U-C PHASE SYSTEM WAS INVESTIGATED BY THERMAL, MICROSCOPIC, X-RAY DIFFRACTION AND CHEMICAL TECHNIQUES WITH THE FOLLOWING RESULTS: THE UC AND UC SUB 2 CONGRUENT MELTING POINTS OCCUR AT THE C/U RATIOS OF 0.99#0.02 (2490#40 DEG) AND 1.95#0.05 (2440#35 DEG), RESPECTIVELY; THE C/U RATIO AT THE UC SUB 2 -C EUTECTIC IS 2.02#0.03 (2430#35 DEG); THE C/U RATIO OF CARBON-SATURATED UC SUB 2 INCREASES FROM 1.905#0.02 BETWEEN 1500 AND 1800 DEG TO 1.915 AT 2000 DEG AND TO 1.96 AT THE UC SUB 2 -C EUTECTIC TEMPERATURE; A PERITECTOID OCCURS AT 1775#25 DEG WHERE B-UC SUB 2, WITH THE C/U RATIO OF 1.78#0.02, COEXISTS UNDER EQUILIBRIUM CONDITIONS WITH B-UC SUB 2 (C/U=1.77+U SUB 2 C SUB 3 PHASES; AND U SUB 2 C SUB 3 DECOMPOSES AT THE HIGHER TEMPERATURE OF 1820#25 DEG.

ABSTRACT 105

BENZ R

HIGH TEMP SCI 2, 221 (1970)

U-UO2-UN2 PHASE DIAGRAM

VARIOUS PHASE REGIONS ARE DEDUCED FROM METALLOGRAPHIC, DEBYE-SCHERER AND HIGH-TEMPERATURE X-RAY DIFFRACTION, AND CHEMICAL ANALYSIS DATA. THE MONOTECTIC TEMPERATURE IN THE U-UO SUB 2 SYSTEM, 2480 DEG, IS LOWERED BY ADDITION OF NITROGEN TO 2340#30 DEG. A 4-PHASE, UO SUB 2 + UN + L SUB 1 + L SUB 2 (L DENOTES LIQUID), STATIONARY POINT EXISTS AT 2340 DEG. AT THE UO SUB 2-UN PSEUDO-BINARY EUTECTIC, 2610#40 DEG AND 0.55#0.15 ATM N SUB 2, SOLUBILITY OF NITROGEN IN THE UO SUB 2 PHASE IS 4 ATOMIC %. BOTH U AND OXYGEN DISSOLVE TO AN APPRECIABLE EXTENT IN UN COEXISTING WITH U(L) + UO SUB 2. THE ATOMIC SOLUBILITIES OF U AND OXYGEN ARE APPROXIMATELY THE SAME WITH A MAXIMUM OF 3 ATOMIC % AT 2100 DEG. A COMPLETE SERIES OF SOLID SOLUTIONS (SS) EXISTS BETWEEN CAF SUB 2-TYPE UO SUB 2 AND MN SUB 2 O SUB 3-TYPE A-U SUB 2 N SUB 3 AT TEMPERATURES ABOVE 1350 DEG. A 3-PHASE REGION EXISTS BETWEEN UN, HEXAGONAL B-U SUB 2N SUB 3, AND UO SUB 0.27N SUB 1.22 (SS) AT 1400 DEG. THE SS' COMPOSITION IN THE 3-PHASE MIXTURE AT 1200 DEG IS UO SUB 0.23N SUB 1.33.

ABSTRACT 106

BENZ R

J AM CHEM SOC 88, 264 (1966)

SOME PHASE EQUILIBRIA IN THE URANIUM-NITROGEN SYSTEM

REACTION LAYERS WERE FORMED ON URANIUM AT VARIOUS TEMPERATURES UP TO 2400 DEG C IN NITROGEN (0.003 TO 2 ATM). REACTION WITH SOLID URANIUM IS PROPAGATED BY SPALLING AND IS MOST RAPID NEAR 800 DEG C. REACTION WITH LIQUID URANIUM OCCURS BY TWO PARALLEL PROCESSES, DIFFUSION THROUGH AND FRACTURING OF UN LAYERS. FROM OBSERVED THICKNESSES OF FRACTURE-FREE LAYERS, CONCENTRATION GRADIENT CHEMICAL INTERDIFFUSION COEFFICIENTS WERE CALCULATED. MARKER EXPERIMENTS INDICATE THAT THE UN LAYERS FORM BY INWARD DIFFUSION OF NITROGEN ATOMS FROM WHICH ARE DEDUCED NITROGEN SELF-DIFFUSION COEFFICIENTS REPRESENTED BY THE EQUATION $D \times 10^5 \text{ SUB } N (\text{CM}^2/\text{SEC}) = 12 \text{ EXP} - (120 + 25)(\text{KCAL}/\text{MOLE})/RT$. NITROGEN SELF DIFFUSION COEFFICIENTS ARE ALSO DEDUCED FROM ESTIMATED NITROGEN ACTIVITY GRADIENTS AND THESE EXHIBIT A DEPENDENCE ON NITROGEN PRESSURE. URANIUM-SATURATED UN COMPOSITIONS RANGE FROM $N/U = 0.991$ TO $0.997 + 0.006$ TEMPERATURES ABOVE 1600 DEG C. CHANGE IN N/U RATIO ACROSS THE UN PHASE IS 0.005 AT ABOUT 1600 DEG C.

ABSTRACT 107

BENZ R

J NUCL MATER 31,93 (1969)

MELTING POINT MAXIMUM OF THC-THN AND OF UC-UN SOLID SOLUTION

MELTING POINTS OF THC-THN AND UC-UN MIXTURES IN NITROGEN ATMOSPHERES WERE DETERMINED. MAXIMA OCCUR 2910 ± 35 DEG C WITH THE COMPOSITIONS $\text{THC SUB } 0.35 \text{ N SUB } 0.65 \pm 0.1$ AND $\text{UC SUB } 0.3 \text{ N SUB } 0.7 \pm 0.1$. FROM A DETERMINATION OF THE NITROGEN ACTIVITY THE EXCESS FREE ENERGIES OF MIXING THE TERMINAL MONONITRIDES AT 2820 DEG C IN THE RESPECTIVE PSEUDO-BINARY SOLID SOLUTIONS ARE INFERRED TO BE -392 ± 2.0 KCAL/MOLE AT THE THN MOLE FRACTION OF 0.45 AND -0.7 ± 1.5 KCAL/MOLE AT THE UN MOLE FRACTION OF 0.50.

ABSTRACT 108

BENZ R

J NUCL MATER 36,135 (1970)

U+N SUB 2 REACTION LAYER GROWTHS

PORTIONS OF THE U-N PHASE DIAGRAM WERE DETERMINED BY X-RAY, METALLOGRAPHIC, CHEMICAL, AND THERMAL ANALYSES OF PHASES EQUILIBRATED WITH $N \text{ SUB } 2$ (UP TO 5 ATM.) AT TEMPERATURES UP TO 2850 DEG. THE U-UN PORTION OF THE DIAGRAM IS A EUTECTIC WITH THE EUTECTIC COMPOSITION NEAR PURE U. THE UN PHASE REGION HAS A U-RICH BOUNDARY WITH AN $N:U$ RATIO EQUAL TO OR LESS THAN 0.96 ± 0.02 AT 1500 DEG AND 0.92 ± 0.02 AT 1800 DEG. THE N-RICH BOUNDARY HAS AN $N:U$ RATIO OF 1.04 ± 0.02 AT 1600 DEG. THE MONONITRIDE MELTS CONGRUENTLY WITH THE $N:U$ RATIO 0.96 ± 0.03 AT 2835 ± 30 DEG. THE BODY-CENTERED-CUBIC HEXAGONAL TRANSITION OF THE SESQUINITRIDE WAS FOUND TO OCCUR AT 1120 DEG, BUT THE TRANSITION TEMPERATURE MAY BE DEPENDENT ON COMPOSITION. THE COMPOSITION OF THE HEXAGONAL PHASE IS UN SUB 1.47 ± 0.02 NEAR THE DECOMPOSITION PRESSURE AT 1315 DEG.

ABSTRACT 109

BENZ R

J NUCL MATER 42, 217 (1972)

X-RAY DIFFRACTION OF UC-UC SUB 2 AND UC-UN ALLOYS AT ELEVATED TEMPERATURES

UNIT-CELL DIMENSIONS OF U-C-N ALLOYS WERE MEASURED AT TEMPERATURES OF 760 TO 2250 DEG C WITH AN X-RAY DIFFRACTOMETER. LATTICE DIMENSIONS OF THE FACE-CENTERED CUBIC PHASE IN BOTH THE UC-UC SUB 2 AND UC-UN SOLUTIONS ARE FOUND TO BE LINEAR FUNCTIONS OF THE UC MOLE FRACTION. IN CARBON SATURATED BODY-CENTERED TETRAGONAL α -UC SUB 2 BETWEEN 1000 AND 1400 DEG C, A SMALL BUT DISTINCT DECREASE IN RATE OF VOLUME CHANGE (SLOPE) OCCURS WITH INCREASING TEMPERATURE. THE DATA SUGGEST THAT THE C/U RATIO IN α -UC SUB 2 AT 1000 DEG C AND BELOW IS 1.97 ± 0.03 , A VALUE IN EXCESS OF THAT PREVAILING IN CARBON-SATURATED α -UC SUB 2 AT HIGHER TEMPERATURES.

ABSTRACT 110

RJORKLUND C W

BULL AM CERAM SOC 46, 901 (1967)

SELF-IRRADIATION DAMAGE IN PLUTONIUM CERAMICS

THE LATTICE DIMENSIONS OF VARIOUS COMPOUNDS INCLUDING PUO SUB 2, PUN, AND SEVERAL PU CARBIDES WERE DETERMINED AFTER STORAGE IN THE -200 DEG TO +400 DEG C RANGE. DOSE RATES WERE VARIED BY INCREASING THE ^{238}Pu ISOTOPIC ABUNDANCE.

ABSTRACT 111

BLANK H

KFK-105 (1962)

BINARY AND MULTICOMPONENT SYSTEMS WITH PLUTONIUM. LITERATURE SEARCH, PHASE DIAGRAMS, AND DATA.

A BIBLIOGRAPHIC SURVEY IS MADE OF THE PHASE DIAGRAMS AND PROPERTIES OF BINARY AND MULTICOMPONENT SYSTEMS WITH PLUTONIUM. DATA WERE PRESENTED ON THE FOLLOWING SYSTEMS: PU-C, PU-C-U, PU-N. REVIEWED PROPERTIES OF CARBIDES AND NITRIDES.

ABSTRACT 112

BLUMENTHAL B

J NUCL MATER 2, 197 (1960)

CONSTITUTION OF LOW CARBON U-C ALLOYS

THE URANIUM-CARBON PHASE DIAGRAM AT LOW CARBON CONCENTRATION WAS DETERMINED BY SATURATION EXPERIMENTS, THERMAL ANALYSES, AND METALLOGRAPHY. THE SYSTEM HAS AN EUTECTIC POINT OF 0.98 AT % CARBON AT 1116.6 DEG C AND TWO EUTECTOID REACTIONS: U SUB (Y) = U SUB (B) + UC AND U SUB (B) = U SUB (α) + UC AT 771.8 DEG C, AND 665.9 DEG C, RESPECTIVELY, 3.0 AND 1.8 DEG C BELOW THE TRANSFORMATION TEMPERATURES OF THE PURE METAL. THE GAMMA SOLUBILITY DECREASES FROM 0.30 ± 0.075 AT.% AT THE EUTECTIC TEMPERATURE TO 0.09 ± 0.04 AT.% AT THE EUTECTOID TEMPERATURE. THE SOLUBILITY OF CARBON IN BETA URANIUM IS PROBABLY LESS THAN 10 PPM BY WEIGHT, IN ALPHA URANIUM LESS THAN 3 PPM.

ABSTRACT 113

BOCKER S

PLUTONIUM 1970 AND OTHER ACTINIDES (1970)
THE U-PU-C-M CARBIDES

IMPROVEMENTS IN THE FABRICATION AND THE PROPERTIES OF URANIUM-PLUTONIUM CARBIDES WERE SOUGHT BY THE ELIMINATION OF THE SESQUICARBIDE AND DICARBIDE PHASES. THE SYSTEMS STUDIED ARE U-PU-C-ZR, U-PU-C-TI, AND U-PU-C-MO. TWO DIFFERENT WAYS OF FABRICATION WERE EMPLOYED: - ARC CASTING IN GRAPHITE MOLOS - SINTERING THE SINGLE PHASE (U,PU)C IS REPLACED BY: - THE SINGLE (U,PU,ZR)C PHASE, - THE TWO (U,PU)C + TIC PHASES, - THE THREE (U,PU)C + (U,PU)C SUB 1.7 MO & MO PHASES, IN ACCORDANCE WITH THE ELEMENT ADDED. AN OBVIOUS IMPROVEMENT WAS NOTED FOR THE COMPATIBILITY BETWEEN 316 STAINLESS STEEL AND U-PU-C-ZR OR U-PU-C-MO BUT THE COMPATIBILITY BETWEEN STEEL AND U-PU-C-TI OR U-PU-C WAS FOUND SIMILAR. THERMAL CONDUCTIVITIES ARE MUCH HIGHER FOR CAST U-PU-C-ZR, U-PU-C-TI., SINTERED AND CAST U-PU-C-MO THAN FOR SINTERED U-PU-C. THE ATMOSPHERIC CORROSION AT 25 DEG C IS IMPROVED FOR ALL THREE SYSTEMS COMPARED TO CAST U-PU-C. TAKING INTO CONSIDERATION THE RESULTS OBTAINED, THE MIXED CARBIDES U-PU-C-M AND MAINLY U-PU-C-ZR SEEM TO PRESENT A GREAT INTEREST AS A FAST REACTOR NUCLEAR FUEL.

ABSTRACT 114

BOETTCHER A

PEACEFUL USES AT ENRGY, GENEVA, VOL 6, 561 (1958)
SOME PROPERTIES OF URANIUM MONOCARBIDE

VARIOUS PROPERTIES OF URANIUM MONOCARBIDE WERE MEASURED. SPECIFIC HEAT FROM 125 DEG TO 250 DEG C, THERMAL EXPANSION COEFFICIENT FROM 20 DEG TO 1000 DEG C AND THERMAL CONDUCTIVITY FROM 60 DEG TO 265 DEG C WERE MEASURED. VALUES FOR ELECTRICAL RESISTANCE AT ROOM TEMPERATURE AND VICKER HARDNESS ARE ALSO GIVEN.

ABSTRACT 115

BONCOEUR M

J NUCL MATER 25, 271 (1968)

LES MONOCARBOXYDES D'URANIUM DEFICITAIRES EN METALLOIDES: COMPOSITION ET PARAMETRE RETICULAIRE

IT HAS BEEN EXPERIMENTALLY ESTABLISHED THAT THERE IS A DEFICIT IN CARBON AND OXYGEN IN URANIUM MONOCARBOXYIDE PREPARED AT 1600 DEG C IN THE PRESENCE OF EXCESS URANIUM. THE FORMULA IS TO BE REPRESENTED AS $UO_{1-x}C_{1-y}$ WHERE x DENOTES A VACANCY. THE MEAN VALUE OF CARBON AND OXYGEN DEFICIENCY IS $x=0.054 \pm 0.03$, AND THE LIMITING OXYGEN SOLUBILITY IS ABOUT 0.35 OXYGEN ATOM PER URANIUM ATOM, THAT IS, THE SAME RATIO AS IN STOICHIOMETRIC MONOCARBOXYIDES. FOR A FIXED OXYGEN CONTENT, THE DEFICIENT MONOCARBOXYIDES HAVE SMALLER LATTICE PARAMETERS THAN THE STOICHIOMETRIC MONOCARBOXYIDES, SO LONG AS OXYGEN SATURATION HAS NOT BEEN REACHED. THIS DIFFERENCE IN PARAMETER CAN BE INTERPRETED IN TERMS OF THE MISSING CARBON AND OXYGEN ATOMS IF ONE ASSUMES THAT OXYGEN HAS ITS COVALENT ATOMIC RADIUS.

ABSTRACT 116

BONCOEUR M

J NUCL MATER 28 , 233 (1968)

EFFECT OF OXYGEN ON THE REGION OF EXISTENCE OF UC PHASES

PHASE BOUNDARY BETWEEN UC AND U + UC IS STUDIED UP TO ABOUT 2100 DEG C.

ABSTRACT 117

BOUCHER R

PLUTONIUM 1965, P485

A STUDY OF PLUTONIUM-BASED ALLOYS CARRIED OUT AT FONTENAY-AUX-ROSES

RESULTS ARE GIVEN OF STUDIES ON THE FABRICATION, STRUCTURE, PHASE TRANSFORMATIONS, EXPANSION COEFFICIENTS, THERMAL CYCLING AND ATMOSPHERIC CORROSION BEHAVIOR OF VARIOUS PLUTONIUM ALLOYS. THE FIRST PART IS CONCERNED WITH THE PRINCIPAL PROPERTIES OF U-PU-MO, U-PU-NB, U-PU-TI AND U-PU-ZR ALLOYS, WHILST THE SECOND PART RELATES TO THE U-PU-FE ALLOYS FOR THE CRITICAL EXPERIMENT MASURCA, THIS WORK BEING SUPPORTED BY THE EURATOM-CEA ASSOCIATION. FINALLY, INITIAL RESULTS ON U-PU-C-MO, U-PU-C-TI AND U-PU-C-ZR ALLOYS ARE REPORTED.

ABSTRACT 118

BOWERSOX D F

J NUCL MAT 21, 219 (1967)

THE SOLUBILITIES OF CARBON, TANTALUM, TUNGSTEN AND RHENIUM IN LIQUID PU

THE SOLUBILITIES OF C, TA, W, AND RE IN LIQUID PU HAS BEEN MEASURED INDIVIDUALLY FROM 700 DEG TO 950 DEG C. AT 750 DEG C THE MOLE FRACTIONS OF THE SOLUTES WERE 0.0161, 0.000850, 0.0000720, AND 0.0162, RESPECTIVELY. THE SOLUBILITIES HAD INCREASED TO 0.0447, 0.00352, 0.000379, AND 0.0405, RESPECTIVELY, AT 950 DEG C. THE DATA FOR EACH ELEMENT WERE FITTED TO AN EQUATION OF THE FORM $\log N_{\text{SUB } X} = A - B/T$, WHERE $N_{\text{SUB } X}$ IS THE SOLUBILITY OF THE ELEMENT X EXPRESSED AS THE MOLE FRACTION AND T IS THE TEMPERATURE IN DEG K.

ABSTRACT 119

BOWERSOX D F

LAMS-2832 (1963)

THE SOLUBILITY OF SELECTED ELEMENTS IN LIQUID PU, I: CARBON

THE SOLUBILITY OF CARBON IN LIQUID PLUTONIUM HAS BEEN MEASURED OVER THE TEMPERATURE RANGE 700 DEG -950 DEG C. THE SOLUBILITY INCREASES FROM 690 PPM (BY WEIGHT) C AT 700 DEG TO 2350 PPM C AT 950 DEG C. THE DATA FIT THE EMPIRICAL EQUATION $\log N_{\text{SUB } C} = 0.50 - 2.30 \times 10^3/T$, WHERE $N_{\text{SUB } C}$ IS THE MOLE FRACTION OF C AND T IS THE TEMPERATURE IN DEGREES KELVIN.

ABSTRACT 120

BOWERSOX D F

PLUTONIUM 1970 VOL 1, P120

THE PARTIAL MOLAR ENTHALPIES OF SOLUTION OF SEVERAL ELEMENTS WHICH FORM COMPOUNDS WITH PLUTONIUM HAVE BEEN CALCULATED BY REGULAR SOLUTION THEORY FROM SOLUBILITY DATA. THE CALCULATED ENTHALPIES ARE (IN KCAL/MOLE): CARBON, 10.5; THULIUM, 9.2; MANGANESE, 4.8; AND RHENIUM, 10.5. THE PARTIAL MOLAR ENTHALPIES OF SOLUTION OF TITANIUM AND ZIRCONIUM, WHICH

ABSTRACT 120 (CONT'D)

FORM SOLID SOLUTIONS WITH PLUTONIUM, WERE ALSO CALCULATED IN LIQUID PLUTONIUM FROM SOLUBILITY DATA. AN EXTRA ENTROPY TERM WAS ADDED TO REGULAR SOLUTION THEORY TO ACCOUNT FOR THE CONFIGURATIONAL ENTROPY DUE TO THE SOLUBILITY OF THE SOLUTE IN THE SOLID SOLUTION. THE CALCULATED ENTHALPIES ARE (IN KCAL/MOLE): ZIRCONIUM, 4.2; TITANIUM, 4.1 FROM 700 DEG TO 750 DEG C, AND 5.3 FROM 800 DEG TO 1000 DEG C.

ABSTRACT 121

BOWMAN A L

ACTA CRYST 21, 670 (1966)

THE CRYSTAL STRUCTURES OF UC SUB 2

A HIGH-TEMPERATURE NEUTRON DIFFRACTION STUDY OF UC SUB 2 SHOWS A TETRAGONAL PHASE AT 1700 DEG C WITH THE C11A CALCIUM CARBIDE TYPE STRUCTURE, A SUB O=3.633, C SUB O=6.036A, Z=0.395, AND A CUBIC PHASE AT 1900 DEG C WITH THE B1 SODIUM CHLORIDE TYPE STRUCTURE, A SUB O=5.488A. THE CUBIC PHASE CONTAINS C SUB 2 GROUPS WHOSE ALIGNMENT WAS REDUCED TO TWO POSSIBLE CASES, FREE ROTATION OR RANDOM ORIENTATION ALONG (111).

ABSTRACT 122

BOWMAN A L

J NUCL MATER 19, 111 (1966)

THERMAL EXPANSION OF URANIUM DICARBIDE AND URANIUM SESQUICARBIDE

THERMAL EXPANSION DATA FOR UC SUB 2 AND U SUB 2 C SUB 3 AT TEMPERATURES ABOVE 1000 DEG C HAVE BEEN OBTAINED FROM HIGH TEMPERATURE NEUTRON DIFFRACTION EXPERIMENTS. DATA FOR U SUB 2 C SUB 3 WAS OBTAINED IN THE TEMPERATURE RANGE OF 1100 TO 1730 DEG C AND FOR UC SUB 2 IN THE RANGE OF 1000 TO 2300 DEG C.

ABSTRACT 123

BOWMAN M G

THE FOURTH URANIUM CARBIDE CONFERENCE TID-7676, P128 (1963)

STUDIES WITHIN THE SYSTEM UC-UC SUB 2. II. THERMODYNAMIC PROPERTIES OF URANIUM CARBIDES

DURING THE PAST FEW YEARS, MANY STUDIES HAVE BEEN MADE OF PHASE RELATIONSHIPS, AND THERMODYNAMIC PROPERTIES OF DIFFERENT PHASES, IN THE U-C SYSTEM. THERMODYNAMIC STUDIES HAVE INCLUDED HEAT OF COMBUSTION MEASUREMENTS ON UC, U SUB 2 C SUB 3 AND "UC SUB 2" AND "UC SUB 2" (UC SUB 1.86), HEAT CAPACITY MEASUREMENTS ON UC AND "UC SUB 2" (UC SUB 2-X), AND VAPORIZATION CHARACTERISTICS OF UC AND "UC SUB 2". UNFORTUNATELY, THE HEAT CAPACITY MEASUREMENTS AND, IN PARTICULAR, THE VAPORIZATION STUDIES HAVE PRODUCED CONFLICTING DATA. IN VIEW OF THIS CONFLICT, RESULTS FROM ADDITIONAL STUDIES (EVEN PRELIMINARY RESULTS FROM WORK IN PROGRESS) ARE OF INTEREST TO THOSE DIRECTLY CONCERNED WITH U-C SYSTEM. SEVERAL STUDIES HAVE BEEN PERFORMED AT THE LOS ALAMOS SCIENTIFIC LABORATORY WHICH HAVE PRODUCED DATA PERTINENT TO ANY EVALUATION OF THE THERMODYNAMIC PROPERTIES OF THE URANIUM CARBIDES. MOST OF THESE OBSERVATIONS AND PAPERS HAVE ALREADY BEEN PUBLISHED. SOME MEASUREMENTS ARE NOW IN PROGRESS AND PRELIMINARY RESULTS HAVE BEEN OBTAINED.

ABSTRACT 124

BRADBURY B T

AED-CONF 65-307-44

ACCOUNT OF SOME WORK ON THE SAFETY ASPECTS OF CARBIDE FAST REACTOR FUELS

THE EXPERIMENTAL RESULTS THUS FAR OBTAINED ON THREE ASPECTS OF FUEL AND CLADDING BEHAVIOR WHICH ARE IMPORTANT TO THE SAFETY OF AN OPERATING FUEL ELEMENT ARE DESCRIBED AND DISCUSSED. THESE ARE THE COMPATIBILITY OF (UPU)C AND UC WITH 316L STAINLESS STEEL CLADDING MATERIAL UNDER BOTH GAS BONDED AND SODIUM BONDED CONDITIONS, THE COMPATIBILITY OF (UPU)C WITH A NUMBER OF NICKEL-BASED ALLOYS, THE GAS RELEASE AND SWELLING BEHAVIOR OF (UPU)C OF VARYING COMPOSITION USING SINTERED, ARC-CAST, AND POWDER FUEL, AND SOME INITIAL EXPERIMENTS ON PLUTONIUM-BEARING OXYCARBIDES WHICH GIVE SOME INDICATION OF THE STABILITY OF THESE FUELS AT HIGH TEMPERATURES.

ABSTRACT 125

BRADBURY B T

ANL-7120, P328 (1965)

AN ACCOUNT OF SOME WORK ON THE SAFETY ASPECTS OF CARBIDE FAST REACTOR FUELS

IN SUMMARY, THREE ASPECTS OF FUEL AND CLADDING BEHAVIOR OF IMPORTANCE TO THE SAFETY OF AN OPERATING FUEL ELEMENT ARE UNDER INVESTIGATION: THE COMPATIBILITY OF (UPU)-C AND U-C WITH 316L STAINLESS STEEL CLADDING MATERIAL UNDER BOTH GAS-BONDED AND SODIUM-BONDED CONDITIONS. THE COMPATIBILITY OF (UPU)-C WITH A NUMBER OF NICKEL-BASED ALLOYS HAS BEEN INVESTIGATED; THE GAS RELEASE AND SWELLING BEHAVIOR OF (UPU)-C OF VARYING COMPOSITION, USING SINTERED, ARC-CAST, AND POWDER FUEL. IRRADIATIONS IN BOTH THERMAL AND FAST FLUXES ARE BEING CARRIED OUT; WITH THE GROWING INTEREST IN PLUTONIUM-BEARING OXYCARBIDES, SOME INITIAL EXPERIMENTS HAVE BEEN COMPLETED WHICH GIVE SOME INDICATION OF THE STABILITY OF THESE FUELS AT HIGH TEMPERATURES. THE EXPERIMENTAL RESULTS SO FAR OBTAINED ARE DESCRIBED AND DISCUSSED IN THIS PAPER.

ABSTRACT 126

BRADBURY B T

PLUTONIUM 1965 P349 (1967)

THE IRRADIATION BEHAVIOR OF PLUTONIUM-URANIUM MONOCARBIDE

THIS PAPER DESCRIBES WORK WHICH HAS BEEN CARRIED OUT AT HARWELL TO STUDY THE BEHAVIOR OF (UO.85 PU0.15)C UNDER IRRADIATION. TWO OF THE PRINCIPAL VARIABLES IN THESE EXPERIMENTS HAVE BEEN THE METHOD OF FABRICATION (ARC-MELTING AND SINTERING) AND THE CARBON CONTENT. BRIEF DESCRIPTIONS ARE GIVEN OF THE METHODS USED. MINIATURE FUEL ELEMENTS, SEALED STAINLESS STEEL TUBES CONTAINING FUEL, HAVE BEEN IRRADIATED IN DIDO AT HARWELL AND IN THE DOUNREAY FAST REACTOR TO BURNUPS OF UP TO 8% (U + PU) ATOMS. THE SWELLING BEHAVIOR OF THE FUEL, THE MIGRATION OF FISSION PRODUCTS (PARTICULARLY XE AND KR) AND THE THERMAL CONDUCTIVITY OF THE FUEL HAVE BEEN STUDIED AS A FUNCTION OF COMPOSITION AND IRRADIATION EXPOSURE. THESE EXPERIMENTS HAVE BEEN SUPPORTED BY MORE FUNDAMENTAL STUDIES OF THE KINETICS AND MECHANISMS OF FISSION GAS MOVEMENT AND RELEASE IN THIS FUEL.

ABSTRACT 127

BRADBURY B T

STUDIES IN RADIATION EFFECTS ON SOLIDS 11, 159 (1967)
RADIATION EFFECTS IN CERAMIC FUELS

RADIATION DAMAGE PROCESSES ARE DISCUSSED. ELECTRON MICROSCOPY HAS BEEN APPLIED FOR STUDYING FISSION TRACTS AND POINT DEFECTS AND LOOPS. PHYSICAL PROPERTY MEASUREMENTS ON UO₂, CARBIDES, AND NITRIDES ARE PRESENTED. THE PRODUCTION AND BEHAVIOR OF GASEOUS AND SOLID FISSION PRODUCTS IN CERAMIC FUELS ARE DISCUSSED. THE FISSION PRODUCTS AND SWELLING BEHAVIOR OF OXIDES AND CARBIDES ARE SUMMARIZED.

ABSTRACT 128

BRETT N H

CARBIDES IN NUCLEAR ENERGY 162 (1964)

THE SUBSTITUTIONAL SOLUBILITY OF OXYGEN IN U-C, (U SUB 0.85 PU SUB 0.15)-C AND PU-C

THE FIRST PART OF THE PAPER DESCRIBES STUDIES ON THE FORMATION OF UC SUB X O SUB Y IN COMPACTS OF POWDERED URANIUM, URANIUM DIOXIDE AND GRAPHITE HEATED IN VACUUM TO TEMPERATURES OF 1100 DEG C TO 1500 DEG C. CERAMOGRAPHIC, X-RAY AND CHEMICAL ANALYSES OF THE PRODUCTS SHOWED THE LIMITING OXYGEN CONTENT UNDER THESE CONDITIONS TO CORRESPOND TO APPROXIMATELY UC SUB 0.7 O SUB 0.3, THE LATTICE PARAMETER DECREASING FROM ABOUT 4.96 Å TO 4.95 Å WITH INCREASING OXYGEN. SIMILAR TECHNIQUES WERE USED TO STUDY THE SOLUTION OF OXYGEN IN POWDERS OF U-C, (U SUB 0.85 PU SUB 0.15)-C AND PU-C DURING HEAT TREATMENT IN ARGON AT 1500 DEG C, THE OXYGEN BEING INTRODUCED BY EXPOSURE OF THE POWDER TO ARGON OF CONTROLLED IMPURITY CONTENT BEFORE HEAT TREATMENT. UNDER THESE CONDITIONS THE LIMIT OF OXYGEN SOLUBILITY IN U-C AND (U SUB 0.85 PU SUB 0.15)-C IS ABOUT 0.25 WT% WHILST PU-C DISSOLVED 1 WT% OXYGEN.

ABSTRACT 129

BREWER L

MODC-1543 (1947)

THE THERMODYNAMIC PROPERTIES AND EQUILIBRIA AT HIGH TEMPERATURES OF URANIUM HALIDES OXIDES NITRIDES AND CARBIDES

VALUES OF THERMODYNAMIC DATA ARE GIVEN FOR THE HALIDES, OXIDES, NITRIDES, AND CARBIDES OF URANIUM. TABLE I CONTAINS MELTING POINT, VAPOR PRESSURE, AND BOILING POINT DATA. TABLE II GIVES VAPORIZATION EQUATIONS AND CONSTANTS. TABLE III GIVES THE THERMODYNAMIC DATA FOR THE AQUEOUS IONS WHICH WERE USED IN CONJUNCTION WITH THE DATA FOR THE SOLID SUBSTANCES. TABLE IV CONTAINS HEATS OF FORMATION AND VALUES OF $(\Delta F - 2H \text{ SUB } 298)/T$ FROM 298 DEG K TO 1500 DEG K. TABLE V CONTAINS THE ENTROPIES AT 298 DEG K AND $-(F - H \text{ SUB } 298)/T$ FOR THE COMPOUNDS. TABLE VI GIVES THE HEAT CONTENT AND ENTROPY INCREASES ABOVE 298 DEG K. REFERENCES ARE GIVEN FOR ALL DATA CITED AND A DISCUSSION OF THE CHEMISTRY OF EACH COMPOUND IS INCLUDED WITH THE REFERENCES. TWELVE FIGURES ARE PRESENTED TO SHOW THE SPECIES THAT EXIST WHEN A HALIDE IS HEATED AT CONSTANT PRESSURES OF ONE ATMOSPHERE, 10⁻³ ATM, AND 10⁻⁶ ATM. THIS REPORT, WHICH WAS ORIGINALLY RELEASED ON SEPTEMBER 20, 1945, WAS REVISED ON APRIL 1, 1947 TO AGREE WITH NEW DATA ON THE HEATS OF FORMATION OF AQUEOUS IONS. IN ADDITION, OTHER EXTENSIVE REVISIONS WERE CARRIED OUT.

ABSTRACT 130

BRIGGS G

CARBIDES IN NUCLEAR ENERGY VOL 1, 231 (1964)

PHASE RELATIONSHIPS IN THE SYSTEMS U-CR-C, U-NI-C, AND U-FE-CR-C

PHASE EQUILIBRIUM RELATIONSHIPS, INCLUDING MELTING RELATIONSHIPS, HAVE BEEN INVESTIGATED IN THE TERNARY SYSTEMS U-CR-C AND U-NI-C AND THE SECTION UC-FE-CR OF THE QUATERNARY SYSTEM, USING A QUENCHING TECHNIQUE. IN THE SYSTEM U-CR-C, THE JOINS UC-CR, UC-CR SUB 23 C SUB 6, UC-CR SUB 7 C SUB 3, UC-UCR SUB 2 AND UCR SUB 2-CR SUB 7 C SUB 3 HAVE BEEN ESTABLISHED. THE PHASE BOUNDARIES ON THE LIQUIDUS SURFACE IN THE PARTIAL SYSTEM UC-CR SUB 7 C SUB 3 -CR HAVE ALSO BEEN DETERMINED. IN THE SYSTEM U-NI-C, THE INCOMPATIBILITY IN THE SOLID STATE BETWEEN UC AND NICKEL HAS BEEN CONFIRMED AND CERTAIN FEATURES OF THE LIQUIDUS SURFACE INVESTIGATED. THE SECTION UC-FE-CR OF THE SYSTEM U-FE-CR-C IS UNUSUAL IN THAT WHILE IRON AND CHROMIUM ARE BOTH COMPATIBLE WITH UC IN THE SOLID STATE, FE-CR SOLID SOLUTIONS REACT WITH IT TO FORM UFE SUB 2 AND A CR SUB 23 C SUB 6 PHASE, PROBABLY CONTAINING SOME IRON IN SOLID SOLUTION. THE LIMITS OF THE PRIMARY PHASE FIELDS IN THE SECTION HAVE BEEN ESTABLISHED.

ABSTRACT 131

BRIGGS G

TRANS BRIT CERAM SOC 62,221 (1963)

SYSTEMS OF UC, UC SUB 2 AND UN WITH TRANSITION METALS.

THE PHASE EQUILIBRIUM RELATIONS IN SYSTEMS OF UC, UC SUB 2, AND UN WITH CR, FE, AND NI WERE INVESTIGATED. POWDERED MIXTURES WERE COLD-PRESSED TO FORM PELLETS AND HEATED IN THORIA CRUCIBLES IN AN ATMOSPHERE OF PURIFIED AR UNTIL EQUILIBRIUM WAS REACHED, AT TEMPERATURES BETWEEN 1000 AND 2000 DEG C. THE SPECIMENS WERE THEN COOLED AND EXAMINED METALLOGRAPHICALLY AND BY X-RAYS FOR PHASE IDENTIFICATION. SOLIDUS AND LIQUIDUS TEMPERATURES WERE DETERMINED FOR SELECTED COMPOSITIONS BY METALLOGRAPHIC EXAMINATION OF PELLETS THAT WERE FIRED AT VARIOUS TEMPERATURES. THE SYSTEMS UC-CR, UC-FE, UC-FE SUB 2, AND UN-FE WERE FOUND TO BE OF THE SIMPLE EUTECTIC TYPE WITH NO EVIDENCE OF SOLID SOLUBILITY. UC AND NI WERE FOUND TO BE INCOMPATIBLE AND THE SOLID PHASE DISTRIBUTION IN THE TERNARY SYSTEM U-NI-C WAS ESTABLISHED. IN THE SYSTEM UN-NI LOSS OF NI OCCURRED WITH FORMATION OF UN1 SUB 5 AT THE N PRESSURE PREVAILING DURING THE EXPERIMENTS. IN THE UC SUB 2 - FE SYSTEM A COMPOUND UFEC SUB 2 FORMS BY A PERITECTIC REACTION BETWEEN UC SUB 2 AND THE LIQUID PHASE AND FORMS A EUTECTIC WITH FE. PRELIMINARY INVESTIGATIONS SUGGEST THAT THE TIE UC SUB 2 -CR DOES NOT EXIST IN THE SYSTEM U-CR-C. SOME THERMODYNAMIC CONSIDERATIONS ARE ALSO PRESENTED.

ABSTRACT 132

BROWNLEE L D

J INST METALS 87 PART 2, 58 (1958)

THE PSEUDO-BINARY SYSTEMS OF URANIUM CARBIDE WITH ZIRCONIUM CARBIDE, TANTALUM CARBIDE, AND NIOBIUM CARBIDE

THE THREE PSEUDO-BINARY SYSTEMS OF URANIUM CARBIDE WITH ZIRCONIUM CARBIDE, TANTALUM CARBIDE, AND NIOBIUM CARBIDE RESPECTIVELY HAVE BEEN EXAMINED. METHODS THAT HAVE BEEN DEVELOPED FOR HANDLING THE HIGHLY PYROPHORIC URANIUM CARBIDE POWDER ARE DESCRIBED. THE MELTING-POINT/MOLECULAR-COMPOSITION CURVES WERE DETERMINED FOR EACH SYSTEM AND FOUND TO BE SMOOTH CURVES. X-RAY ANALYSIS SHOWS THAT A COMPLETE RANGE OF SOLID SOLUTIONS EXISTS IN EACH SYSTEM AND THAT THE

ABSTRACT 132 (CONT'D)

LATTICE-SPACING/MOLECULAR-COMPOSITION CURVES OBEY VEGARDS LAW VERY CLOSELY.

ABSTRACT 133

BRUCKLACHER D

CEGR INT CONF ON PHYS METALLURGY OF REACTOR FUEL ELEMENTS (1973)
CREEP OF FISSILE CERAMIC MATERIALS UNDER NEUTRON IRRADIATION

THE CREEP STRAIN-RATE FOR UN IS LOWER BY X30 COMPARED TO UO SUB 2. CREEP IS ENHANCED BY IRRADIATION AT TEMPERATURES < 900 DEG C. THEORETICAL CONSIDERATIONS INDICATE THAT UN AND UC SHOULD CREEP AT A LOWER RATE THAN UO SUB 2 AT LOW TEMPERATURES APPROX X300 AT MAXIMUM). ABOVE 900 TO 1000 DEG C A STEEP RISE OF ϵ WITH T IS ANTICIPATED DUE TO FORMATION OF ORIENTED POINT DEFECT CLUSTERS OR TO THE INCREASE IN CONCENTRATION.

ABSTRACT 134

BRUCKLACHER D

FAST REACTOR FUEL AND FUEL ELEMENTS PROC OF INT MEETING GFK KARLSRUHE (1970)

INVESTIGATIONS ON CREEP OF CERAMIC NUCLEAR FUELS UNDER NEUTRON IRRADIATION

PRELIMINARY IN-REACTOR CREEP TESTS ON UN AND UC PELLETS (REL. DENSITY 94 OR 85% TD) WERE CONDUCTED. RADIAL AND AXIAL COMPRESSIVE STRESS WAS APPLIED AND CREEP CHARACTERISTICS WERE ASSESSED FROM DIMENSIONAL CHANGE, OF THE FUEL PELLETS (DIAMETER AND LENGTH). CREEP RESULTS WERE OBTAINED FOR UN (0.5 WT % O, GS APPROX 20 UM, 94% TD) AND UC (4.9 WT % C, 0.5 LT % O, 85% TD) AT FISSION RATE OF $2-3 \times 10^{11}-9/\text{SEC}$. A MAX. SPECIMEN TEMPERATURE OF 600 DEG C < T < 850 DEG C AT BURNUPS OF 15,000 AND 25,000 MWD/T AND PRESSURE OF APPROX 2.5 KP/MM². APPROXIMATE CREEP RATES BETWEEN 2.5×10^{-7} AND $1.25 \times 10^{-6}/\text{HR}$ WERE CALCULATED, I.E., AN ORDER OF MAGNITUDE LOWER THAN UO SUB 2 UNDER COMPARABLE CONDITIONS.

ABSTRACT 135

BRUCKLACHER D

J NUCL MATER 42,285 (1972)

CREEP BEHAVIOR OF CERAMIC NUCLEAR FUELS UNDER NEUTRON IRRADIATION

THEORETICAL ESTIMATION OF THE IRRADIATION-INDUCED CREEP RATE OF UO SUB 2 RESULTED IN A CREEP RATE RANGE BETWEEN ABOUT $6 \times 10^{-11}-6/\text{H}$ AND $8 \times 10^{-11}-5/\text{H}$ FOR A FISSION RATE OF 1×10^{14} F/CM³-SEC AND A STRESS OF 2 KGF/MM². CREEP IS ESSENTIALLY DUE TO THE "THERMAL RODS" ALONG THE FISSION FRAGMENT TRACKS. THEREFORE, CREEP RATES SHOULD DEPEND WEAKLY ON TEMPERATURE (BELOW 1000-1200 DEG C) AND MUST BE MARKEDLY LOWER FOR CARBIDE AND NITRIDE FUEL. TO PROVE THIS ESTIMATE BY EXPERIMENTS, SEVERAL TYPES OF IN-PILE CREEP CAPSULES WERE DEVELOPED BY WHICH THE LENGTH OR DIAMETER CHANGE OF PNEUMATICALLY LOADED FUEL SAMPLES CAN BE MEASURED CONTINUOUSLY. IN-PILE CREEP EXPERIMENTS ON UO SUB 2 WERE PERFORMED AT NOMINAL TEMPERATURES BETWEEN 250 AND 850 DEG C. THE CREEP RATES ARE PROPORTIONAL TO STRESS (0 TO 4 KGF/MM²) AND IN A PRELIMINARY APPROXIMATION, ALSO TO FISSION RATE (1×10^{13} TO 2×10^{14} F/CM³-SEC) AND ARE IN THE RANGE ESTIMATED BEFORE. WITHIN THE LIMITS OF INACCURACY, THE IN-PILE CREEP RATE IS INDEPENDENT OF TEMPERATURE (250-850 DEG C). IN-PILE CREEP TESTS ON SOME UN SAMPLES RESULTED IN CREEP RATES

ABSTRACT 135 (CONT'D)

THAT ARE LOWER BY AN ORDER OF MAGNITUDE THAN FOR UO₂ SUB 2 UNDER COMPARABLE CONDITIONS. THE POROSITY DEPENDENCE OF THE UN IN-PILE CREEP RATE WAS FOUND TO AGREE WITH AN ADEQUATE OUT-OF-PILE RELATIONSHIP FOR CERAMIC MATERIALS.

ABSTRACT 136

BRUCKLACHER D
KFK-817 (1968)

INVESTIGATIONS OF THE CREEP OF CERAMIC FUELS UNDER NEUTRON RADIATION

AN EFFECTIVE COEFFICIENT OF SELF DIFFUSION, D^* , UNDER IRRADIATION WAS DERIVED AND D^* WAS ESTIMATED FOR UO₂ SUB 2, UC AND UN.

ABSTRACT 137

BUCKLEY S N
AERE-R-3872 (1961)

THE FORMATION AND PROPERTIES OF SUB-STOICHIOMETRIC URANIUM MONOCARBIDE

THE LATTICE PARAMETER OF URANIUM MONOCARBIDE IN ARC MELTED U-UC ALLOYS VARIES WITH THE ALLOY CARBON CONTENT, REACHING A MINIMUM VALUE 4.950 Å AT 35 AT %C. SLIGHTLY SUB-STOICHIOMETRIC ALLOYS (47 AT %C) EXHIBIT COMPARABLE PARAMETER CHANGES IF QUENCHED FROM 2000 DEG C. ON ANNEALING THESE ALLOYS AT LOWER TEMPERATURES A PRECIPITATE OF URANIUM PARTICLES ABOUT 1/2 U IN SIZE IS OBSERVED IN THE CARBIDE GRAINS, AND THE LATTICE PARAMETER OF THE LATTER EXPANDS TO THE VALUE 4.960 Å CHARACTERISTIC OF THE STOICHIOMETRIC CARBIDE. THE PHENOMENA ARE INTERPRETED AS EVIDENCE OF A HITHERTO UNSUSPECTED SOLID SOLUBILITY OF URANIUM IN THE CARBIDE, THE CRYSTAL STRUCTURE OF WHICH BECOMES A DEFECT LATTICE WITH CARBON ATOMS MISSING FROM THEIR NORMAL POSITIONS IN THE NaCl TYPE STRUCTURE. A REVISED FORM OF THE SOLIDUS CURVE COMPUTED FROM THERMODYNAMIC DATA IN CONJUNCTION WITH THE EXPERIMENTAL RESULTS PREDICTS A MAXIMUM SOLID SOLUBILITY OF 1/2 AT %U IN UC AT ABOUT 2 000 DEG C.

ABSTRACT 138

RUGL J
RMI-1692 (1964)

PHASE THERMODYNAMIC OXIDATION AND CORROSION STUDIES OF THE SYSTEMS URANIUM-NITROGEN

THE PRESSURE-TEMPERATURE DEPENDENCE OF UN DECOMPOSITION AND MELTING, OF EQUILIBRIUM BETWEEN THE UN AND U SUB 2 N SUB 3 PHASES, AND OF NITROGEN SOLUTION IN THE U SUB 2 N SUB 3 PHASE WAS DETERMINED AS WELL AS THE SOLUBILITY OF UN IN LIQUID URANIUM, FROM THE EXPERIMENTAL DATA, THERMODYNAMIC FUNCTIONS FOR THE FORMATION OF U SUB 2 N SUB 3 FROM UN AND NITROGEN GAS AND FOR THE SOLUTION OF NITROGEN IN U SUB 2 N SUB 3 WERE DETERMINED. FOR THE LATTER, INTEGRATED THERMODYNAMIC FUNCTIONS FOR THE SOLUTION OF NITROGEN IN U SUB 2 N SUB 3 WERE CALCULATED. THE OXIDATION KINETICS OF UN IN CO SUB 2, OXYGEN, AND WATER-SATURATED AIR WERE FOUND TO OBEY THE LINEAR WEIGHT-GAIN LAW WITH ACTIVATION ENERGIES RANGING FROM 10400 TO 15400 CAL/MOLE. THE OXIDATION PRODUCT IN ATMOSPHERIC GAS AT TEMPERATURES OF 300 DEG C AND GREATER WAS U SUB 3 O SUB 8. UN CORRODED IN 300 DEG C WATER TO FORM UO₂ SUB 2, BUT THE RATE OF CORROSION WAS HIGHLY SENSITIVE TO STOICHIOMETRY AND TO DENSITY WITH CAST, 100% DENSE,

ABSTRACT 138 (CONT'D)

STOICHIOMETRIC UN EXHIBITING OPTIMUM CORROSION RESISTANCE AS COMPARED WITH NONSTOICHIOMETRIC UN PREPARED EITHER BY CASTING OR BY POWDER METALLURGY. CORROSION RATES IN 100 DEG C WATER, 350 DEG C SANTOWAX R, AND 820 DEG C NAK WERE LOW OR NEGLIGIBLE.

ABSTRACT 139

BUGL J

CONF-45-3 (1963)

PHASE RELATIONSHIPS IN THE URANIUM-NITROGEN SYSTEM

STUDIES WERE MADE TO DEVELOP URANIUM MONONITRIDE AS A FUEL MATERIAL AND TO PROVIDE INFORMATION ON THE IDENTITY AND EQUILIBRIUM RELATIONSHIPS BETWEEN THE VARIOUS PHASES. CRYSTALLOGRAPHY OF URANIUM-NITROGEN COMPOUNDS IS DISCUSSED. PREPARATION AND CHARACTERIZATION OF UN ARE DESCRIBED. MELTING POINT AND DECOMPOSITION PRESSURE, SOLUBILITY IN LIQUID URANIUM, DECOMPOSITION PRESSURE OF U SUB 2 N SUB 3, AND EQUILIBRIUM COMPOSITIONS IN THE U SUB 2 N SUB 3-UN SUB 2 REGION WERE DETERMINED.

ABSTRACT 140

BUGL J

IND SPEC REP SER 13 215 (1964); NUCL MET AIME 10, 215 (1964)

THERMODYNAMICS OF THE U SUB 2 N SUB 3 PHASE REGION.

THERMODYNAMIC FUNCTIONS FOR THE FORMATION OF U SUB 2 N SUB 3 FROM UN AND NITROGEN WERE CALCULATED ON THE BASIS OF VAPOR PRESSURE MEASUREMENTS OVER UN-U SUB 2 N SUB 3 MIXTURES, AND PARTIAL MOLAL QUANTITIES FOR THE SOLUTION OF NITROGEN IN U SUB 2 N SUB 3 WERE DETERMINED. FROM THE LATTER, INTEGRATED THERMODYNAMIC FUNCTIONS FOR THE SOLUTION OF NITROGEN IN U SUB 2 N SUB 3 WERE CALCULATED.

ABSTRACT 141

BUGL J

J AM CERAM SOC 47, 425 (1964)

PHASE RELATIONS IN THE SYSTEM URANIUM-NITROGEN

AT N PRESSURE < 2.5 ATM, UN DECOMPOSED < 2850 DEG. AT N PRESSURES > 2.5 ATM, UN MELTED CONGRUENTLY AT 2850 DEG. U SUB 2 N SUB 3 AND UN SUB 2, ALTHOUGH STRUCTURALLY DISSIMILAR, FORM A SERIES OF CONTINUOUS SOLID SOLUTIONS. AT HIGH PRESSURES AND LOW TEMPERATURES, ONLY UN SUB 2 FORMED. AT 1 ATM. N PRESSURE, UN DECOMPOSED AT 2800 DEG AND U SUB 2 N SUB 3 AT 1345 DEG.

ABSTRACT 142

BUGL J

NUCL MET AIME 10, 463 (1964)

CORROSION AND OXIDATION CHARACTERISTICS OF URANIUM MONONITRIDE

THE OXIDATION KINETICS OF UN IN CO SUB 2, OXYGEN, AND WATER-SATURATED AIR ARE FOUND TO OBEY THE LINEAR WEIGHT-GAIN LAW WITH ACTIVATION ENERGIES RANGING FROM 10,400 TO 15,400 CAL/MOLE. THE OXIDATION PRODUCT AT TEMPERATURES OF 300 C AND GREATER IS U SUB 3 O SUB 8. UN COPRODES IN 300 C WATER TO FORM UO SUB 2 BUT THE RATE OF CORROSION IS HIGHLY SENSITIVE TO

ABSTRACT 142 (CONT'D)

STOICHIOMETRY AND TO DENSITY, WITH CAST, 100 PER CENT DENSE, STOICHIOMETRIC UN EXHIBITING OPTIMUM CORROSION RESISTANCE AS COMPARED WITH NON-STOICHIOMETRIC UN PREPARED EITHER BY CASTING OR BY POWDER METALLURGICAL TECHNIQUES. CORROSION RATES IN 100 C WATER, 350 C SANTOWAX R, AND 820 C NAK ARE SMALL OR NEGLIGIBLE.

ABSTRACT 143

RUGL J

NUCLEONICS 22, 69 (1964)

URANIUM MONONITRIDE - A NEW REACTOR FUEL

THE RESULTS OF STUDIES ON THE ELECTRICAL, MECHANICAL, STRUCTURAL, THERMAL, AND THERMODYNAMIC PROPERTIES; CLADDING COMPATIBILITY; AND CORROSION RESISTANCE OF UN, AS WELL AS ON THE PREPARATION OF UN, FABRICATION OF UN COMPACTS, AND RADIATION EFFECTS ON UN ARE REVIEWED. SOME COMPARISONS WITH THE PROPERTIES OF OTHER URANIUM COMPOUNDS ARE INCLUDED.

ABSTRACT 144

BURDI G F

NAA-SR-7617 (1965)

REFRACTORY FUELS AND CLADDINGS

CURRENTLY AVAILABLE PROPERTY DATA ON HIGH TEMPERATURE NUCLEAR COMPOUNDS (UC, UN, AND UD SUB 2), CERAMIC DISPERSIONS (AL SUB 2 O SUB 3-UD SUB 2 AND BEO-UD SUB 2), AND CERMET (MOUC, -UN, AND -UC SUB 2) FUELS AND POTENTIAL CLADDINGS (NB, IR, MO, RE, TA, TI, V, AND W) ARE REPORTED.

ABSTRACT 145

BURDI G F

NAA-SR-8617 VOL 3 (1965)

SNAP TECHNOLOGY HANDBOOK, VOL. 3: REFRACTORY FUELS AND CLADDINGS

HAS REVIEWED AND ASSESSED VARIOUS PROPERTIES OF U-C AND U-N SYSTEMS. THE PROPERTIES CONSIDERED ARE MELTING POINT, VAPOR PRESSURE, THERMAL CONDUCTIVITY, HEAT CAPACITY AND CHEMICAL COMPATIBILITY.

ABSTRACT 146

BURDICK M D

J RES NATL BUR STD 54, 217 (1955)

AN X-RAY STUDY OF THE SYSTEM URANIUM MONOCARBIDE-URANIUM DICARBIDE-BERYLLIUM CARBIDE

MIXED CARBIDE PREPARATIONS WITHIN THE SYSTEM URANIUM MONOCARBIDE- URANIUM DICARBIDE-BERYLLIUM CARBIDE WERE INVESTIGATED AFTER HEATING AND QUENCHING. X-RAY DIFFRACTION METHODS WERE USED TO IDENTIFY THE PHASES FOUND AND TO DETERMINE THE DEGREE OF INTERACTION. CARBIDE ALLOYS WERE STUDIED AFTER TREATMENTS AT 1,700 DEG AND 1,900 DEG C, AND A CONSTITUTIONAL DIAGRAM FOR THE 1,700 DEG C LEVEL IS PRESENTED. NO TERNARY COMPOUNDS WERE IDENTIFIED WITHIN THE SYSTEM. THE LIMIT OF SOLUBILITY OF BERYLLIUM CARBIDE IN URANIUM MONOCARBIDE AT 1,700 DEG AND 1,900 DEG C WAS FOUND TO BE 20 MOLE PERCENT AND 40 MOLE PERCENT, RESPECTIVELY. LATTICE

ABSTRACT 146 (CONT'D)

PARAMETERS BASED ON X-RAY PATTERNS IN THE BACK-REFLECTION REGION FAILED TO INDICATE ANY OTHER INTERACTIONS, BUT EVIDENCE IS PRESENTED TO INDICATE SOME SOLID SOLUTION AMONG THE URANIUM CARBIDES WITHOUT LATTICE PARAMETER CHANGE. THE ROOM-TEMPERATURE STABILITY OF URANIUM SESQUICARBIDE (U_2C_3), WHICH HAS BEEN REPORTED BY OTHER INVESTIGATORS, WAS VERIFIED. X-RAY DIFFRACTION DATA WERE OBTAINED FOR THIS CUBIC COMPOUND, USING $CuK\alpha$ RADIATION.

ABSTRACT 147

BURGETT R

NLCO-885 (1963)

SUMMARY TECHNICAL REPORT (ON FEED MATERIALS) FOR THE PERIOD APRIL 1-JUNE 30, 1963

HIGH-TEMPERATURE DECOMPOSITION OF URANIUM MONONITRIDE. A VAPORIZATION STUDY OF UN WAS CONDUCTED AT 1600 TO 2000 DEG C, AND THE ENTHALPY OF DECOMPOSITION WAS DETERMINED TO BE 68.7 KCAL/MOLE.

ABSTRACT 148

BURNHAM J B

CARBIDES IN NUCLEAR ENERGY, HARWELL A5 (1963)

PLUTONIUM BEARING REFRACTORY CARBIDES

THERE ARE A NUMBER OF ATTRACTIVE SCHEMES FOR USING PUC IN OTHER THAN ITS PURE FORM, OR IN NOVEL FUEL ELEMENT DESIGNS, TO CIRCUMVENT VOLATILITY PROBLEMS WHICH OTHERWISE MAY LIMIT IT AS A FUEL MATERIAL. THE HANFORD PROGRAMME INCLUDES STUDIES OF THE PROPERTIES OF PUC, UC-PUC, MIXTURES OF PUC WITH REFRACTORY CARBIDES, AND PUC-REFRACTORY METAL CERMETS. THE MELTING POINTS OF MIXTURES OF PUC WITH TAC, ZRC, AND WC HAVE BEEN DETERMINED; THEY RANGE FROM 2000 TO 3200 DEG C. PNEUMATIC IMPACTION HAS BEEN USED TO FORM VARIOUS PUC CERMETS WITH MATRICES OF TA, W, OR MO, AND THE FUEL-MATRIX AND CORE-CLADDING REACTIONS OF THESE CERMETS HAVE BEEN STUDIED AT TEMPERATURES TO 2000 DEG C. PURE, ARC MELTED PUC HAS A CARBON DEFICIENT STRUCTURE VARYING IN LATTICE PARAMETER FROM 4.9738 ± 0.0006 A AT 49 AT % C TO 4.950 ± 0.003 A AT 38 AT % C. THE FORMATION OF THE ZETA PHASE WAS VERY SENSITIVE TO HEAT TREATMENTS; THE DENSITY OF THIS PHASE WAS 15.3 G/CM^3 . THE SINTERING BEHAVIOR OF PUC COMPACTS INDICATED A RELATIVELY HIGH RATE OF VAPORIZATION (2 PERCENT WEIGHT LOSS IN FOUR HOURS AT 1500 DEG C UNDER VACUUM). IN EXPERIMENTS WITH MOLTEN UC-PUC THE PU/U RATIO DECREASED BY A FACTOR OF TWO AFTER EIGHT MINUTES IN THE ARC.

ABSTRACT 149

BUSSY P

PLUTONIUM 1960, P589

COMPARISON OF DIFFERENT FUELS DESTINED FOR THE FAST REACTOR RAPSODIE

SINCE THE RAPSODIE REACTOR MAY BE USED WITH PLUTONIUM-BASED FUELS, THE PHYSICAL, CHEMICAL, AND NUCLEAR PROPERTIES OF MATERIALS ARE COMPARED FOR THE THREE FOLLOWING FUELS U-PU-MO ALLOY, U-PU MIXED OXIDES, AND U-PU MIXED CARBIDES.

ABSTRACT 150

CAMPBELL G M

J PHYS CHEM 73,350 (1969)

THERMODYNAMIC PROPERTIES OF PLUTONIUM NITRIDE BY GALVANOSTATIC POTENTIAL DETERMINATION

A GALVANOSTATIC TECHNIQUE HAS BEEN DEVELOPED FOR THE DETERMINATION OF EQUILIBRIUM POTENTIALS IN FUSED SALTS. THE TECHNIQUE MAKES IT POSSIBLE TO MEASURE THE EMF OF METAL-METAL ION COUPLES WITHOUT REQUIRING THE PRESENCE OF THE METAL FOR LONG PERIODS OF TIME. THIS HAS OBVIOUS ADVANTAGES, ESPECIALLY IN THE CASE OF VERY REACTIVE METALS WHERE SURFACE IMPURITIES ARE DIFFICULT TO ELIMINATE BY THE USUAL TECHNIQUES. THE TECHNIQUE WAS USED TO OBTAIN DIRECT MEASUREMENTS ON THE CELL $\text{Pu(s)}|\text{PuCl}_3|\text{PuCl}_3\text{ SUB 3, LiCl-KCl}|\text{N SUB 2(g), PuN(s)}$ OVER THE TEMPERATURE RANGE 714-1032 DEG K. THE REACTION OF PU WITH N SUB 2 AT THESE TEMPERATURES PRECLUDES OBTAINING THE EMF BY OTHER METHODS. OVER THIS TEMPERATURE RANGE, AT 1 ATM N SUB 2 THE EMF IS $E = 7.90071 - 2.31690 \times 10^{-4}T + 2.517855 \times 10^{-6}T^2 - 9.1644 \times 10^{-9}T^3$ (#0.003) V. ABOVE THE MELTING POINT OF PU (913 DEG K) THE STANDARD FREE ENERGY OF FORMATION OF PUN IS $- \Delta G_{\text{SUB T}} = 73.8 - 0.0225T$ KCAL/MOL OF PUN. FROM THE CONDITION $S_{\text{SUB 298(PUN)}} - S_{\text{SUB 298(PU)}} = S_{\text{SUB 298(UN)}} - S_{\text{SUB 298(U)}}$ THE ESTIMATE $- \Delta H_{\text{SUB 298}} = 72.5$ KCAL/MOL IS MADE. THEORETICAL DEVELOPMENT OF THE TECHNIQUE IS INCLUDED.

ABSTRACT 151

CAMPBELL G M

LA-DC-7747

THERMODYNAMIC PROPERTIES OF PLUTONIUM MONONITRIDE FROM ELECTROMOTIVE FORCE MEASUREMENTS

THE EMF OF THE CELL $\text{Pu(s)}|\text{Pu}^{3+}(\text{X SUB 1}), \text{LiCl-KCl}|\text{LiCl-KCl}, \text{Ag}^+(\text{X SUB 2}=0.000568)|\text{Ag}$ OVER THE TEMPERATURE RANGE FROM 685 TO 729 DEG K AND COMPOSITION RANGE $\text{X SUB 1}=0.000594$ TO 0.0215 MOLE FRACTION WAS DETERMINED. POTENTIALS WERE DETERMINED FOR FOUR CELLS OF THE TYPE $\text{N SUB 2(g, P SUB 1), PuN(s)}|\text{Pu}^{3+}(\text{X SUB 1})|\text{LiCl-K-Cl}|\text{LiCl-KCl}, \text{Ag}^+(\text{X SUB 2}=0.000568)|\text{Ag}$ OVER THE TEMPERATURE RANGE FROM 695 TO 716 DEG K AND THE COMPOSITION RANGE $\text{X SUB 1}=0.0177$ TO 0.0193 . THE CELLS BEHAVED IN A REVERSIBLE MANNER. THE EMF WAS INDEPENDENT OF THE DIRECTION OF TEMPERATURE APPROACH AND OBEYED THE NERNST EQUATION WITH RESPECT TO NITROGEN PRESSURE AND THE Pu^{3+} CONCENTRATION. THE EMF WAS INDEPENDENT OF TIME AFTER AN INITIAL 24 HOUR CELL EQUILIBRATION PERIOD FOR CELLS OF THE SECOND TYPE. THE FREE ENERGY OF FORMATION OF PUN AT 700 DEG K WAS DETERMINED TO BE -60 ± 1 KCAL/MOLE.

ABSTRACT 152

CAMPBELL G M

LA-DC-9619

THERMODYNAMIC PROPERTIES OF PLUTONIUM COMPOUNDS BY EMF TECHNIQUES

THERMODYNAMIC PROPERTIES OF PLUTONIUM COMPOUNDS BY EMF TECHNIQUES. EMF CELLS BASED ON THE PLUTONIUM-PLUTONIUM CHLORIDE ELECTRODE HAVE BEEN USED TO DETERMINE HIGH TEMPERATURE THERMODYNAMIC PROPERTIES OF PuCl_3 SUB 3, MOLTEN SALT SOLUTIONS OF PuCl_3 SUB 3, AND PLUTONIUM COMPOUNDS. BOTH SOLID AND MOLTEN SALT ELECTROLYTIC CELLS HAVE BEEN EMPLOYED. SUCH CELLS PRESENT UNIQUE EXPERIMENTAL PROBLEMS BECAUSE OF THE LOW MELTING POINT AND THE ELECTRONEGATIVE NATURE OF PLUTONIUM. SPECIAL EXPERIMENTAL TECHNIQUES HAVE BEEN EMPLOYED TO OBTAIN REVERSIBLE CELL POTENTIALS. THE FREE ENERGY OF FORMATION BASED ON EMF MEASUREMENTS IS REPORTED FOR PuCl_3 SUB 3, PUN, PuO_2

ABSTRACT 152 (CONT'D)
SUB 2, PU SUB 2 C SUB 3 AND PUC.

ABSTRACT 153
CAMPBELL G M
LA-3945 (1968)
THERMODYNAMIC PROPERTIES OF PUN BY GALVANOSTATIC POTENTIAL DETERMINATION

THE EMF OF THE CELL $\text{Pu}(s,l) | \text{PuCl SUB 3}, \text{LiCl-KCl} | \text{N SUB 2}(g), \text{PUN}(s)$ HAS BEEN DETERMINED OVER THE TEMPERATURE RANGE 714 TO 1032 DEG K BY USING A W MICROELECTRODE, THE EQUILIBRIUM POTENTIAL OF THE $\text{Pu}(s,l)$ ELECTRODE WAS DETERMINED BY GALVANOSTATIC TECHNIQUE, AVOIDING THE COMPLICATIONS ARISING FROM REACTION OF N SUB 2 WITH PU. OVER THIS TEMPERATURE RANGE, AT 1 ATM N SUB 2 THE EMF IS $E = 7.90071 - 2.31690 \times 10^{-2} + 2.517855 \times 10^{-5} T^{*2} - 9.1644 \times 10^{-9} T^{*3}$ (# 0.003) VOLTS. ABOVE THE MELTING POINT OF PU(913 DEG K) THE STANDARD FREE ENERGY OF FORMATION OF PUN IS $\Delta G \text{ SUB T} = 73.8 - 0.0225 T \text{ KCAL/MOLE PUN}$. FROM THE CONDITION $S \text{ SUB 298} (\text{PUN}) - S \text{ SUB 298} (\text{PU}) = S \text{ SUB 298} (\text{UN}) - S \text{ SUB 298} (\text{U})$ THE ESTIMATE $-\Delta H \text{ SUB 298} = 72.5 \text{ KCAL/MOLE}$ IS MADE.

ABSTRACT 154
CAMPBELL G M
PLUTONIUM 1970 AND OTHER ACTINIDES
THERMODYNAMIC PROPERTIES OF THE PU-C SYSTEM

MASS SPECTROMETRIC-KNUDSEN EFFUSION AND EMF TECHNIQUES WERE USED TO MEASURE PU ACTIVITIES IN THE PU-C SYSTEM OVER THE TEMPERATURE RANGE 900 TO 2200 DEG K AND COMPOSITION RANGE PU TO PUC SUB 2 + C. THERMODYNAMIC PROPERTIES AT 298 DEG K WERE ESTIMATED.

ABSTRACT 155
CAMPBELL G M
TRANS AM NUCL SOC 9, 43 (1966)
THERMODYNAMIC PROPERTIES OF PLUTONIUM MONONITRIDE FROM ELECTROMOTIVE FORCE MEASUREMENTS

FROM THE EXPERIMENTAL WORK, FREE ENERGY OF FORMATION OF PUN IS GIVEN BY THE EQUATION $\Delta G \text{ SUB T} = -99 + 0.055T$, KCAL/MOLE FOR THE REACTION $\text{Pu}(s) + 1/2 \text{ N SUB 2}(g, p=1 \text{ ATM}) = \text{PUN}(s)$. THE VALUE AT 700 DEG K IS COMPARED WITH THE VALUE OF FREE ENERGY OF FORMATION OF UN AT 700 DEG K.

ABSTRACT 156
CAMPBELL G M
6TH US/JAPAN CERAM FUELS INFORMATION EXCHANGE, SEATTLE, S-10 (1970)
HIGH-TEMPERATURE ELECTROCHEMICAL STUDIES OF PUC SUB 0.9 AND PUC SUB 1.5

EMF MEASUREMENTS HAVE BEEN MADE ON PUC SUB 0.9 AND PUC SUB 1.5 MOLTFN SALT SYSTEMS FROM 922 TO 1060 DEG K. VALUES OF THE FREE ENERGIES OF FORMATION OF PUC SUB 0.9 AND PUC SUB 1.5 WERE OBTAINED AS FOLLOWS: $\Delta G \text{ SUB F} = -16650 + 0.352T \text{ CAL/MOLE FOR PUC SUB 1.5}$; $\Delta G \text{ SUB F} = -14059 + 1.6T \text{ CAL/MOLE FOR PUC SUB 0.9}$.

ABSTRACT 157

CARNIGLIA S C

CARBIDES IN NUCL ENERGY, HARWELL C13 (1963)

SINGLE CRYSTAL AND DENSE POLYCRYSTAL URANIUM CARBIDE: THERMAL, MECHANICAL, AND CHEMICAL PROPERTIES

ESSENTIALLY 100% DENSE URANIUM-CARBON COMPOSITIONS RANGING ON BOTH SIDES OF STOICHIOMETRIC UC HAVE BEEN PREPARED BY ARC CASTING AND BY ELECTRON BEAM FLOATING-ZONE REFINING FOLLOWED BY THERMO-CHEMICAL ADJUSTMENT OF COMPOSITION. RECENTLY, FLOATING-ZONE REFINING BY INDUCTION HEATING IN INERT ATMOSPHERE HAS BEEN STUDIED. TYPICAL RESULTANT MATERIAL CHARACTERISTICS ARE PRESENTED. THERMAL DIFFUSIVITY OF HYPOSTOICHIOMETRIC UC HAS BEEN MEASURED BY THE NEWLY-DEVELOPED LASER PULSE TECHNIQUE. THE CALCULATED CONDUCTIVITY IS RELATIVELY INSENSITIVE TO TEMPERATURE, AND APPEARS TO DECREASE WITH INCREASING FREE URANIUM CONTENT IN THE TWO-PHASE SYSTEM. THERMAL EXPANSION DATA DISCLOSE THE A-B AND B-Y TRANSITIONS OF URANIUM IN HYPOSTOICHIOMETRIC UC, BUT ARE INDEPENDENT OF COMPOSITION ABOVE 4.8 WT. % CARBON. HIGH-TEMPERATURE BENDING STRENGTH AND COMPRESSIVE CREEP MEASUREMENTS HAVE BEEN ANALYZED IN TERMS OF DISLOCATION AND GRAIN-BOUNDARY PROCESSES, AND AGAIN SHOW CLEAR CORRELATIONS WITH THE U/C RATIO AND RESULTANT SINGLE OR TWO-PHASE STRUCTURE. SELECTED STUDIES HAVE BEEN CARRIED OUT OF CHEMICAL INTERACTIONS BETWEEN HYPO- AND HYPERSTOICHIOMETRIC URANIUM CARBIDE AND TYPICAL FUEL-CLADDING METALS: TYPE 304 STAINLESS STEEL, ZIRCONIUM AND NIOBIUM ALLOYS. MECHANISMS AND KINETICS ARE DESCRIBED.

ABSTRACT 158

CARROLL D F

HW-SA-3370 (1964)

PUN AND THE REFRACTORY NITRIDES

THE PROPERTIES OF PUN ARE COMPARED WITH THESE OF PUN SUB 2, PUC, UN SUB 2, UN, AND UC. A STUDY WAS MADE OF THE THERMAL STABILITY OF PUN, UN, THN, TIN, ZRN, AND PUN-50 MOL.% UN BY HEATING FOR 4 H AT 1800 DEG C IN VACUUM AND VARIOUS ATMOSPHERES. THN, TIN, AND ZRN ARE QUITE STABLE IN VACUUM, WHILE 100% OF PUN, 53% OF PUN-UN, AND 19% OF UN ARE LOST. THE MELTING BEHAVIOR OF THESE NITRIDES WAS ALSO STUDIED. SOLID SOLUTIONS OF PUN-UN WERE OBTAINED OVER THE WHOLE COMPOSITION RANGE, AND X-RAY RESULTS ARE GIVEN. IT IS CONCLUDED THAT PUN LOOKS ATTRACTIVE AS A POSSIBLE REACTOR FUEL MATERIAL BUT THAT ITS HIGH DECOMPOSITION PRESSURE PRESENTS A SERIOUS PROBLEM.

ABSTRACT 159

CHACKRABORTY D M

ACTA CRYST 18, 811 (1965)

CRYSTAL CHEMISTRY OF HIGHER CARBIDES OF PLUTONIUM

EVIDENCE OF A HIGHER CARBIDE OTHER THAN PU SUB 2 C SUB 3 AND PUC WAS GIVEN BY X-RAY DIFFRACTION PATTERNS.

ABSTRACT 160

CHANG R

J APPL PHYS 33, 858 (1962)

FLOW AND RECOVERY PROPERTIES OF NEARLY STOICHIOMETRIC POLYCRYSTALLINE URANIUM CARBIDE AND THE MECHANISM OF WORK HARDENING OF CRYSTALLINE SOLIDS

THE FLOW AND RECOVERY PROPERTIES OF NEARLY STOICHIOMETRIC POLYCRYSTALLINE URANIUM CARBIDE WERE STUDIED IN THE TEMPERATURE RANGE 1500 DEG TO 1900 DEG C AT STRAIN RATES VARYING BETWEEN 2×10^{-5} /SEC TO 2×10^{-3} /SEC. THE FLOW DATA SEEM TO FOLLOW A RELATIONSHIP $\sigma \approx K \dot{\epsilon}^{0.5} \exp(-37500/R/T)$, WHERE $\dot{\epsilon}$ IS THE STRAIN RATE, K A PROPORTIONALITY CONSTANT, R THE GAS CONSTANT, T THE ABSOLUTE TEMPERATURE, AND σ THE FLOW STRESS AT STRAIN = 0.001. A MATHEMATICAL EVALUATION FROM RECOVERY DATA OF THE ACTIVATION VOLUME ASSOCIATED WITH DISLOCATION MOTION IS PRESENTED AND ITS POTENTIAL TO YIELD BASIC INFORMATION ON THE MECHANISM OF WORK HARDENING IS DISCUSSED.

ABSTRACT 161

CHARLES E JR

LADC-5487 (1962)

THE THERMODYNAMIC PROPERTIES OF THE URANIUM AND PLUTONIUM CARBIDES

THE THERMODYNAMIC PROPERTIES OF PLUTONIUM AND URANIUM CARBIDES ARE INVESTIGATED AT TEMPERATURES FROM 298 TO 2500 DEG K. THE THERMODYNAMIC PROPERTIES CONSIDERED ARE HEAT OF COMBUSTION, HEAT OF FORMATION, FREE ENERGY OF FORMATION, ENTROPY OF FORMATION, ABSOLUTE ENTROPY, AND HEAT CONTENT, WITH SPECIAL EMPHASIS ON HEAT OF COMBUSTION AND ERRORS IN ITS MEASUREMENT. THE CARBIDES ARE STUDIED WITH REGARD TO THE DIFFERENT CARBON FORMS AND CONTENT.

ABSTRACT 162

CHASANOV M G

NUCL SCI AND ENG 30, 310 (1967)

COMPATIBILITY OF TYPE 304 STAINLESS STEEL WITH SODIUM PASTE REACTOR FUELS

IN THE STATIC CORROSION TESTS DESCRIBED ABOVE, IT WAS FOUND THAT SODIUM PASTES OF UO₂ SUB 2 AND UN WERE COMPATIBLE WITH TYPE-304 STAINLESS STEEL AT 1400 DEG F, FOR THE TEST PERIOD OF 1000 H. WITH THE CARBIDE PASTES, IT WAS OBSERVED THAT WHILE SIGNIFICANT CARBURIZATION OF THE STEEL DID OCCUR IN THE PASTE OF A VERY HYPERSTOICHIOMETRIC CARBIDE, CARBURIZATION BY THE CARBIDE PASTES WAS NO MORE SEVERE THAN REPORTED IN THE LITERATURE FOR SODIUM-BONDED CARBIDE PELLETS. IT APPEARS THAT THE USE OF HYPOSTOICHIOMETRIC CARBIDES IN PASTE FUELS COULD REDUCE THE CARBURIZATION OF TYPE-304 STAINLESS STEEL TO QUITE ACCEPTABLE LEVELS. IN THE LIGHT OF THE EFFECTS OF IRRADIATION ON CARBIDES REPORTED BY HAHN, IT WOULD SEEM THAT IN ORDER TO AVOID CARBURIZATION OF STEELS DURING LONG-TERM REACTOR OPERATION OF CARBIDE PASTE FUELS, THE USE OF HYPOSTOICHIOMETRIC CARBIDES WOULD BE VIRTUALLY MANDATORY.

ABSTRACT 163

CHIKALLA T D

HW-74024 (1962)

LATTICE CONSTANTS AND PHASE RELATIONS OF ARC-MELTED PLUTONIUM - CARBON ALLOYS

THE NONSTOICHIOMETRIC PHASE WHICH OCCURS DURING ARC MELTING OF PUC HAS BEEN FOUND TO EXIST IN THE REGION EXTENDING FROM 39.8 TO 49.1 AT. % C. THE ASSOCIATED LATTICE CONSTANTS FOR CARBON DEFICIENT AND CARBON RICH PUC ARE 4.9583 AND 4.9742 Å, RESPECTIVELY. DENSITY MEASUREMENTS HAVE SHOWN THAT THE DEFECT NaCl STRUCTURE OCCURS WITH A CARBON DEFICIENCY. BELOW 39.8 AT. % C THERE IS SOME INDICATION OF PLUTONIUM SOLUBILITY IN THE NONEQUILIBRIUM CAST STRUCTURE. HEAT TREATMENT CAUSED THE APC CAST PHASE BOUNDARIES TO DECREASE SLIGHTLY AND HAS SHOWN THE EXISTENCE OF THE ZETA PHASE CHARACTERIZED BY A VERY LARGE NUMBER OF WEAK AND DIFFUSE LINES. AN UNUSUAL CHANGE HAS BEEN DETECTED IN THE LATTICE CONSTANT OF THE PUC PHASE WITH TIME AT ROOM TEMPERATURE.

ABSTRACT 164

CHIOTTI P

J AM CERAM SOC 35, 123 (1952)

EXPERIMENTAL REFRACTORY BODIES OF HIGH-MELTING NITRIDES, CARBIDES, AND URANIUM DIOXIDE

A PROCEDURE FOR THE PREPARATION OF THE NITRIDES AND CARBIDES OF SEVERAL METALS AND THE PREPARATION OF REFRACTORY BODIES FROM THEM IS DESCRIBED. THE INVESTIGATION SHOWS THAT REASONABLY STRONG AND DENSE BODIES CAN BE PREPARED FROM THESE MATERIALS AS WELL AS FROM UO SUB 2. THE MELTING POINTS OF THN, UN, AND UC ARE DETERMINED TO BE 2630±50, 2650±100, AND 2590±50 DEG C, RESPECTIVELY.

ABSTRACT 165

CHIOTTI P

J LESS COMMON METALS 10, 273 (1966)

THERMODYNAMIC PROPERTIES OF URANIUM OXYCARBIDES

THE E.M.F. OF FUSED-SALT CELLS OF THE TYPE U/KCL/LICL-UC SUB 3 / UO SUB X C SUB (1-X),C HAVE BEEN MEASURED OVER THE TEMPERATURE RANGE 450-750 DEG C AND FOR OXYCARBIDE COMPOSITIONS OF 0.11-0.82 MOLE FRACTION UO. CONSIDERING THE OXYCARBIDE AS A PSEUDOBINARY SOLID SOLUTION OF UO AND UC THE FOLLOWING RELATIONS WERE DERIVED FROM THE DATA
 $\Delta G^{**}XS(UC)/(1-XUC)^{**2} = -24,000 + (24,230 - 44.7T)XUC$ AND
 $\Delta G^{**}XS(UO)/(1-XUO)^{**2} = -24,000 + (24,230 - 44.7T)(XUC - 0.5)$ WHERE $\Delta G^{**}XS$ IS THE RELATIVE EXCESS PARTIAL MOLAL FREE ENERGY IN CAL/MOLE FOR COMPONENTS UC AND UO RESPECTIVELY. THE STANDARD FREE-ENERGIES OF FORMATION OF UC AND UO AT 1023 DEG K ARE CALCULATED TO BE -24.7 AND -129.6 KCAL/MOLE RESPECTIVELY.

ABSTRACT 166

CHRISTENSEN J A

HW-72031 (1963)

HIGH-TEMPERATURE, SHORT-TIME, URANIUM CARBIDE-METAL REACTIONS

THE RELATIVE COMPATIBILITY OF UC WITH NINE METALS WAS INVESTIGATED. SAMPLES OF UC WERE HEATED IN CONTACT WITH W, TA, MO, ZIRCALOY-2, A1Si 304L SS, INCONEL, HASTELLOY F, Nb-1% ZR, AND Nb-33% TA-1% ZR, FOR 10 MIN

ABSTRACT 166 (CONT'D)

PERIODS AT 1000 TO 2400 DEG C. W AND MO WERE THE LEAST REACTIVE METALS TESTED. THE UC-STAINLESS STEEL REACTION WAS THE MOST RAPID AT ALL TEMPERATURES. ZR, NB, AND NI-BASE ALLOYS REACTED LEAST OF THE COMMON CLADDING MATERIALS. DECARBURIZATION OF HYPERSTOICHIOMETRIC UC (UC SUB 1+X) RESULTED IN EXCESSIVE CARBIDE FORMATION IN NB AND PROBABLY IN SOME OF THE OTHER ALLOYS.

ABSTRACT 167

CHRISTENSEN J A

TRANS AM NUCL SOC 9, 42 (1966)

IRRADIATION PERFORMANCE OF UN-20 WT.% PUN FUELS AT HIGH HEAT RATINGS AND BURNUPS

THREE UN-20 WT.% PUN FUELED CAPSULES WERE ENCAPSULATED IN 304L STAINLESS STEEL. IN POSTIRRADIATION STUDIES, FUEL-SHEATH REACTION IN THE FORM OF APPARENT GRAIN-BOUNDARY DETERIORATION IN THE STAINLESS STEEL NEAR THE INNER SURFACE OF THE CLADDING WAS EVIDENT IN ALL THREE CAPSULES. THE REACTION ZONE WAS APPROXIMATELY 0.002 CM THICK AND HAD ABOUT A 30% HIGHER KNOOP HARDNESS THAN THE ADJACENT UNAFFECTED METAL.

ABSTRACT 168

CHROMONOSHKIN V V

THERMODYNAMICS VOL 1, P359

VAPOR PRESSURE OF URANIUM MONOCARBIDE

THE PARTIAL VAPOR PRESSURES OF URANIUM AND CARBON OVER URANIUM MONOCARBIDE HAVE BEEN STUDIED IN THE TEMPERATURE RANGE 1900 - 2400 DEG K BY A DIFFERENTIAL KNUDSEN METHOD. THE FOLLOWING EQUATIONS WERE OBTAINED FOR THE TEMPERATURE DEPENDENCES OF THE VAPOR PRESSURE (MM HG): $\log P_{\text{SUB U}} = 10.054 - (2.809 \times 10^4)/T$ $\log P_{\text{SUB C}} = 2.515 - (1.324 \times 10^4)/T$ THE PARTIAL HEAT OF SUBLIMATION OF URANIUM (2H SUB 298) ASSESSED BY THE SECOND- AND THIRD-LAW METHODS WAS 13.6 AND 123 KCAL/MOL RESPECTIVELY. UP TO A TEMPERATURE OF 2100 DEG K MAINLY CARBON ATOMS VAPORIZED, AND ABOVE THIS TEMPERATURE URANIUM ATOMS.

ABSTRACT 169

CHURB W

BMI-1551 (1961)

DIFFUSION COEFFICIENTS OF URANIUM AND CARBON IN URANIUM MONOCARBIDE

THE RATES OF DIFFUSION OF CARBON-14 IN URANIUM MONOCARBIDE ARE DESCRIBED BY THE EQUATION, $D_{\text{SUB C}} = 0.02 \exp(-50,000/RT)$, OVER THE TEMPERATURE RANGE, 1200 TO 2000 DEG C. THE RATES OF DIFFUSION OF URANIUM-235 IN URANIUM MONOCARBIDE ARE DESCRIBED BY THE EQUATION, $D_{\text{SUB U}} = 0.0013 \exp(-64,000/RT)$, OVER THE TEMPERATURE RANGE, 1600 TO 2100 DEG C. ATTEMPTS TO DETERMINE RATES OF INTERDIFFUSION IN THE URANIUM CARBIDES FORMED BETWEEN LIQUID URANIUM AND GRAPHITE WERE FRUSTRATED BY LACK OF A SUITABLE ANALYTICAL TECHNIQUE. THE RATES OF GROWTH OF THE MONOCARBIDE LAYER FORMED ARE DESCRIBED BY THE RATE-PROCESS EQUATION, $K_D = X^2/T = 16.6 \exp(-71,300/RT)$, OVER THE TEMPERATURE RANGE, 1200 TO 2000 DEG C.

ABSTRACT 170

CHURB W
BULL AM CERAM SOC 41 (1962)
PROPERTIES OF URANIUM CARBIDES

PROPERTIES OF URANIUM CARBIDES ARE REVIEWED AND BROUGHT UP TO DATE. PHOTOGRAPHS AND PHOTOMICROGRAPHS OF URANIUM CARBIDES FABRICATED BY MELTING AND CASTING TECHNIQUES AND BY POWDER METALLURGY TECHNIQUES ARE PRESENTED. RECENT DATA CONFIRM THAT URANIUM MONOCARBIDE HAS METALLIC CONDUCTIVITY (A THERMAL CONDUCTIVITY OF APPROXIMATELY 0.055 CAL/S-CM- DEG C AND A RESISTIVITY OF APPROXIMATELY 35 MICROHM-CM) AND THAT IT HAS THE STRENGTH AND HARDNESS OF IONIC MATERIALS (A COMPRESSIVE STRENGTH OF 51000 LB/IN**2 , A TRANSVERSE RUPTURE STRENGTH OF 10000 LB/IN**2 , AND A HARDNESS OF 700 KG/MM**2). THE CORROSION RESISTANCE OF URANIUM CARBIDES IS POOR IN WATER, BUT IS GOOD IN HYDROCARBONS. URANIUM MONOCARBIDE IS COMPATIBLE WITH ALUMINIUM, COPPER, MAGNESIUM, MILD STEEL, AND ZIRCONIUM TO THE MAXIMUM TEMPERATURES OF USEFULNESS OF THESE METALS AS STRUCTURAL MATERIALS. IT IS NOT COMPATIBLE WITH INCONEL OR STAINLESS STEEL AT 800 DEG C. URANIUM MONOCARBIDE SHOWS NO GROSS STRUCTURAL DAMAGE AFTER IRRADIATION TO A BURNUP OF 25000 MWD/T OF URANIUM AT 600 DEG C. HEAT TREATMENT IS SHOWN TO MARKECLY AFFECT THE MICROSTRUCTURE AND PROPERTIES OF ALLOYS CONTAINING 7 AND 9 WT. % CARBON. MINOR ALLOY ADDITIONS OF THE REFRACTORY METAL CARBIDES GREATLY IMPROVE THE STPENGTH, HARDNESS, AND CORROSION RESISTANCE TO URANIUM MONOCARBIDE.

ABSTRACT 171

CHURB W
J NUCL MATER 13, 63 (1964)
DIFFUSION IN URANIUM MONOCARBIDE

THE RATES OF DIFFUSION ARE DESCRIBED BY THE FOLLOWING EQUATIONS: **14C IN UC, $0.02 \exp(-50,000/RT)$, AT 1200-1940 DEG ; **235U IN UC, $0.0013 \exp(-64,000/RT)$, AT 1600-2120 DEG ; AND CHEMICAL DIFFUSION OF C IN UC, $0.0002 \exp(-22,000/RT)$, 1200-2100 DEG .

ABSTRACT 172

CHURB W
J NUCL MATER 23, 336 (1967)
TERNARY PERITECTICS BETWEEN TUNGSTEN, MOLYBDENUM, AND URANIUM MONOCARBIDE

PHASE EQUILIBRIA STUDIES IN U-MO-C AND U-W-C SYSTEMS TO DEFINE TERNARY PERITECTICS HAVE BEEN CARRIED OUT. HAS ALSO GIVEN PHASE DIAGRAMS FOR U-MO- C SYSTEM AT 1800 AND 2000 DEG C INDICATING A REGION CONTAINING THREE PHASES.

ABSTRACT 173

CHURB W
NUCL SCI ENG 29, 176 (1967)
BUFFERING OF URANIUM MONOCARBIDE TO CONTROL CARBON ACTIVITY

THE UTILIZATION OF THE THEORETICAL PRINCIPLE THAT ACTIVITIES MUST REMAIN CONSTANT AT CONSTANT TEMPERATURE AND PRESSURE IF THE NUMBER OF PHASES PRESENT IS EQUAL TO THE NUMBER OF ELEMENTAL CONSTITUENTS PRESENT WAS DESCRIBED. THE POTENTIAL WAS OUTLINED FOR USE OF THIS PRINCIPLE TO ACHIEVE COMPATIBILITY BETWEEN URANIUM CARBIDE AND CERTAIN METALS. A SAMPLE OF UC ALLOYED WITH 5 AT.% TUNGSTEN TO CONTROL ITS CARBON ACTIVITY

ABSTRACT 173 (CONT'D)

SHOWED NO EMBRITTLEMENT OF STAINLESS STEEL AFTER BEING IN POSITIVE CONTACT FOR 3000 H AT 800 DEG C (1472 DEG F)

ABSTRACT 174

CHURR W

TRANS AM SOC METALS 53, 465 (1961)

CONSTITUTION OF THE PARTIAL SYSTEM: URANIUM MONOCARBIDE URANIUM DICARBIDE

IT IS DEMONSTRATED THAT A MISCIBILITY GAP EXISTS BETWEEN UC, HAVING THE NaCl-TYPE CRYSTAL STRUCTURE, AND THE HIGH-TEMPERATURE ALLOTROPE OF UC SUB 2, HAVING THE CaF₂ SUB 2 -TYPE STRUCTURE. EVIDENCE FOR IMMISCIBILITY OF THESE STRUCTURES AT 2200 DEG C IS PRESENTED. THE ADDITIONAL REACTIONS DEMANDED BY SUCH A MISCIBILITY GAP ARE DESCRIBED. A EUTECTIC WAS LOCATED AT 6.4 WT. % CARBON AND 2350 DEG C BETWEEN UC CONTAINING ABOUT 6.0 WT. % CARBON AND UC SUB 2 CONTAINING ABOUT 6.6 WT. % CARBON. A EUTECTOID WAS LOCATED AT 7 TO 7.5 WT. % CARBON AND JUST BELOW 1800 DEG C BETWEEN UC AND TETRAGONAL UC SUB 2. IT IS PRESUMED THAT THE TRANSFORMATION OF CUBIC UC SUB 2 TO TETRAGONAL UC SUB 2 OCCURS AT ABOUT 9 WT. % CARBON AND 1820 DEG C BY A PERITECTOID-TYPE REACTION.

ABSTRACT 175

CLIFFORD J C

LA-4951 (1973)

THERMAL NEUTRON IRRADIATION OF SODIUM-BONDED SOLID SOLUTION (U,Pu)C FUEL

SMALL AMOUNTS OF PELLETIZED, SINGLE-PHASE, URANIUM-PLUTONIUM CARBIDE, SODIUM-BONDED TO TYPE 316 STAINLESS STEEL CLADDING, WERE IRRADIATED IN A THERMAL FLUX TO DETERMINE WHETHER FUEL, CLAD, AND SODIUM WOULD REMAIN MUTUALLY COMPATIBLE AS BURNUP PROGRESSED. URANIUM FOR THE FUEL WAS FULLY ENRICHED IN ²³⁵U, PRODUCING A SURFACE-TO-CENTERLINE FISSION RATIO OF APPROX 12: 1. DURING THESE IRRADIATIONS, THE MAXIMUM FUEL SURFACE OPERATING TEMPERATURE WAS 730 DEG C, THE MAXIMUM POWER DENSITY WAS 760 W/G, AND THE MAXIMUM BURNUP ATTAINED WAS 13 AT.%. THESE FIGURES ARE BASED ON FISSION EVENTS ONLY. THE IRRADIATED FUEL SHOWED NO EVIDENCE OF ATTACK BY SODIUM AND NO OTHER SURFACE CHANGES, ALTHOUGH EXTENSIVE CRACKING, SODIUM LOGGING, AND A NOBLE FISSION-PRODUCT-CONTAINING PHASE WERE OBSERVED IN VARIOUS SAMPLES. THE CLADDING ON INSIDE SURFACES SHOWED EVIDENCE OF LIGHT, INTERMITTENT CARBURIZATION AT ALL OPERATING TEMPERATURES (600 TO 720 DEG C), AND SIGMA-PHASE FORMATION, DUE TO THERMAL AGING, AT THE HIGHEST TEST TEMPERATURES. NO EVIDENCE WAS FOUND THAT WOULD PRECLUDE TESTING OF SODIUM-BONDED, SINGLE-PHASE, URANIUM-PLUTONIUM CARBIDE FUEL IN A FAST FLUX AT LINEAR POWER RATINGS OF APPROX 30 KW/FT TO BURNUPS OF 10 TO 12 AT.%.

ABSTRACT 176

CLOUGH D J

PROC INT CONF FAST REACTOR FUEL AND FUEL ELEMENTS,

ANS MEETING, KARLSRUHE 321 (1970)

IRRADIATION INDUCED CREEP OF CERAMIC FUELS

IN-PILE CREEP OF HYPERSTOICHIOMETRIC UC UNDER UNIAXIAL TENSILE STRESS (UC SUB 2 AND U SUB 2 C SUB 3, 30 UM GS, 95.5% TD) WAS MEASURED DURING A 72 DAY IRRADIATION. FRACTURE OCCURRED AFTER 0.8% STRAIN, AT AN EFFECTIVE

ABSTRACT 176 (CONT'D)

TEMPERATURE OF APPROX 802 DEG C AND A BURNUP 0.154%, AND THE MINIMUM CREEP RATE WAS 5×10^{-6} /HR. THE CREEP BEHAVIOR WAS ANALYZED IN TERMS OF $\dot{\epsilon} = A \cdot R \cdot D$ (R IS RATING IN W/G); $A \cdot R = 2 \times 10^{-12} \cdot R$ MM²/N-SEC FOR UC COMPARES WITH $2 \times 10^{-13} \cdot R$ MM²/N-SEC FOR UO SUB 2. THE MINIMUM TENSILE CREEP RATE IN UC OF 5×10^{-6} /HR ESTABLISHED AFTER 500 HRS IRRADIATION AT 800 DEG C AND UNDER A STRESS OF 26 N/MM² AND 6×10^{-12} FISS/CM³-SEC IS THE SAME AS UNIRRADIATED COMPRESSION CREEP RATES AT 1100 DEG C OVER SIMILAR PERIODS. A PRIMARY CREEP REGIME WAS NOTICED, HAVING A CREEP RATE OF APPROX= 5×10^{-5} /HR.

ABSTRACT 177

COMMISSARIAT EN AT
AEC-TR-6359
THE FUEL FOR RAPSODIE

THE PROPERTIES OF VARIOUS FUEL ELEMENTS FOR USE IN RAPSODIE WERE EVALUATED. PHYSICAL AND THERMAL PROPERTIES, RADIATION STABILITY, AND BURNUP OF UC-PUC, PUO SUB 2, -UO SUB 2, AND PU-MO-U WERE STUDIED. CLADDING WAS ALSO INVESTIGATED. THE RESULTS ARE DISCUSSED.

ABSTRACT 178

CONNER J G
BMT-1900 (1968)
A COMPENDIUM OF PROPERTIES AND CHARACTERISTICS FOR SELECTED LMFBR CLADDING MATERIALS

DATA ARE COMPILED FOR CLADDING MATERIALS THAT APPEAR TO BE THE MOST ATTRACTIVE FOR LMFBR APPLICATION AS OF 1967. THE PROPERTIES OF BOTH UNIRRADIATED AND IRRADIATED MATERIALS ARE INCLUDED AND, IN THE LATTER CATEGORY, MIXED THERMAL AND FAST FLUX IRRADIATION DATA ARE PRESENTED ALONG WITH THE LESS AVAILABLE FAST FLUX DATA. JOINING TECHNIQUES ARE REVIEWED FOR THE VARIOUS CLADDING MATERIALS AS THE TECHNIQUES PERTAIN TO FUEL-ELEMENT FABRICATION. BOTH THE AUSTENITIC STAINLESS STEELS AND THE NICKEL-BASE ALLOYS, HASTELLOY X AND INCONEL 625, EXHIBIT AN ELEVATED-TEMPERATURE IRRADIATION EMBRITTLEMENT, ALTHOUGH DATA FOR THE NICKEL-BASE ALLOYS ARE LIMITED. NIOBIUM-1 WT% ZIRCONIUM AND THE BINARY AND TERNARY VANADIUM-BASE ALLOYS PROVIDE GOOD STRENGTH AND DUCTILITY AT ELEVATED TEMPERATURES, AND IRRADIATION DAMAGE APPEARS MINIMAL. THE STAINLESS STEELS AND THE NICKEL-BASE ALLOYS EXHIBIT GOOD SODIUM CORROSION RESISTANCE UP TO 600 AND 650 DEG C, RESPECTIVELY; ABOVE THESE TEMPERATURES MASS-TRANSFER PROBLEMS OCCUR, ESPECIALLY WITH THE NICKEL-BASE ALLOYS. IN GENERAL, VANADIUM ALLOYS SHOW SODIUM CORROSION RESISTANCE AT 650 DEG C SUPERIOR TO THAT OF NIOBIUM ALLOYS, ALTHOUGH BOTH SYSTEMS PRESENT PROBLEMS IN CONTAMINATED SODIUM. GOOD COMPATIBILITY WITH OXIDE AND NITRIDE FUELS IS GENERALLY INDICATED FOR THE STAINLESS STEELS AND THE NICKEL-BASE ALLOYS, BUT COMPATIBILITY WITH METALLIC AND CARBIDE FUELS PRESENTS CERTAIN PROBLEMS. LIMITED DATA FOR THE VANADIUM ALLOYS SHOW ENCOURAGING COMPATIBILITY RESULTS WITH MOST POTENTIAL LMFBR FUELS.

ABSTRACT 179

COOBS J H
ORNL-3885, P3 (1966)
FUELED-GRAPHITE DEVELOPMENT

METHODS FOR COATING PYROLYTIC CARBON TO UC SUB 2 AND THC SUB 2 FUEL PARTICLES ARE DISCUSSED IN SOME DETAIL. THE RESULTS OF A PHASE STUDY OF THE PSEUDOBINARY SYSTEM UC SUB 2 - THC SUB 2 ARE PRESENTED. TABULATIONS OF THERMODYNAMIC DATA FOR THE UC AND UC SUB 2 SYSTEMS ARE GIVEN. TECHNIQUES FOR CONVERTING SOL-GEL OXIDE PARTICLES TO CARBIDES ARE DISCUSSED. HEAT AND IRRADIATION TESTS WERE PERFORMED ON THE PYROLYTIC CARBON COATED FUEL PARTICLE. RESULTS FROM THESE TESTS ARE PRESENTED. FUEL ASSEMBLIES EMPLOYING CARBON COATED FUELS WERE TESTED.

ABSTRACT 180

COOK J L
ORNL-TM-1188 (1965)
STUDIES OF THE THORIUM-URANIUM DICARBIDE PSEUDOBINARY SYSTEM IN THE PRESENCE OF EXCESS OF GRAPHITE

THIS STUDY COMBINED DILATOMETRY, X-RAY DIFFRACTION, METALLOGRAPHY, THERMAL ANALYSIS, AND CHEMICAL ANALYSIS TO PROVIDE A BETTER UNDERSTANDING OF THE PHASE RELATIONSHIPS FOR THE UC SUB 2-THC SUB 2 PSEUDOBINARY SYSTEM. THERMAL EXPANSION AS A FUNCTION OF TEMPERATURE UP TO 1000 DEG C WAS DETERMINED FOR UC SUB 2, THC SUB 2, AND THE (U,THC) SUB 2 ALLOYS USING DROP-CAST AND MACHINED SPECIMENS. THE MICROSTRUCTURAL FEATURES OF ALL AS-CAST ALLOYS WERE SIMILAR AND ALL CONTAINED EXCESS GRAPHITE. ONLY ANNEALS ABOVE 1500 DEG C FOR EXTENDED PERIODS OF TIME CAUSED SIGNIFICANT CHANGES IN THE MICROSTRUCTURE OF THE CARBIDE OR THE MORPHOLOGY OF THE GRAPHITE. MICROHARDNESS TENDED TO INCREASE SLOWLY WITH ANNEALING TIME AT 1900 DEG C BUT DID NOT CHANGE SIGNIFICANTLY FOR LOWER TEMPERATURE ANNEALS. POWDER X-RAY DIFFRACTION PATTERNS WERE GENERALLY DIFFUSE AND DID NOT IMPROVE APPRECIABLY WITH ANNEALING FOR MATERIAL THAT CONTAINED MUCH EXCESS GRAPHITE. SPECIMENS OF THC SUB 2 THAT CONTAINED ONLY A TRACE OF FREE GRAPHITE GAVE SHARP DIFFRACTION PATTERNS AFTER ANNEALING AT 1400 DEG C AND BELOW. X-RAY DIFFRACTION REVEALED THAT TWO DISTINCTLY DIFFERENT BODY-CENTERED TETRAGONAL STRUCTURES COEXISTED FOR ALLOYS IN THE COMPOSITION RANGE FROM 35 TO 42 MOLE PER CENT THC SUB 2. DILATOMETRY AND THERMAL ANALYSIS CLEARLY SHOWED TWO PHASE TRANSFORMATIONS IN THC SUB 2 (1500±25 DEG C AND 1430±10 DEG C), AND THE RESULTS INDICATED THAT THE HIGHER TEMPERATURE TRANSFORMATION WAS DIFFUSIONLESS. TWO SIMILAR TRANSFORMATIONS WERE OBSERVED FOR THC SUB 2-RICH ALLOYS CONTAINING UP TO 25 MOLE PER CENT UC SUB 2. ONE PHASE TRANSFORMATION WAS OBSERVED FOR UC SUB 2 AT 1768±25 DEG C. ONE SOLID-STATE TRANSFORMATION OCCURRED FOR THE (U,THC) SUB 2 ALLOYS IN THE COMPOSITION RANGE FROM 25 TO 75 MOLE PER CENT THC SUB 2. THE TRANSFORMATION TEMPERATURES IN THIS COMPOSITION RANGE PASSED THROUGH A MINIMUM (APPROXIMATELY 1100 DEG C) AT APPROXIMATELY 46 MOLE PER CENT THC SUB 2. TWO PHASE DIAGRAMS, EITHER OF WHICH IS CONSISTENT WITH EXPERIMENTAL OBSERVATIONS, WERE PROPOSED FOR THE UC SUB 2-THC SUB 2 PSEUDOBINARY SYSTEM. THE MEAN COEFFICIENTS OF EXPANSION FOR THE (U,THC) SUB 2 ALLOYS BETWEEN ROOM TEMPERATURE AND 1000 DEG C VARIES FROM 8.6×10^{-6} /DEG C FOR THC SUB 2 TO 13.5×10^{-6} /DEG C FOR UC SUB 2.

ABSTRACT 181

COROFUNKS E H P
J NUCL MATER 42, 233 (1972)
HEAT CAPACITY OF URANIUM MONONITRIDE

HEAT CAPACITY MEASUREMENTS WERE MADE ON UN AT HIGH TEMPERATURES. THE RESULTS OF LOW-TEMPERATURE HEAT CAPACITY DATA BY WESTRUM AND BARBER (J CHEM PHYS 45, 635 (1966)) ARE INCLUDED. SINCE THERE WAS A SMOOTH CONTINUITY BETWEEN THE LOW-TEMPERATURE DATA AND HIGH-TEMPERATURE MEASUREMENTS, IT WAS CONCLUDED THAT THE HEAT CAPACITY OF UN IS NOW KNOWN OVER A WIDE RANGE OF TEMPERATURES.

ABSTRACT 182

COSTA P
NUCLEAR METALLURGY AIME 10,83 (1964)
MAGNETIC TRANSITIONS IN URANIUM AND PLUTONIUM MONONITRIDES
MONOCARBIDES AND SESQUICARBIDES

RESISTIVITY AND THERMOELECTRIC POWER MEASUREMENTS SHOW ANOMALIES WHICH INDICATE THE PRESENCE OF MAGNETIC TRANSFORMATIONS IN UN, U SUB 2 C SUB 3, PU AND PU SUB 2 C SUB 3. THESE RESULTS AND PREVIOUS ON UC AND PUC ARE DISCUSSED.

ABSTRACT 183

COSTA P
PHYS LETT 7, 21 (1963)
RESISTIVITY AND THERMOELECTRIC POWER OF THORIUM, URANIUM, AND PLUTONIUM CARBIDES

MEASUREMENTS ARE GIVEN FOR THC, UC, AND PUC AT <1200 DEG K. THE RESULTS WERE CONSISTENT WITH A 60 BAND IN THC, A (60,5F) BAND IN UC, AND ANTIFERROMAGNETIC PROPERTIES IN PUC.

ABSTRACT 184

COUNSELL J F
TRANS FARADAY SOC 62 1736 (1966)
THERMODYNAMIC PROPERTIES OF URANIUM COMPOUNDS
LOW-TEMPERATURE HEAT CAPACITY AND ENTROPY OF THREE URANIUM NITRIDES

THE HEAT CAPACITIES OF UN, UN SUB 1.59, AND UN SUB 1.73 WERE MEASURED FROM 11 TO 320 DEG K. THE C SUB P CURVES FOR THE THREE COMPOUNDS SHOW ANOMALIES AT 52, 94, AND 33 DEG K, RESPECTIVELY, CORRESPONDING TO MAGNETIC ORDERING PHENOMENA. THE VALUES OF THE STANDARD THERMODYNAMIC FUNCTIONS ARE TABULATED, TOGETHER WITH HEATS AND ENTROPIES OF THE MAGNETIC TRANSITIONS. UN UNDERGOES TYPE-1 ANTIFERROMAGNETIC ORDERING AT 52 DEG K; THE ENTROPY INCREMENT ASSOCIATED WITH THIS ORDERING (0.15 CAL/MOLE-DEG) IS SUBSTANTIALLY LESS THAN THE EXPECTED MAGNETIC ENTROPY. COMPARISON IS MADE WITH MAGNETIC TRANSITIONS IN OTHER URANIUM COMPOUNDS, NOTABLY UO SUB 2 AND UO WHOSE MAGNETIC ENTROPIES MAY BE CALCULATED WITH REASONABLE ACCURACY. IT SEEMS THAT THE ENTROPY OF SPIN ORDERING REPRESENTS ONLY A PART OF THE TOTAL MAGNETIC ENTROPY. POSSIBLE REASONS FOR THIS ARE DISCUSSED.

ABSTRACT 185

CRAIG J A

TRANS MET SOC AIME 242, 1809 (1968)

A STUDY OF THE FREE ENERGIES OF FORMATION OF UC AND UCS

THE GIBBS FREE ENERGIES OF FORMATION OF UC SUB 2 AND UC WERE MEASURED BY EQUILIBRATING TWO-PHASE MIXTURES OF UC SUB 2 + C AND UC SUB 2 + UC WITH LIQUID BISMUTH. THE MEASURED EQUILIBRIUM CONCENTRATIONS OF URANIUM IN THE BISMUTH COMBINED WITH AVAILABLE ACTIVITY COEFFICIENT INFORMATION YIELDED URANIUM ACTIVITIES IN THESE TWO-PHASE REGIONS. MEASUREMENTS ON UC SUB 2 WERE PERFORMED OVER THE RANGE 1015 DEG TO 1160 DEG K AND ON UC OVER THE RANGE 1115 DEG TO 1165 DEG K. THE VALUES OBTAINED FOR UC SUB 2 ARE IN EXCELLENT AGREEMENT WITH VALUES DETERMINED USING COMBUSTION CALORIMETRY AND LOW-TEMPERATURE HEAT CAPACITY MEASUREMENTS. THE UC VALUES ARE IN FAIR AGREEMENT WITH THE CALORIMETRIC VALUES, DIFFERING BY ABOUT 10 PCT FROM THE CALORIMETRIC DETERMINATION.

ABSTRACT 186

CRAIG J A

UNIV OF MICHIGAN THESIS (1966)

A STUDY OF THE FREE ENERGIES OF FORMATION OF URANIUM MONOCARBIDE AND URANIUM DICARBIDE

THE FREE ENERGIES OF UC SUB 2 AND UC WERE DETERMINED BY MEASURING THE ACTIVITIES OF URANIUM IN THE TWO-PHASE REGIONS UC SUB 2 + C AND UC + UC SUB 2 OF THE URANIUM-CARBON SYSTEM AT TEMPERATURES 1015 TO 1165 DEG K. EACH ACTIVITY WAS DETERMINED BY MEASURING THE CONCENTRATION OF URANIUM IN A BISMUTH MELT AT EQUILIBRIUM WITH THE TWO-PHASE MIXTURE OF INTEREST, UC SUB 2 + C OR UC + UC SUB 2. FROM THE CONCENTRATION DATA, THE ACTIVITY OF URANIUM IN THE MELT CAN BE OBTAINED USING ACTIVITY COEFFICIENT DATA. THE ACTIVITIES OF URANIUM IN THE TWO REGIONS ARE SUMMARIZED. FROM THE ACTIVITY OF URANIUM IN THE UC SUB 2 + C REGION, THE FREE ENERGY OF FORMATION OF UC SUB 2 WAS COMPUTED. THE FREE ENERGY OF FORMATION OF UC WAS COMPUTED AND THE CALCULATED VALUES ARE TABULATED.

ABSTRACT 187

CRANE J

NUCLEAR METALLURGY 10,765 (1964)

EFFECTS OF FABRICATION AND COMPOSITION ON THE IRRADIATION STABILITY OF URANIUM CARBIDE

THE IRRADIATION BEHAVIOR OF CAST URANIUM CARBIDE CONTAINING 4.4, 4.8 AND 5.2 W/O CARBON AND OF SINTERED CARBIDE CONTAINING 4.4 AND 4.8 W/O CARBON WAS EVALUATED AT BURN-UPS FROM 14,000 TO 40,000 MWD/T (1 A/D BURN-UP IS ROUGHLY EQUIVALENT TO 7,500 MWD/T) AND A HEAT FLUX OF 24 TO 37 KW/FT. THE DATA INDICATE THAT 5.2 W/O CARBON FUEL CAN WITHSTAND BURN-UPS TO 38,000 MW-D/TON U AT 1100 TO 1200 DEG C WITH RELEASE OF ONLY 5% OF THE TOTAL FISSION GAS FORMED AND WITH DIAMETRAL SWELLING OF 1.5% PER A/D BURN-UP. THE 4.8 W/O CARBON MATERIAL SHOWED SOMEWHAT POORER BEHAVIOR BUT WAS SUBSTANTIALLY BETTER THAN THE 4.4 W/O CARBON FUEL. FOR ALL PRACTICAL PURPOSES, URANIUM CARBIDE WAS FOUND TO BE COMPATIBLE WITH NB-1 W/O ZR (USED AS THE CANNING MATERIAL) TO 1000 DEG C FOR 9000 HOURS EXPOSURE.

ABSTRACT 188

CRANE J

TRANS AM NUCL SOC 7, 100 (1964)

ELEVATED-TEMPERATURE PROPERTIES OF URANIUM CARBIDE

MEASUREMENTS OF THERMAL EXPANSION, THERMAL CONDUCTIVITY AND HOT HARDNESS OF URANIUM CARBIDE WERE MADE FROM ROOM TEMPERATURE TO 1000 DEG C. THE EFFECTS OF CARBON CONTENT AND FABRICATION METHOD ON THESE PROPERTIES WERE ALSO STUDIED.

ABSTRACT 189

CRANE J

UNC-5080 (1964)

THE DEVELOPMENT OF URANIUM CARBIDE AS A NUCLEAR FUEL

METHODS OF FABRICATING URANIUM CARBIDE BY POWDER METALLURGY AND SKULL ARC CASTING TECHNIQUES WERE DEVELOPED, OUT-OF-PILE PROPERTY MEASUREMENTS FROM ROOM TEMPERATURE TO 1000 DEG C WERE PERFORMED, AND THE IRRADIATION BEHAVIOR OF URANIUM CARBIDE WAS EVALUATED. THERMAL EXPANSION MEASUREMENTS REPORTED SHOWED THAT FROM 500 TO 1000 DEG C 4.4 AND 5.2 WT. % CARBON MATERIALS HAVE SLIGHTLY HIGHER COEFFICIENTS THAN UC, AND EXPANSION OF CAST MATERIALS IS SLIGHTLY HIGHER THAN SINTERED CARBIDE OF EQUIVALENT CARBON CONTENT. THE AVERAGE COEFFICIENT OF LINEAR EXPANSION FROM ROOM TEMPERATURE TO 1000 DEG C FOR ALL TYPES OF CARBIDE TESTED IS WITHIN THE RANGE OF 11.1 TO $11.8 \times 10^{-6}/\text{DEG C}$. THERMAL CONDUCTIVITY MEASUREMENTS INDICATED THAT THE CONDUCTIVITY COEFFICIENT DECREASES SLIGHTLY AS A FUNCTION OF TEMPERATURE TO 400 DEG C AND THEN RISES STEADILY TO 1000 DEG C. DETAILED VALUES GIVEN IN THIS REPORT SHOW THE 4.4 CAST MATERIAL TO HAVE THE HIGHEST COEFFICIENT AT 1000 DEG C (0.31 W/CM DEG C) AND THE 4.8 SINTERED THE LOWEST (0.22 W/CM DEG C). ELECTRICAL RESISTIVITY WAS 200 UOHM-CM AT 1000 DEG C FOR THE 4.8 SINTERED MATERIAL. HARDNESS MEASUREMENTS TAKEN AT ROOM TEMPERATURE AND FROM 500 TO 1100 DEG C ARE TABULATED. RESULTS SHOWED THAT ABOVE 500 DEG C THE 5.2 MATERIAL IS SUPERIOR TO ALL OTHER TYPES TESTED. AT 800 DEG C THE 4.4 MATERIAL WAS TOO SOFT TO TEST. THE IRRADIATION BEHAVIOR OF URANIUM CARBIDE AT BURNUPS RANGING FROM 14300 MWD/ U (2 AT. %) TO 40100 MWD/T U (5 AT. %) AT FUEL SURFACE TEMPERATURES OF 625 TO 1000 DEG C AND FUEL CENTRELIN TEMPERATURES OF 1000 TO 1350 DEG C IS DESCRIBED IN DETAIL. THE DATA INDICATE THAT THE 5.2 WT % CARBON MATERIAL CAN WITHSTAND BURNUPS UP TO 36000 MWD/T U AT 1100 TO 1200 DEG C WITH RELEASE OF ONLY 5% OF THE TOTAL FISSION GAS FORMED AND DIAMETRICAL SELLING OF 1.5% /AT. % BURNUP. THE 4.8 MATERIAL SHOWED SOMEWHAT POORER BEHAVIOR BUT WAS SUBSTANTIALLY BETTER THAN THE 4.4 FUEL. URANIUM CARBIDE UNDER THESE TEST CONDITIONS WAS FOUND TO BE COMPATIBLE WITH NB-1 WT. % ZR IN ALL CASES EXCEPT ONE WHICH COULD BE AVOIDED BY CAPSULE DESIGN MODIFICATION. IN GENERAL, IN-PILE AND OUT-OF-PILE BEHAVIOR OF URANIUM CARBIDE WAS FOUND TO BE MORE SENSITIVE TO CARBON CONTENT THAN FABRICATION METHOD. IN MANY CASES, DIFFERENCES IN BEHAVIOR WERE ASSOCIATED WITH THE CHARACTERISTICS OF FREE URANIUM AT THE SPECIFIC CONDITIONS OF TEST.

ABSTRACT 190

CRAWLEY H J

AERE-R-4873 (1965)

SOME MEASUREMENTS OF THE DAMPING CHARACTERISTICS

AS PART OF A PROGRAM TO MEASURE DAMPING CAPACITY OF FUEL PINS, THE YOUNG'S MODULUS OF UC WAS MEASURED FROM 25 TO 800 DEG C. THE MODULUS OF

ABSTRACT 190 (CONT'D)

SINTERED UC WAS LOWER THAN THAT OF CAST UC. THE TEMPERATURE INCREASE CAUSED APPROX 10% REDUCTION IN MODULUS.

ABSTRACT 191

CUNNINGHAM G W

BMI-1601 (1962)

THERMODYNAMICS FOR COMPATIBILITY STUDIES OF METAL-CLAD URANIUM CARBIDE

THERMOCHEMICAL DATA FOR THE CARBIDES OF MOLYBDENUM, NIOBIUM, TANTALUM, TITANIUM, TUNGSTEN, URANIUM, AND ZIRCONIUM WERE CRITICALLY REVIEWED, AND THE FREE ENERGY OF FORMATION A FUNCTION OF TEMPERATURE WAS CALCULATED FOR THESE CARBIDES. ON THE BASIS OF THESE DATA, METAL CLADDINGS OF NIOBIUM, TANTALUM, TITANIUM, AND ZIRCONIUM WOULD BE EXPECTED TO REACT WITH URANIUM CARBIDES IN THE TEMPERATURE RANGE OF 1000 TO 2000 DEG C. DATA ARE INSUFFICIENT TO PREDICT THE BEHAVIOR OF MOLYBDENUM, BUT TUNGSTEN SHOULD NOT REACT EXTENSIVELY WITH STOICHIOMETRIC UC BELOW 1800 DEG C. THE MONOCARBIDE (UC) IS THE MOST STABLE OF THE URANIUM CARBIDES IN CONTACT WITH THE METALS LISTED, AND U SUB 2 C SUB 3 AND UC SUB 2 WOULD BE EXPECTED TO REACT WITH ALL THE METALS OVER THE ENTIRE TEMPERATURE RANGE OF 1000 TO 2000 DEG C.

ABSTRACT 192

DALTON J T

AERE-R-5948 (1969)

PHASE RELATIONSHIPS IN THE URANIUM-PLUTONIUM-DICARBIDE SYSTEM

THE U SUB 2 C SUB 3 + C = UC SUB 2 FORMATION TEMPERATURE HAS BEEN DETERMINED AS 1590 DEG C AND THE PU SUB 2 C SUB 3 + C = PUC SUB 2 REACTION TEMPERATURE AS 1650 DEG C. THE TRANSFORMATION AND FORMATION TEMPERATURES OF (U,PU)C SUB 2 ALLOYS HAVE BEEN DETERMINED DILATOMETRICALLY. A HIGH TEMPERATURE DIFFRACTOMETER HAS BEEN USED TO SHOW THAT A NARROW PHASE FIELD OF TWO IMMISCIBLE F C C PHASES EXISTS IN THE UC SUB 2-PUC SUB 2 SYSTEM. ALL ALLOYS ABOVE 1750 DEG C WERE FOUND TO BE F C C. MELTING DATA DETERMINED FOR STOICHIOMETRIC AND HYPERSTOICHIOMETRIC (U,PU)C SUB 2 ALLOYS WAS USED TOGETHER WITH ROOM TEMPERATURE X-RAY DIFFRACTION AND OTHER DATA, TO CONSTRUCT AN ISOPLETH BETWEEN UC SUB 2 AND PUC SUB 2.

ABSTRACT 193

DALTON J T

CARBIDES IN NUCL ENERGY, HARWELL A8 (1963)

EQUILIBRIA IN THE SYSTEM URANIUM-PLUTONIUM-CARBON

STUDIES OF THE PHASES PRESENT AT TEMPERATURES UP TO 2000 DEG C IN ALLOYS IN THE U-PU-C SYSTEM CONTAINING 50 TO 60 AT. % C HAVE BEEN MADE USING METALLOGRAPHIC AND X-RAY DIFFRACTION TECHNIQUES. COMPLETE SOLID SOLUBILITY OF PLUTONIUM SESQUICARBIDE IN URANIUM SESQUICARBIDE HAS BEEN OBSERVED. THE RAISING OF THE TRANSFORMATION TEMPERATURE U SUB 2 C SUB 3 = UC + UC SUB 2 WITH PLUTONIUM ADDITIONS IS DESCRIBED AND THE COMPOSITION RANGE OVER WHICH THIS TRANSFORMATION OCCURS IS ILLUSTRATED ON AN ISOTHERMAL SECTION AT 2000 DEG C. SEVERE PLUTONIUM SEGREGATION HAS BEEN NOTED IN SOME ARC MELTED ALLOYS AND THE TIME AND TEMPERATURE NECESSARY TO ELIMINATE IT HAS BEEN DETERMINED. SOME LIMITED DATA ON LIQUIDS

ABSTRACT 193 (CONT'D)
TEMPERATURES ARE INCLUDED.

ABSTRACT 194
DALTON J T
LIBBY-COCKCROFT MEETING (1968)
THE URANIUM-PLUTONIUM-CARBON SYSTEM

THE U-PU-C PHASE DIAGRAM IS DISCUSSED. MELTING POINTS OF VARIOUS PHASES WERE OBTAINED.

ABSTRACT 195
DALTON J T
NUCL MET, MET SOC AIME 17, 829 (1970)
ON THE URANIUM-PLUTONIUM- CARBON PHASE DIAGRAM PART I, MELTING BEHAVIOUR AND THE ISOPLETH FOR THE DICARBIDE REGION

THE MELTING TEMPERATURES OF ALLOYS HAVING NOMINAL COMPOSITIONS ON THE TIE UC SUB 2 -PUC SUB 2 ARE REPORTED AND DISCUSSED. A MINIMUM IS OBSERVED IN THE LIQUIDUS TEMPERATURES AT HIGH PU CONCENTRATIONS BECAUSE OF THE PERIYECTIC MELTING BEHAVIOR OF PUC SUB 2. THE ISOPLETH FOR THE REGION, UC SUB 2 -PUC SUB 2 HAS BEEN DETERMINED USING DILATOMETRY AND HIGH TEMPERATURE X-RAY DIFFRACTOMETRY. THE TEMPERATURES FOR THE REACTIONS, (UPU)C SUB 2 = (UPU)C SUB 1.5 + 0.5C AS A FUNCTION OF PU CONTENT HAVE BEEN DETERMINED USING A DILATOMETER. AT LOW PU CONCENTRATIONS, EXAMINATIONS OF RAPIDLY QUENCHED ALLOYS WERE MADE USING X-RAY POWDER PHOTOGRAPHY AND CERAMOGRAPHY. THIS REGION, WITH LOW PU CONCENTRATIONS, IS THE ONLY REGION WHERE THE TETRAGONAL (UPU)C SUB 2 PHASE APPEARS TO BE THERMODYNAMICALLY STABLE. STUDIES USING A HIGH TEMPERATURE X-RAY DIFFRACTOMETER SHOW THAT EXCEPT FOR PU CONCENTRATIONS LESS THAN APPROX 10 AT. % THE ONLY STABLE DICARBIDE PHASES HAVE FACE-CENTRED CUBIC STRUCTURES, BUT AT LOW PU CONCENTRATIONS, DICARBIDES WITH A STABLE TETRAGONAL STRUCTURE WERE FOUND. AT 1800 DEG C, THE LATTICE PARAMETERS OF CUBIC UC SUB 2 AND PUC SUB 2 ARE CLOSE, 0.548NM AND 0.570NM, BUT DO NOT FORM A COMPLETE RANGE OF SOLID SOLUTION. HIGH TEMPERATURE DIFFRACTOMETRY HAS SHOWN CONCLUSIVELY THAT THE TETRAGONAL DICARBIDES OBSERVED AT ROOM TEMPERATURE ARE METASTABLE PHASES. ALL THE CUBIC DICARBIDE ALLOYS COOLED TO ROOM TEMPERATURE SHOW THE PRESENCE OF THE TETRAGONAL DICARBIDE AND SESQUICARBIDE. AT HIGH PU CONCENTRATIONS IT IS INCREASINGLY DIFFICULT TO PREVENT THE DECOMPOSITION OF THE TETRAGONAL DICARBIDE TO THE SESQUICARBIDE AND CARBON.

ABSTRACT 196
DALTON J T
U K RESEARCH NEWSLETTER HL68/2451 (1968)
PHYSICAL PROPERTIES: THE URANIUM-PLUTONIUM-CARBON SYSTEM

MELTING BEHAVIOR, PHASE EQUILIBRIA, AND LATTICE PARAMETERS OF THE U-PU-C SYSTEM ARE DISCUSSED.

ABSTRACT 197

DANAN J

CEA-R-4453 (1973)

THE STUDY OF THE ELECTRONIC AND MAGNETIC PROPERTIES OF SOME ACTINIDE COMPOUNDS BY SPECIFIC HEAT MEASUREMENTS

SPECIFIC HEAT MEASUREMENTS WERE MADE ON THN, THC, U SUB X TH SUB 1-X S, AND UC SUB 1-X N SUB X. THE CARBONITRIDE WAS STUDIED FROM 8 TO 300 DEG K. MAGNETIC AND ELECTRONIC CONTRIBUTIONS TO SPECIFIC HEATS OF UC, UN, US, U SUB X TH SUB 1-X S, AND CARBONITRIDES OF URANIUM WERE ALSO STUDIED.

ABSTRACT 198

DANAN J

J NUCL MATER, 45, 339 (1973)

SPECIFIC HEAT FROM 35 TO 300 DEG K FOR PU SUB 2 C SUB 3

MEASURED THE SPECIFIC HEAT OF PU SUB 2 C SUB 3 WITH THE PRECISION OF #5% IN THE TEMPERATURE RANGE OF 35 TO 300 DEG K. THERMODYNAMIC PROPERTIES SUCH AS ENTHALPY AND ENTROPY ARE CALCULATED AT ROOM TEMPERATURE

ABSTRACT 199

DAYTON R W

BMI-1473 (1960)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER 1960.

ALTERNATE FABRICATION METHODS FOR UC, MELTING AND CASTING TECHNIQUES FOR URANIUM-CARBON ALLOYS, MECHANICAL AND PHYSICAL PROPERTIES OF URANIUM MONOCARBIDE, EFFECTS OF RADIATION ON UC AND OTHERS ARE DISCUSSED.

ABSTRACT 200

DAYTON R W

BMI-1711 (1965)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY 1965

PROGRESS IS REPORTED ON DEVELOPMENT OF REACTOR MATERIALS AND COMPONENTS, REACTOR FUELS DEVELOPMENT, RADIOISOTOPE AND RADIATION APPLICATIONS, COATED-PARTICLE FUEL MATERIALS DEVELOPMENT, AND SUPPORT WORK FOR THE ARMY ML-1 PROGRAM.

ABSTRACT 201

DAYTON R W

BMI-1738 SECT B (1965)

PROGRESS RELATING TO CIVILIAN APPLICATIONS

THE THERMAL DIFFUSIVITY OF PUN WAS MEASURED OVER THE TEMPERATURE RANGE OF 250 TO 1400 DEG C. THERMAL CONDUCTIVITIES OF PUN WERE THEN CALCULATED USING DETERMINED PUN THERMAL-DIFFUSIVITY AND DENSITY VALUES AND UN SPECIFIC HEAT VALUES. RESULTS OF INITIAL COMPATIBILITY TESTS OF PUN AND AEC - GRADE HELIUM ARE ALSO GIVEN.

ABSTRACT 202

DE COMBARIE A

CCMP REND 256, 5518 (1963)

SPECIFIC HEAT OF URANIUM MONO-CARBIDE AT LOW TEMPERATURE

SPECIFIC HEAT OF A SAMPLE OF URANIUM MONOCARBIDE WAS MEASURED BETWEEN 1.5 TO 4.2 DEG K AND BETWEEN 20 DEG TO 85 DEG K. FROM THE MEASUREMENTS, ELECTRONIC SPECIFIC HEAT, γ , AND THE DEBYE TEMPERATURE, θ SUB D. WERE DETERMINED. THESE MEASUREMENTS HAVE ALLOWED TO IDENTIFY THE ELECTRONIC STRUCTURE OF URANIUM MONOCARBIDE.

ABSTRACT 203

DE CONINCK R

J NUCL MATER 46, 213 (1973)

THERMAL DIFFUSIVITY AND CONDUCTIVITY OF U SUB 2 C SUB 3 UP TO 2200 DEG K

THE THERMAL DIFFUSIVITY AND CONDUCTIVITY OF U SUB 2 C SUB 3 WERE MEASURED BETWEEN 1000 AND 2200 DEG K USING A MODULATED ELECTRON-BEAM APPARATUS, AND AT 313.6 DEG K USING A SCHROEDER APPARATUS. BETWEEN ROOM TEMPERATURE AND 2050 DEG K, THE THERMAL CONDUCTIVITY FOLLOWS THE EQUATION $K = (5.05 * 10^{-2} + 5.63 * 10^{-5}) T (* K^{-1} * CM^{-1})$. ABOVE 2050 DEG K, A SUDDEN DECREASE OCCURS DUE TO TRANSFORMATION OF U SUB 2 C SUB 3 TO UC + UC SUB 2. THIS REACTION CAN BE REVERSED, ENDING WITH SPECIMEN FAILURE FROM CRACKING.

ABSTRACT 204

DE KEROULAS F

J NUCL MATER 44,64 (1972)

COEFFICIENT OF DISTRIBUTION OF URANIUM AND PLUTONIUM BETWEEN THE SYSTEMS (U,PU)C + (U,PU) SUB 2 C SUB 3

WE EXAMINED BY MICROPROBE ANALYSER THE DISTRIBUTION OF URANIUM AND PLUTONIUM BETWEEN THE PHASES (U,PU)C AND (U,PU) SUB 2 C SUB 3. TWO TYPES OF SAMPLES WERE AVAILABLE, WITH PU/(U+PU) RATIOS OF 0.20 AND 0.50. THE PROPORTION OF (U,PU) SUB 2 C SUB 3 VARIED FROM 10 TO 70%. TWO EQUILIBRIA TEMPERATURES, 1500 DEG C AND 1700 DEG C, WERE USED. MEASUREMENTS OF THE DISTRIBUTION COEFFICIENTS $K_{SUB U} = \text{AMOUNT OF URANIUM IN (U,PU)C} / \text{AMOUNT OF URANIUM IN (U,PU) SUB 2 C SUB 3}$, $K_{SUB PU} = \text{AMOUNT OF PLUTONIUM IN (U,PU)C} / \text{AMOUNT OF PLUTONIUM IN (U,PU) SUB 2 C SUB 3}$ FOR EACH OF THE 14 SAMPLES LED TO VALUES OF THE COEFFICIENTS INDEPENDENT OF TEMPERATURE AND PROPORTIONS OF THE TWO PHASES.

ABSTRACT 205

DE NOVION C

ORNL-TR-2443

MECHANICAL PROPERTIES AT HIGH TEMPERATURE OF CERAMICS BASED ON PLUTONIUM. APPLICATION TO FUEL ELEMENTS

A REVIEW OF ELASTIC AND CREEP PROPERTIES OF OXIDE, CARBIDE AND NITRIDE-BASED FUELS IS PRESENTED.

ABSTRACT 206

DE NOVIOM C

PLUTONIUM 1970, P509

MECHANICAL PROPERTIES OF URANIUM AND PLUTONIUM BASED CERAMICS.

THE ELASTIC CONSTANTS OF THE FOLLOWING COMPOUNDS WERE MEASURED: -MIXED URANIUM AND PLUTONIUM CARBIDES AND NITRIDES ($U_{SUB} 0.85 PU_{SUB} 0.15$)C AND ($U_{SUB} 0.85 PU_{SUB} 0.15$)N AS A FUNCTION OF POROSITY. -CARBONITRIDES ($U_{SUB} 0.85 PU_{SUB} 0.15$)C ($U_{SUB} 1-X N_{SUB} X$) AS A FUNCTION OF CARBON CONTENT FOR A 9% VOLUME POROSITY; A MAXIMUM IN COHESION ENERGY WAS EVIDENCED AROUND $X = 0.80$. -MIXED OXIDES OF URANIUM AND PLUTONIUM ($U_{SUB} 1-X PU_{SUB} X$)O $2\#Y$ FOR VALUES OF U/PU RATIO = 85/15, 80/20, 24/76 AND VOLUME POROSITY = 3-4%; YOUNG'S MODULUS INCREASES WITH PU CONTENT AND GOES THROUGH A MAXIMUM AT STOICHIOMETRIC COMPOSITION, THE COMPRESSIVE CREEP VELOCITY AT HIGH TEMPERATURES (1150-1700 DEG C) OF CARBONITRIDES ($U_{SUB} 0.85 PU_{SUB} 0.15$)C ($U_{SUB} 0.65 N_{SUB} 0.35$) HAS ALSO BEEN MEASURED; IT CAN BE EXPRESSED BY THE EQUATION: $\dot{\epsilon} \text{ APPROX} = 6 \cdot 10^{**} - 13 \cdot 0^{***} N \exp (-E/RT)$, WITH $N \text{ APPROX} = 2.3$, $E \text{ APPROX} = 100 \text{ KCAL/MOLE}$.

ABSTRACT 207

DECRESCENTE M A

CARBIDES IN NUCL ENERGY, HARWELL C88 (1963)

HIGH TEMPERATURE PROPERTIES OF URANIUM CARBIDE

THIS PAPER PRESENTS THE UNCLASSIFIED RESULTS OF URANIUM CARBIDE INVESTIGATIONS AT THE CONNECTICUT ADVANCED NUCLEAR ENGINEERING LABORATORY. THE STUDIES ARE PART OF A USAEC SUPPORTED PROGRAMME DIRECTED TOWARD PROVIDING HIGH PERFORMANCE MATERIALS FOR HIGH TEMPERATURE LIQUID-METAL COOLED REACTORS. EXPERIMENTAL DATA PERTAINING TO THE THERMAL DECOMPOSITION, HEAT CAPACITY, THERMAL CONDUCTIVITY, THERMAL DIFFUSION, AND HOT HARDNESS OF SINTERED URANIUM CARBIDE ARE PRESENTED. THE DATA ARE REVIEWED IN LIGHT OF IMPURITY AND STOICHIOMETRY VARIATIONS, THE EXPERIMENTAL METHODS, AND COMPARISONS WITH PUBLISHED RESULTS.

ABSTRACT 208

DEISS H

THERMO NUCL MATER P625 (1962)

VAPORIZATION OF URANIUM AND URANIUM CARBIDE UNDER VACUUM

THE AIM OF THE INVESTIGATION WAS TO OBTAIN THIN DEPOSITS AS PURE AS POSSIBLE OF URANIUM, THE MONOCARBIDE (UC) AND DICARBIDE ($UC_{SUB} 2$). THE ADVANTAGES OF THE VAPORIZATION TECHNIQUE USED (HEATING BY ELECTRON BOMBARDMENT) ARE EXPLAINED. THE VAPORIZATION OF RELATIVELY PURE URANIUM USUALLY PRODUCES HIGHLY OXIDIZED DEPOSITS, WHEREAS THE VAPORIZATION OF URANIUM CARBIDES GIVES PRACTICALLY OXIDE-FREE DEPOSITS. IT IS SHOWN, BY A THERMODYNAMIC ARGUMENT, THAT AS A RESULT OF THE FORMATION OF CO, THE PARTIAL PRESSURE OF THE OXYGEN IS CONSIDERABLY LOWERED AND THAT, UNDER THESE CONDITIONS, THE AFFINITY OF THE URANIUM FOR OXYGEN IS PRACTICALLY ZERO. THE UC AND $UC_{SUB} 2$ COMPOUNDS WERE OBTAINED WITHOUT DIFFICULTY UPON VAPORIZING URANIUM CARBIDES.

ABSTRACT 209

DELBASSINE A

PROCEEDINGS OF IAEA SYMP ON FUEL AND FUEL ELEMENTS FOR FAST REACTORS
JULY 2-6, (1973)

BEHAVIOUR OF URANIUM CARBIDE PELLETS IRRADIATED TO HIGH BURN-UPS

UNDER A CEN-SCK (MOL, BELGIUM) PROGRAM ON ADVANCED NUCLEAR FUELS, 36 URANIUM CARBIDE PELLETS CONTAINED IN A POM-TYPE DEVICE WERE IRRADIATED IN THE BELGIAN BR 2 REACTOR. THE PURPOSE OF THIS EXPERIMENT WAS TO COMPARE THE BEHAVIOR OF LOW AND HIGH DENSITY FUELS, WHETHER STABILIZED OR NOT WITH VANADIUM OR CHROMIUM, AND TO STUDY THE EFFECT OF THE CARBON AND OXYGEN CONTENTS. IN THE CASE OF 32 OF THE PELLETS, THE BURN-UP LAY BETWEEN 60000 AND 100000 MW.D/T, WITH A POWER DENSITY OF 950 W/G FOR THE PELLET WITH HIGHEST BURN-UP. THE REMAINING FOUR PELLETS WERE PLACED IN CONTACT WITH SAMPLES OF AUSTENITIC AND FERRITIC STAINLESS STEELS, IN ORDER TO MAKE AN IN-PILE STUDY OF THE COMPATIBILITY OF THESE STEELS WITH STABILIZED URANIUM CARBIDE. AFTER IRRADIATION, THE VARIOUS TYPES OF FUEL WERE EXAMINED IN THE LABORATORIES OF THE EUROPEAN INSTITUTE OF TRANSURANIUM ELEMENTS, AND IT WAS SHOWN THAT: (1) CARBON ACTIVITY DOES NOT VARY APPRECIABLY; (2) FISSION PRODUCTS DO NOT MIGRATE AND DO NOT FORM NEW PHASES VISIBLE IN THE OPTICAL MICROSCOPE; (3) THE RELEASE RATE OF FISSION GASES IS LOW; (4) (4) THE DISTRIBUTION AND FORM OF POROSITIES ARE DEPENDENT ON OXYGEN AND CARBON CONTENTS AND ON THE PRESENCE OF VANADIUM.

ABSTRACT 210

DELL R M

AERE-R-4253, (1963)

THE NITRIDES AND SULPHIDES OF URANIUM, THORIUM AND PLUTONIUM: A REVIEW OF PRESENT KNOWLEDGE

INFORMATION ON THE CHEMICAL AND PHYSICAL PROPERTIES OF THE NITRIDES AND SULFIDES OF U, TH, AND PU IS PRESENTED. LITERATURE PUBLISHED BEFORE THE END OF 1962 IS THE BASIS OF THE INFORMATION.

ABSTRACT 211

DELL R M

J NUCL MATER 21, 328 (1967)

THE IGNITION OF URANIUM MONONITRIDE AND URANIUM MONOCARBIDE IN OXYGEN

AN EXPERIMENTAL STUDY HAS BEEN MADE OF THE THERMAL IGNITION OF UN AND UC IN OXYGEN AND AIR. THE PRODUCTS OF REACTION ARE U_3O_8 AND N_2O OR CO SUB 2 RESPECTIVELY. THE PRESENCE OF A GASEOUS REACTION PRODUCT LEADS TO A MORE COMPLEX SITUATION THAN PREVAILS DURING THE IGNITION OF A METAL. USING SINTERED POWDERS (UN) AND SMALL PIECES OF FABRICATED MATERIAL (UN AND UC) IGNITION TEMPERATURES IN THE RANGE 280-400 DEG C WERE MEASURED TWELVE OR MORE DIFFERENT FACTORS HAVE BEEN IDENTIFIED WHICH INFLUENCES EITHER THE REACTION RATE OR THE RATE OF HEAT REMOVAL AND THEREFORE HELP TO DEFINE THE IGNITION TEMPERATURE. OF THESE, THE SURFACE AREA AND PARTICLE SIZE OF THE SOLID ARE THE PRIMARY FACTORS, WITH MASS AND GEOMETRY OF THE SPECIMEN AND GAS FLOW RATE ALSO PLAYING IMPORTANT ROLES.

ABSTRACT 212

DELL R M

TRANS FARADAY SOC 63,1286 (1967)

HYDROLYSIS OF URANIUM MONONITRIDE

AN EXPERIMENTAL STUDY HAS BEEN MADE OF THE HYDROLYSIS OF UN IN WATER VAPOR+ARGON MIXTURES OF CONTROLLED COMPOSITION. THE KINETICS OF REACTION ARE FOLLOWED GRAVIMETRICALLY AND BY ESTIMATION OF THE AMMONIA LIBERATED. FOR POWDERED UN THE REACTION PROCEEDS RAPIDLY ABOVE APPROX 340 DEG C. SOME SPECIMENS HYDROLYZE COMPLETELY TO UO_2 , AMMONIA AND HYDROGEN ($UN+2H_2 \rightarrow UO_2 + NH_3 + 1/2 H_2$) WHEREAS OTHERS YIELD A SOLID PRODUCT CONTAINING SIGNIFICANT AMOUNTS OF U_2N_3 + X AND DISSOLVED NITROGEN. THE DIFFERENCE IS ASCRIBED TO PARTICLE TEXTURE: WHEN THE RELEASE OF AMMONIA IS INHIBITED IT REACTS FURTHER WITH UN TO FORM U_2N_3 . THE OVERALL ACTIVATION ENERGY OF HYDROLYSIS IS 21 KCAL/MOLE. EXPERIMENTS WITH SINGLE CRYSTALS OF UN, HYDROLYZED AT HIGHER TEMPERATURES, SHOW THAT AN EPITAXIALLY ORIENTED SANDWICH STRUCTURE OF U_2N_3 AND UO_2 IS FORMED ON THE SURFACE OF THE CRYSTAL, EXACTLY AS DURING OXIDATION. THIS SURFACE FILM PROTECTS UN FROM HYDROLYSIS AT LOW TEMPERATURES. SOME EXPERIMENTS ON THE HYDROLYSIS OF UC SINGLE CRYSTALS ARE ALSO DESCRIBED.

ABSTRACT 213

DEVITA F

ENERGY NUCL MILAN 19,676 (1972)

DESIGN AND CONSTRUCTION OF A DEVICE FOR CONTINUOUS MEASUREMENTS OF CREEP IN URANIUM CARBIDE UNDER IRRADIATION

A DEVICE HAS BEEN DESIGNED AND CONSTRUCTED, WHICH ALLOWS CONTINUOUS X MEASUREMENT OF CREEP IN A URANIUM CARBIDE HOLLOW TUBE SPECIMEN, UNDER AXIAL COMPRESSION, NEUTRON IRRADIATION AND HIGH TEMPERATURE CONDITIONS. NEUTRON DISTRIBUTION AND THERMAL-MECHANICAL STRESS DISTRIBUTION HAVE BEEN CALCULATED IN ORDER TO EITHER CHECK THE SYSTEM SECURITY OR DETERMINE TEST PARAMETERS WHICH AFFECT CREEP: I.E., TEMPERATURE, STRESS, AND FISSION DENSITY. THEY MAY BE VARIED IN A FAIRLY WIDE RANGE. PRELIMINARY TESTS CONFIRMED THE FUNCTIONALITY OF THE DEVICE COMPONENTS.

ABSTRACT 214

DONNER D

J NUCL MATER 45 , 293 (1972/73)

PROPERTIES OF URANIUM VACANCIES IN URANIUM MONOCARBIDE

FROM THE EXCESS RESISTIVITY OBTAINED BY QUENCHING FROM TEMPERATURES BETWEEN 1300 AND 1600 DEG C A FORMATION ENERGY OF 1.7 EV IS DETERMINED. THE QUENCHED IN RESISTIVITY RECOVERS WITH AN ACTIVATION ENERGY OF 2.2 EV IN THE TEMPERATURE REGION BETWEEN 400 AND 600 DEG C. THESE TWO VALUES ARE ATTRIBUTED TO THE FORMATION AND MIGRATION ACTIVATION ENERGIES OF URANIUM VACANCIES, RESPECTIVELY. IT IS FURTHER SHOWN THAT URANIUM MONOCARBIDE REMAINS SINGLE-PHASE, IF THE DEVIATION FROM STOICHIOMETRY DOES NOT EXCEED MORE THAN A FEW TENTHS OF ONE PERCENT AND IF GASES (MAINLY OXYGEN) ARE IN SOLID SOLUTION.

ABSTRACT 215

DROEGE J W

BMI-1918, (1971)

DIFFUSION IN NITRIDES

SELF-DIFFUSION BEHAVIOR OF N SUB 2 IN UN WAS DETERMINED IN THE TEMPERATURE RANGE FROM 1640 TO 2080 DEG K AND N SUB 2 PRESSURE RANGE FROM 10^{-3} TO 10^{-1} ATM. USING AN N¹⁵ ISOTOPIC TRACER TECHNIQUE AND A LARGE GRAIN UN SPECIMEN. SELF-DIFFUSION OF N SUB 2 IN (U,PU)N WAS DETERMINED IN THE TEMPERATURE RANGE FROM 1500 TO 1820 DEG K AND AT A N SUB 2 PRESSURE OF 10^{-1} ATM. THE RESULTS WERE CONSISTENT WITH A $P^{1/2}$ DEPENDENCE. THE SELF-DIFFUSION COEFFICIENT OF N SUB 2 IN (U,PU)N WAS FOUND TO BE THE SAME, WITHIN EXPERIMENTAL ERROR, AS THAT FOUND IN UN.

ABSTRACT 216

DROWART J

J NUCL MATER 12, 319 (1964)

THE HEAT OF SUBLIMATION OF URANIUM AND THE CONSISTENCY OF THE THERMODYNAMIC DATA FOR URANIUM COMPOUNDS

A REVIEW OF THERMOCHEMICAL DATA FOR VAPORIZATION OF THE OXIDES AND CARBIDES OF URANIUM WAS MADE TO DERIVE INDIRECT VALUES FOR THE HEAT OF SUBLIMATION OF URANIUM FROM THE CORRESPONDING THERMODYNAMIC CYCLES. THE VALUES OBTAINED WERE IN GOOD AGREEMENT WITH THE DIRECT VALUE DETERMINED BY MASS-SPECTROMETRY, $\Delta H_{SUB 298,S} (U) = 125.5 \pm 2.5$ KCAL/G ATOM AND WITH THE VALUE $\Delta H_{SUB 298,S} (U) = 126 \pm 5$ KCAL/G ATOM ALSO DETERMINED BY MASS SPECTROMETRY BY DE MARIA, BURNS, DROWART, AND INGRAM.

ABSTRACT 217

DRUMMOND J L

J CHEM SOC 4, 4785 (1957)

THE PREPARATION AND PROPERTIES OF SOME PLUTONIUM COMPOUNDS, PART 7: PLUTONIUM CARBIDES

PLUTONIUM MONOCARBIDE, PUC, HAS BEEN PREPARED BY THE REACTION OF GRAPHITE WITH PLUTONIUM METAL OR HYDRIDE AT ABOUT 900 DEG. A SESQUICARBIDE, PU SUB 2C SUB 3, WAS FORMED, IN ADDITION TO THE MONOCARBIDE, BY THE REDUCTION OF PLUTONIUM DIOXIDE WITH GRAPHITE AT 1800-1900 DEG. BOTH CARBIDES ARE REACTIVE AND EASILY HYDROLYSED BY DILUTE ACID OR BOILING WATER. STRONG CHEMICAL AND X-RAY EVIDENCE SUGGESTS THAT A HIGHER CARBIDE EXISTS BUT IT HAS NOT BEEN IDENTIFIED UNEQUIVOCALLY.

ABSTRACT 218

DWYER D E

BNL-900, P29 (1964)

CHEMISTRY AND CHEMICAL ENGINEERING DIVISION

DATA WERE OBTAINED AS THE FREE ENERGIES OF FORMATION DICARBIDE OF U;

ABSTRACT 219

EICK H A

THERMO NUCL MATER, P558 (1962)

VAPORIZATION STUDIES OF THE URANIUM DICARBIDE PHASE

FROM ABSOLUTE EFFUSION RATES OF URANIUM, ITS PARTIAL PRESSURES IN EQUILIBRIUM WITH URANIUM DICARBIDE AND CARBON WERE DETERMINED OVER THE TEMPERATURE RANGE 2060 TO 2820 DEG K. THE DICARBIDE PHASE WAS PREPARED BY THE REACTION OF URANIUM DIOXIDE WITH GRAPHITE IN A GRAPHITE CUP WHICH ALSO SERVED AS A LINER IN THE TANTALUM EFFUSION CELL. IN PRELIMINARY STUDIES IT WAS FOUND THAT THE SAMPLE WAS EASILY CONTAMINATED WITH OXYGEN WHICH CAUSED AN ABNORMALLY HIGH VOLATILITY. EXTENSIVE HEATING OF THE SAMPLE IN A VACUUM OF ABOUT 10^{-6} MM HG REMOVED THIS OXYGEN. CHEMICAL ANALYSES OF A MELTED SAMPLE ESTABLISHED THE COMPOSITION AS UC SUB 1.90. ABOUT ONE PER CENT OF THE EFFUSING GASEOUS URANIUM (IN ALL ITS FORMS) WAS CONDENSED ON PLATINUM COLLECTORS WHICH WERE ANALYZED BY ALPHA-COUNTING OF EITHER THE U-233 OR U-235 ISOTOPE. MASS SPECTROMETRIC STUDIES INDICATED THE EFFUSATE CONTAINED GASEOUS URANIUM, MONATOMIC AND TRIATOMIC CARBON, AND URANIUM DICARBIDE; THE RATIO OF U+ TO (UC SUB 2)+ WAS 4 AT ABOUT 2800 DEG K. WITHIN THE PRECISION OF THE PRESENT STUDY THE GASEOUS DICARBIDE MAY BE NEGLECTED IN THE PRESSURE CALCULATIONS. THE PLOT OF LOG P VS. $1/T$ MAY BE CHARACTERIZED AS TWO NEARLY PARALLEL LINEAR REGIONS, ONE OBSERVED AT LOWER AND THE OTHER AT HIGHER TEMPERATURES. POINTS ON THE HIGHER TEMPERATURE LINE DIFFER BY A FACTOR OF 1.1 FROM POINTS ON AN EXTRAPOLATION OF THE OTHER LINE; A GRADUAL TRANSITION REGION EXISTS BETWEEN THE TWO. THE TWO LINES DESCRIBING THE DATA ARE: $\log P(\text{ATM}) = -34.568/T + 7.01$ (2060 TO 2460 DEG K) AND $\log P(\text{ATM}) = -33.593/T + 7.00$ (2540 TO 2820 DEG K). IT IS BELIEVED THERE ARE FEWER UNCERTAINTIES IN THE LOWER TEMPERATURE REGION, THE FREE ENERGY OF FORMATION WAS DERIVED FROM IT: $\Delta F \text{ SUB } F (\text{UC SUB } 1.90) = 51,400 + 6.02T$. THE CALCULATED ENTROPY OF UC SUB 1.90 IS THEN 47 E. U. WITH AN ESTIMATED ERROR OF #2 E. U.

ABSTRACT 220

EICK H A

T10-17413 (1962)

THERMODYNAMIC PROPERTIES OF CARBIDES AT HIGH TEMPERATURES

CURRENTLY AVAILABLE THERMOCHEMICAL DATA AND NUMEROUS CALCULATIONS INVOLVING COMPARISONS AND CRITICAL EVALUATIONS ARE PRESENTED CONCERNING THE CARBIDES OF PU, TH, AND U. BECAUSE OF THE DIFFICULTIES INVOLVED, THERE ARE VERY FEW METHODS PRESENTLY AVAILABLE WHICH CAN BE EMPLOYED TO DETERMINE THE FREE ENERGY AND ENTROPY OF FORMATION OF A CONDENSED PHASE. AT TEMPERATURES ABOVE 2000 DEG C. TO DATE, EXTREMELY HIGH PRECISION IN THE MEASUREMENTS OF RATES OF EFFUSION IN GENERAL HAVE NOT BEEN OBTAINED.

ABSTRACT 221

ELKINS P E

NAA-SR-7502

COMPATIBILITY OF URANIUM CARBIDE FUELS WITH CLADDING MATERIALS

EXPERIMENTS WERE CONDUCTED, TO DETERMINE THE COMPATIBILITY LIMITATIONS OF URANIUM CARBIDE FUELS WITH SEVERAL CLADDING MATERIALS, BOTH IN A SODIUM ENVIRONMENT AND IN DIRECT CONTACT. HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE WAS FOUND TO BE COMPATIBLE WITH TYPE 304 STAINLESS STEEL, NR-1 WT. % ZR, AND 3ZL, UNDER CONDITIONS OF LOOSELY FITTED FUEL SPECIMENS IN CAPSULES OF THE CLADDING MATERIALS IN QUESTION, EITHER IN THE PRESENCE OR ABSENCE OF A SODIUM BONDING MEDIUM. AT TEMPERATURES BELOW 1800 DEG F, NEITHER

ABSTRACT 221 (CONT'D)

URANIUM NOR CARBON WAS TRANSFERRED BY THE SODIUM TO THESE CLADDING MATERIALS. BASED ON TESTS UP TO 6000 H, HYPERSTOICHIOMETRIC UC WITHOUT A LIQUID METAL BONDING MEDIUM IS COMPATIBLE, UP TO 1600 DEG F, WITH THE THREE CLADDING MATERIALS TO THE EXTENT THAT THE OBSERVED REACTIONS, EVEN AT 1600 DEG F, WERE LOCALIZED AND LIMITED IN DEPTH. HOWEVER, IN A SODIUM ENVIRONMENT, THIS FUEL IS INCOMPATIBLE WITH TYPE 304 STAINLESS STEEL BY REASON OF THE HIGH CARBON ACTIVITY OF HYPERSTOICHIOMETRIC UC, THE EFFECTIVE CARBON TRANSFER PATH OFFERED BY THE SODIUM, AND THE CARBURIZING POTENTIAL OF STAINLESS STEEL. THE RESULTANT EMBRITTLEMENT OF THE STAINLESS STEEL RENDERS THIS SYSTEM UNSUITABLE FOR REACTOR OPERATION. COMPATIBILITY TESTS WITH NB-1 WT. % ZR AND 3 ZL CAPSULES CONTAINING CARBON-SATURATED SODIUM, USED IN ORDER TO OBTAIN MAXIMUM CARBURIZATION RATES, EXHIBITED SATISFACTORY COMPATIBILITY BELOW 1600 DEG F. AT HIGHER TEMPERATURES, 1800 AND 2000 DEG F, CARBURIZATION RATES WERE EXCESSIVE, WITH EVIDENCE IN SOME CASES OF ACCELERATED EFFECTS CAUSED BY SPALLING OF THE CARBIDE LAYER. HASTELLOY, N, NICHROME V, AND ALL HIGH-CHROMIUM STEELS EXAMINED WERE SUSCEPTIBLE TO CARBURIZATION, AND ARE UNSUITED FOR USE WITH HYPERSTOICHIOMETRIC UC UNLESS AN EFFECTIVE AND RELIABLE CARBON BARRIER IS DEVELOPED.

ABSTRACT 222

ENDEBROCK R W

BMI-1690 (1964)

PREPARATION AND PROPERTIES OF CAST UN

METHODS WERE DEVELOPED TO PREPARE URANIUM MONONITRIDE, BOTH AS POLYCRYSTALLINE MATERIAL AND AS LARGE SINGLE CRYSTALS, BY CONSUMABLE-ELECTRODE ARC-MELTING PROCEDURES. UN SINGLE CRYSTALS EXHIBITED AN AVERAGE KNOOP HARDNESS OF 555 AND A VICKERS HARDNESS OF 515. DENSITIES OBTAINED BY THE DISPLACEMENT TECHNIQUE VARIED FROM 99-100% OF THEORETICAL. CONGRUENT MELTING OCCURRED AT 2850 ± 50 DEG C AT AND ABOVE A NITROGEN PRESSURE OF 2.5 ATM. AN INITIAL FILM OF OXIDE WHICH FORMED ON CRYSTAL SURFACES OFFERED PROTECTION FROM FURTHER OXIDATION. SOME INFORMATION REGARDING UN STRUCTURE AS DETERMINED FROM SINGLE CRYSTALS OF UN WAS ALSO OBTAINED. HOT-HARDNESS VALUES FOR SINGLE CRYSTALS AT 1000 DEG C AND ABOVE WERE ABOUT 30% LOWER THAN THOSE OF HOT ISOSTATICALLY PRESSED UN POWDER. HARDNESS VARIED FROM ABOUT 90 DPHN AT 1000 DEG C TO ABOUT 25 DPHN AT 1400 DEG C. THERMAL CONDUCTIVITY VARIED LINEARLY FROM 0.04-0.062 CAL/CM S DEG C OVER THE 50-1000 DEG C TEMPERATURE RANGE. ELECTRIC RESISTIVITY FOR POLYCRYSTALLINE AND MONOCRYSTALLINE UN VARIED FROM 157 UOHM CM AT 25 DEG C TO 194 UOHM CM AT 1000 DEG C. TIN ALLOYED WITH UN APPEARED TO ACT SYNERGISTICALLY TO MAINTAIN UN STOICHIOMETRY AT THE EXPENSE OF TIN NITROGEN SOLUBILITY.

ABSTRACT 223

ENDEBROCK R W

IMD SPEC REP SER 13, 557 (1964); NUCL MET AIME 10, 557 (1964)

CHARACTERIZATION AND PROPERTIES OF ARC MELTED URANIUM MONONITRIDE

URANIUM MONONITRIDE, BOTH AS POLYCRYSTALLINE MATERIAL AND AS LARGE SINGLE CRYSTALS, CAN BE PREPARED BY CONSUMABLE-ELECTRODE ARC-MELTING PROCEDURES. THE METHODS ARE DESCRIBED. UN SINGLE CRYSTALS SHOWED AN AVERAGE KNOOP HARDNESS OF 555 AND A VICKERS HARDNESS OF 500. DENSITIES OBTAINED BY THE DISPLACEMENT TECHNIQUE VARIED FROM 99-100.1% OF THEORETICAL. CONGRUENT

ABSTRACT 223 (CONT'D)

MELTING OCCURRED AT 2850±50 DEG C AT AND ABOVE 2.5 ATM NITROGEN. AN INITIAL FILM OF OXIDE, WHICH FORMED ON CRYSTAL SURFACES OFFERED PROTECTION FROM FURTHER OXIDATION. SOME INFORMATION REGARDING UN STRUCTURE AS DETERMINED FROM SINGLE CRYSTALS OF UN IS ALSO PRESENTED.

ABSTRACT 224

ERBEN E

METALL 27, 693 (1973)

GRAIN GROWTH OF URANIUM CARBIDE WITHIN TEMPERATURE RANGES OF 1500 TO 1900 DEG C

RESULTS ARE PRESENTED OF INVESTIGATIONS ON THE GRAIN GROWTH OF ELECTRON-BEAM-MELTED UC HAVING A CARBON CONTENT OF 4.65 AND 4.88 WT % IN THE TEMPERATURE RANGE OF 1500 TO 1900 DEG C, AT TEST TIMES OF 1/2 TO 24 HRS. WHEREAS AT 1500 DEG C, FOR ALL THREE COMPOSITIONS ONLY A RELATIVELY SMALL GRAIN GROWTH OCCURRED, AT 1700 AND 1900 DEG C A CONSIDERABLE GRAIN GROWTH WAS OBSERVED, WHERE IN ANY CASE THE GREATEST GRAIN GROWTH WAS EXHIBITED BY THE SUBSTOICHIOMETRIC URANIUM MONOCARBIDE, WHEREAS THE VALUES FOR STOICHIOMETRIC OR SUPERSTOICHIOMETRIC URANIUM MONOCARBIDE DID NOT DIFFER SIGNIFICANTLY. THE ACTIVATION ENERGIES FOR THE RANGE 1500 TO 1700 DEG C FOR ALL THREE COMPOSITIONS INVESTIGATED ARE OF THE SAME ORDER AS THAT FOR THE SELF-DIFFUSION OF CARBON AND URANIUM IN URANIUM MONOCARBIDE, WHEREAS IN THE RANGE 1700 TO 1900 DEG C ONLY, THE SUBSTOICHIOMETRIC URANIUM MONOCARBIDES EXHIBIT THIS VALUE. THE VALUES FOR THE STOICHIOMETRIC AND SUPERSTOICHIOMETRIC URANIUM MONOCARBIDE, HOWEVER, ARE 1/4 OF THE ACTIVATION ENERGIES FOR THE SELF-DIFFUSION.

ABSTRACT 225

ERVIN G JR

NAA-SR-11813 (1966)

ZONE MELTING OF URANIUM MONOCARBIDE

TWO FURNACES FOR FLOAT-ZONE MELTING ARE DESCRIBED BRIEFLY, AND DATA ON ZONE MELTING OF UC ARE PRESENTED. INDUCTION ZONE MELTING OF UC IN A HE ATMOSPHERE DOES NOT CAUSE MUCH LOSS OF U BY PREFERENTIAL VAPORIZATION, AND IT WAS THEREFORE POSSIBLE TO MAKE USE OF THE COMPOSITIONAL CHANGES ALONG THE LENGTH OF THE ZONE-MELTED ROD TO CALCULATE DISTRIBUTION COEFFICIENTS FOR EXCESS U AND C IN UC. THESE DISTRIBUTION COEFFICIENTS INDICATE THE SHAPE OF THE U-C PHASE DIAGRAM IN THE NEIGHBOURHOOD OF THE MELTING POINT OF UC. ELECTRON BEAM ZONE MELTING IN VACUUM PRODUCED SINGLE CRYSTALS OF UC, NORMALLY CONTAINING UC SUB 2 AS A SECOND PHASE; BUT, AT FAST TRANSVERSE RATE, THE EVAPORATION OF U WAS MINIMIZED AND SINGLE-PHASE SINGLE CRYSTALS OF UC WERE PRODUCED.

ABSTRACT 226

ERWIN G JR

NAA-SR-12395 P139 (1966)

QUARTERLY TECHNICAL PROGRESS REPORT, JAN.- MARCH 1967

DEVELOPMENTS ARE REPORTED FOR STUDIES ON: CROSS SECTION ANALYSIS; INTEGRAL REACTOR-PHYSICS EXPERIMENTS; BASIC-THEORY IMPROVEMENT; FAST SPECTRUM DOPPLER MEASUREMENTS; BOILING STUDIES FOR SODIUM REACTOR SAFETY; MEASUREMENT OF DOPPLER COEFFICIENTS; REACTOR DYNAMICS SIMULATOR

ABSTRACT 226 (CONT'D)

DEVELOPMENT; FISSION PRODUCT CONTAMINATION CONTROL; CHARACTERIZATION OF NA FIRES AND FISSION PRODUCT RELEASE; FISSION EFFECTS IN METAL FUELS; SODIUM REACTOR EXPERIMENT OPERATION; REFRACTORY MODERATOR MATERIALS; FBR FUEL DEVELOPMENT, FUEL CLADDING, AND STRUCTURAL MATERIALS; COOLANT CHEMISTRY; MATERIALS MANAGEMENT; MECHANICAL PROPERTIES; DYNAMIC LOOP TESTING; MODES OF FAILURE AND HE DEGRADATION; BASIC PROPERTIES OF UC TYPE FUELS; NA CHEMISTRY; HNPf RETIREMENT; HNPf FUEL ELEMENTS; HIGH TEMPERATURE CHEMISTRY; RADIATION CHEMISTRY; ELECTRONIC STRUCTURE OF METALS AND ALLOYS; RADIATION DAMAGE IN CRYSTALLINE SOLIDS; RADIATION CHEMISTRY OF CHROMOSOMES.

ABSTRACT 227

EVANS P E

J NUCL MATER 10, 43 (1963)

URANIUM NITRIDES

THE STRUCTURE OF URANIUM NITRIDES AND ON THE PREPARATION OF THE MONONITRIDE IS REVIEWED. THE MONONITRIDE WAS PREPARED AS A FINELY DIVIDED UNCONTAMINATED POWDER BY HYDRIDING URANIUM TURNINGS, DECOMPOSING THE HYDRIDE, FORMING HIGHER NITRIDES, AND REDUCING THEM TO THE MONONITRIDE, THE SESQUINITRIDE WAS FOUND TO BE BODY-CENTERED CUBIC AND THE MONONITRIDE FACE-CENTERED CUBIC. DISSOCIATION OCCURS WHEN THE MONONITRIDE IS HEATED TO EXCESSIVE TEMPERATURES IN VACUO OR IN AN ARGON ATMOSPHERE, BUT IN A NITROGEN ATMOSPHERE THE FORMATION OF HIGHER NITRIDES PRECEDES DISSOCIATION. DENSITY AND MICROHARDNESS WERE MEASURED.

ABSTRACT 228

EYRE B L

J NUCL MATER 26, 249 (1968)

THE FORMATION AND BEHAVIOR OF GAS BUBBLES IN A NON-UNIFORM TEMPERATURE ENVIRONMENT

IRRADIATION OF URANIUM- AND PLUTONIUM-BASED FUELS RESULTS IN THE ACCUMULATION OF FISSION PRODUCTS OF WHICH ABOUT 10% ARE THE INERT GASES XENON AND KRYPTON. THESE GAS ATOMS ARE INSOLUBLE AND PRECIPITATE IN THE MATRIX TO EVENTUALLY FORM GAS BUBBLES. THIS PAPER CONSIDERS IN DETAIL THE NUCLEATION AND SUBSEQUENT BEHAVIOR OF THE GAS BUBBLES IN A NON-UNIFORM TEMPERATURE ENVIRONMENT. IT IS THEREFORE PARTICULARLY RELEVANT TO CERAMIC FUELS IN WHICH STEEP TEMPERATURE GRADIENTS ARE TYPICALLY PRESENT DURING OPERATION. FINALLY, THE THEORY DEVELOPED IN THE PAPER HAS BEEN APPLIED TO A URANIUM CARBIDE PELLET OPERATING UNDER A SPECIFIC SET OF CONDITIONS TYPICAL OF THOSE EXISTING IN A FAST REACTOR ENVIRONMENT. UP TO 10% BURN-UP THE PREDICTED SWELLING IS CONSISTENT WITH THE VALUES ESTIMATED FROM EXPERIMENTS.

ABSTRACT 229

EYRE B L

PHIL MAG 9,545 (1964)

ELECTRON MICROSCOPE STUDIES OF URANIUM DICARBIDE PRECIPITATES IN URANIUM CARBIDE SINGLE CRYSTALS

A METHOD FOR PREPARING THIN FILMS OF UC SINGLE CRYSTAL CONTAINING UC SUB 2 PRECIPITATES IS DESCRIBED. THE FILMS HAVE BEEN EXAMINED BY TRANSMISSION ELECTRON MICROSCOPY AND USING SELECTED AREA DIFFRACTION TECHNIQUES THE CRYSTALLOGRAPHIC RELATIONS BETWEEN THE UC SUB 2 AND THE UC MATRIX HAVE BEEN ESTABLISHED. TWINNING IS OBSERVED IN THE UC SUB 2 PRECIPITATES AND THIS IS ATTRIBUTED TO THE INTERACTIONS WHICH OCCUR WHEN UC SUB 2 CRYSTALS OF DIFFERENT ORIENTATION INTERSECT. A MECHANISM IS PROPOSED FOR THE FORMATION OF UC SUB 2 IN SLIGHTLY HYPERSTOICHIOMETRIC UC.

ABSTRACT 230

FARR J D

CARBIDES IN NUCLEAR ENERGY VOL I, 184 (1964)

THERMODYNAMIC PROPERTIES AND PHASE RELATIONSHIPS IN THE U-C SYSTEM AND SELECTED U-M-C SYSTEMS

RESULTS OF EXTENSIVE PHASE AND THERMODYNAMIC STUDIES MADE OVER THE LAST FEW YEARS STRONGLY SUGGEST ONLY SMALL DIFFERENCES IN STABILITY FOR THE DIFFERENT URANIUM CARBIDES. PARTIAL PHASE DIAGRAM STUDIES HAVE BEEN MADE ON SEVERAL U-M-C TERNARY SYSTEMS. STUDIES OF THE U-ZR-C AND THE U-NB-C SYSTEM INDICATE IMPROVED PHYSICAL PROPERTIES AND STABILITY FOR (U-M-C) SOLID SOLUTIONS IN SOME REACTOR FUEL APPLICATIONS. A RELATIVELY LARGE NUMBER OF COMPOUNDS OF THE TYPE UMC SUB 2 EXIST AND MAY EXHIBIT DESIRABLE PROPERTIES AS FUELS FOR SPECIFIC REACTORS. FOR EXAMPLE, UMC SUB 2 DOES NOT HYDROLYZE AND DOES NOT REACT WITH C TO FORM UC SUB 2.

ABSTRACT 231

FARR J D

COO-1149-29; LA-DC-6867 (1965); THERMOPHYSICAL PROPERTIES AT EXTREME TEMPERATURES AND PRESSURES, P162 (1965)

URANIUM DICARBIDE AND DIURANIUM TRICARBIDE. PREPARATION AND CHEMICAL THERMODYNAMIC PROPERTIES FROM 5 TO 350 DEG K.

LOW-TEMPERATURE HEAT CAPACITIES OF HYPOSTOICHIOMETRIC UC SUB 1.94 AND OF UC SUB 2 C SUB 3 DETERMINED BY ADIABATIC CALORIMETRY SHOWED A TYPICAL SIGMOIDAL TEMPERATURE DEPENDENCE AND NO THERMAL ANOMALIES. THERMODYNAMIC PROPERTIES AT 298.15 DEG K DERIVED FROM THESE DATA FOR THE HEAT CAPACITY (C SUB P), ENTROPY (S SUB O), ENTHALPY FUNCTION ((H SUB O - H SUB O) / T), AND GIBBS ENERGY FUNCTION ((-G SUB O - H SUB O DEG O) / T) ARE 14.52, 16.33, 8.46, 7.87, AND 25.66, 32.93, 16.20, 16.73 CAL/(GFM DEG K) FOR UC SUB 1.94 AND UC SUB 2 C SUB 3, RESPECTIVELY.

ABSTRACT 232

FARR J D

J PHYS CHEM 63, 1455 (1959)

THE PREPARATION OF URANIUM MONOCARBIDE AND ITS HEAT OF FORMATION

THE PREPARATION OF URANIUM MONOCARBIDE, UC, BY DIRECT COMBINATION OF THE ELEMENTS IS DESCRIBED. ITS HEAT OF FORMATION WAS FOUND BY COMBUSTION CALORIMETRY TO BE ΔH_{298}° SUB 298 DEG K. = -21.0 ± 1.0 KCAL./MOLE. THE COMBUSTION EXPERIMENTS WERE DONE WITH UC-UC SUB 2 MIXTURES IN ORDER THAT

ABSTRACT 232 (CONT'D)

THE FINAL URANIUM OXIDE FORMED WOULD BE STOICHIOMETRIC U SUB 3 O SUB 8.

ABSTRACT 233

FERGUSON I F

AERE-M-819 (1961)

HIGH TEMPERATURE X-RAY DIFFRACTION STUDIES PART 2. URANIUM MONOCARBIDE AND URANIUM DICARBIDE

A HIGH-TEMPERATURE X-RAY POWDER DIFFRACTION STUDY HAS BEEN MADE OF URANIUM MONOCARBIDE (UC SUB 0.83) AND URANIUM DICARBIDE (UC SUB 1.82). THE CUBE CELL EDGE, A SUB T, OF UC SUB 0.83 AT A TEMPERATURE T DEG C WAS GIVEN BY THE RELATION: A SUB T = $4.9592 (1 + (10.98 \pm 0.08) \cdot 10^{-6} T)$ Å; 20 DEG < T DEG < 690 DEG. FOR UC SUB 1.82, THE DIMENSIONS OF THE TETRAGONAL UNIT CELL, A SUB T AND C SUB T, AT A TEMPERATURE T DEG WERE GIVEN BY THE RELATIONS: A SUB T = $3.5256 (1 + (16.56 \pm 0.23) \cdot 10^{-6} T)$ Å; C SUB T = $6.0014 (1 + 10.43 \cdot 10^{-6} T)$ Å; 20 DEG < T DEG < 935 DEG.

ABSTRACT 234

FERRIS L M

CARBIDES IN NUCL ENERGY, HARWELL A1 (1963)

PHASE RELATIONSHIPS IN THE URANIUM-CARBON SYSTEM AS DETERMINED BY CHEMICAL, METALLOGRAPHIC, AND X-RAY DIFFRACTION METHODS. ORNL-TM-668, CONF-206-1,

PHASE IDENTIFICATION IN THE URANIUM-CARBON SYSTEM WAS ACCOMPLISHED BY ANALYZING A SERIES OF HIGH-PURITY AS-CAST AND HEAT-TREATED SPECIMENS. THE SPECIMENS WERE CHARACTERIZED BY CHEMICAL ANALYSES FOR URANIUM, TOTAL CARBON, FREE CARBON, OXYGEN, AND TUNGSTEN; BY X-RAY DIFFRACTION, BY METALLOGRAPHIC EXAMINATION, AND BY THE GASES EVOLVED ON HYDROLYSIS. ON HYDROLYSIS, URANIUM MONOCARBIDE YIELDED PREDOMINANTLY METHANE; URANIUM METAL (IN U-UC ALLOYS), HYDROGEN; URANIUM DICARBIDE, ABOUT 40 VOL. % HYDROGEN, 15 VOL. % METHANE, AND 45 VOL. % C SUB 2 - TO C SUB 8 -HYDROCARBONS, AND URANIUM SESQUICARBIDE, ABOUT 60 VOL. % HYDROGEN, 40 VOL. % C SUB 2 - TO C SUB 8 -HYDROCARBONS, AND VIRTUALLY NO METHANE. AS-CAST SPECIMENS WITH COMPOSITIONS BETWEEN UC SUB 0.4 AND UC SUB 1.0 (2 TO 4.8 WT. % C) WERE BINARY MIXTURES OF URANIUM METAL AND URANIUM MONOCARBIDE (UC). HEAT-TREATMENTS OF UC SPECIMENS AT TEMPERATURES BETWEEN 1275 DEG AND 2000 DEG C PRODUCED NO EFFECT SHOWING THAT URANIUM MONOCARBIDE IS STABLE IN THIS TEMPERATURE RANGE. IN ATTEMPTS TO PREPARE UC SUB 2.0, THE MAXIMUM COMBINED-C/U ATOM RATIO OBTAINED WAS 1.85 ± 0.03 (8.5 WT. % C). SPECIMENS WITH HIGHER TOTAL-C/U ATOM RATIOS WERE BINARY MIXTURES OF UC SUB 1.85 AND GRAPHITE. HEAT TREATING THESE SPECIMENS AT TEMPERATURES BETWEEN 1260 DEG AND 2000 DEG C HAD NO EFFECT ON THEIR X-RAY DIFFRACTION PATTERNS, HYDROLYSIS PRODUCTS, OR COMBINED-C/U ATOM RATIOS. NO URANIUM SESQUICARBIDE WAS DETECTED EVEN AFTER HEATING FOR 60 H AT 1450 DEG C OR 240 H AT 1260 DEG C ALTHOUGH THE OXYGEN AND NITROGEN CONCENTRATIONS OF THE SPECIMENS WERE LESS THAN 0.1 WT. % AND 105 PPM, RESPECTIVELY. THEREFORE, URANIUM DICARBIDE IS A CARBON DEFICIENT COMPOUND OF COMPOSITION UC SUB 1.85 WHICH IS THERMALLY STABLE AT LEAST TO SHORT HEAT-TREATMENTS AT TEMPERATURES BETWEEN 1260 DEG AND 2000 DEG C. AS-CAST SPECIMENS AND SPECIMENS HEAT-TREATED ABOVE 1900 DEG C WITH COMPOSITION BETWEEN UC AND UC SUB 1.85 (4.8 TO 8.5 WT. % C) WERE BINARY MIXTURES OF THE MONOCARBIDE AND DICARBIDE. METALLOGRAPHIC EXAMINATION INDICATED THAT A MONOCARBIDE-DICARBIDE SOLID SOLUTION WITH A COMPOSITION OF ABOUT UC SUB

ABSTRACT 234 (CONT'D)

1.65 (7.7 WT. % C) EXISTED AT 1900 DEG C IN EQUILIBRIUM WITH EXCESS MONOCARBIDE.

ABSTRACT 235

FESSLER M H

AEC-PWAC-482 (1965)

COMPRESSIVE CREEP OF UC AND UN

OUT-OF-PILE COMPRESSIVE CREEP TESTS WERE PERFORMED ON UC AND UN. HYPERSTOICHIOMETRIC UC (4.9% C) DEFORMED AT 6000 PSI-10,000 PSI IN THE RANGE 1100-1300 DEG C GAVE $\dot{\epsilon} = 2.06 \times 10^{-2} \times \exp(-44000/R/T)$ STOICHIOMETRIC UC, UNDER THE SAME CONDITIONS, GAVE $\dot{\epsilon} = 2.1 \times 10^{-4} \times \exp(-51700/R/T)$ HIGH OXYGEN CONTAINING UN GAVE $\dot{\epsilon} = 2.75 \times 10^{-5} \times \exp(-62000/R/T)$ AT 6000 PSI AND $\dot{\epsilon} = 6.9 \times 10^{-5} \times \exp(-60000/R/T)$ AT 8000 PSI, OVER THE TEMPERATURE RANGE 1100 TO 1350 DEG C. LOW OXYGEN CONTAINING UN SHOWED AN INCREASE IN CREEP RATES BY A FACTOR OF 10.

ABSTRACT 236

FRENCH P M

PLUTONIUM 1965, P697

MECHANICAL PROPERTIES AND COMPATIBILITY OF URANIUM-PLUTONIUM CARBIDES

THE MECHANICAL PROPERTIES OF BOTH SINTERED AND SKULL-CAST U-PU CARBIDES WERE MEASURED AT TEMPERATURES UP TO 900 DEG C. HARDNESS, COMPRESSION, INDENTATION CREEP, AND THE RELIEF OF INTERNAL STRESSES AT 1400 TO 1600 DEG C WERE STUDIED. THE MIXED CARBIDE WAS COMPATIBLE WITH TYPE 316L STAINLESS STEEL UP TO 900 DEG C, ALTHOUGH SLIGHT SURFACE CARBURIZATION WAS OBSERVED. THE INTRODUCTION OF A SODIUM BOND CAN LEAD TO GROSS CARBURIZATION OF THE STEEL IN THE PRESENCE OF HYPERSTOICHIOMETRIC CARBIDE. COMPATIBILITY STUDIES ON NICKEL-BASED ALLOYS SHOWED REACTIONS TO OCCUR AT AS LOW AS 650 DEG C.

ABSTRACT 237

FROST B R T

J NUCL MATER 10, 265 (1963)

THE CARBIDES OF URANIUM

A REVIEW IS PRESENTED ON THE CRYSTALLOGRAPHY AND PROPERTIES OF THE CARBIDES OF U, WITH PARTICULAR EMPHASIS ON THE MONOCARBIDE. FABRICATION METHODS ARE BRIEFLY DISCUSSED. THE PROPERTIES OF MOST IMPORTANCE TO FUEL ELEMENT PERFORMANCE, COMPATIBILITY AND IRRADIATION BEHAVIOR, ARE INCLUDED.

ABSTRACT 238

FUJINO T

J PHYS CHEM SOLIDS 34, 1611 (1973)

NON-STOICHIOMETRY IN URANIUM SESQUINITRIDE

A STATISTICAL MODEL IS PROPOSED FOR ANALYZING THERMODYNAMIC PROPERTIES OF NON-STOICHIOMETRIC URANIUM SESQUINITRIDE. IT CONSISTS OF THE COMBINATION OF THE SITE EXCLUSION MECHANISM AND CLUSTER FORMATION REACTIONS. THE MODEL WAS APPLIED TO THREE IONIC POSSIBILITIES. FITTING THE THEORETICAL EQUATIONS TO THE EXPERIMENTALLY OBSERVED DATA SUGGESTS THE EXISTENCE OF UN SUB 1.75 PHASE. THE ENERGY REQUIRED FOR NITROGEN ATOM FOR OCCUPYING THE LATTICE SITE OF THE CRYSTAL, E , WAS CALCULATED TO BE -120.5 KCAL/MOLE, AND THE INTERACTION ENERGY TO FORM CLUSTERS, $E_{\text{SUB C}}$, WAS -11.07 KCAL/MOLE.

ABSTRACT 239

FUJISHIRO S

NIPPON GENSHIRYOKU GAKKAISHI 3, 913 (1961)

THE DISSOCIATION PRESSURE OF UC SUB 2 AT HIGH TEMPERATURE AND THE THERMODYNAMIC PROPERTIES

PERTINENT THERMODYNAMIC PROPERTIES OF URANIUM DICARBIDE WERE INVESTIGATED BY MEASURING THE DISSOCIATION PRESSURE OF URANIUM AT HIGH TEMPERATURES IN THE REACTION $\text{UC SUB 2(S)} = \text{U(G)} + 2 \text{C(S)}$ BY MEANS OF THE KNUDSEN-CELL EFFUSION METHOD. THE β COUNTING METHOD WAS EMPLOYED TO DETERMINE THE WEIGHT OF THE CONDENSATE ON THE TARGET. THE DISSOCIATION PRESSURE, P , IS EXPRESSED BY $\log P_{\text{U}} (\text{ATM}) = -30600/T + 6.36$ IN THE TEMPERATURE RANGE 2448 TO 2731 DEG K AND, THEREFORE, THE STANDARD FREE ENERGY CHANGE $\Delta F = 140000 - 29.12T$. COMBINING THIS WITH OTHER THERMODYNAMIC DATA THE HEAT OF FORMATION OF UC SUB 2 WAS ESTIMATED TO BE -33240 CAL IN THE SAME TEMPERATURE RANGE.

ABSTRACT 240

FULKERSON W

NUCL MET, MET SOC AIME 17, 374 (1970)

ELECTRICAL AND THERMAL PROPERTIES OF THE NaCl STRUCTURED METALLIC ACTINIDE COMPOUNDS

LITERATURE DATA FOR THE NaCl STRUCTURED METALLIC COMPOUNDS UC, PUC SUB 1-X, (U,Pu)C, AND UN ARE REVIEWED AND, WHERE DATA PERMIT, PREFERRED THERMAL CONDUCTIVITY, γ , AND ELECTRICAL RESISTIVITY, ρ , VALUES ARE ASSIGNED. THESE VALUES ARE THEN ANALYZED IN ORDER TO ESTIMATE THE RELATIVE PROPORTIONS OF ELECTRONIC AND PHONON CONDUCTIVITY IN THESE MATERIALS. GAPS IN THE STATE OF OUR KNOWLEDGE ARE POINTED OUT. IN ADDITION, SOME PRELIMINARY RESULTS ON THE α AND γ OF THN AND (TH,U)N ALLOYS ARE REPORTED.

ABSTRACT 241

FULKERSON W

TRANS AM NUCL SOC 12, 591 (1969)

FUNDAMENTAL PROPERTIES OF UN

AN ATTEMPT IS MADE TO CORRELATE FOLLOWING PROPERTIES OF UN : (1) ELECTRONIC STRUCTURE AND BONDING; (2) TRANSPORT AND MAGNETIC PROPERTIES ; AND (3) SELF-DIFFUSION AND STOICHIOMETRY.

ABSTRACT 242

GAMBA O O

NAA-SR-10929 (1965)

THE NATURE AND PROPERTIES OF THE CARBIDES OF URANIUM

THIS REPORT IS AN EVALUATION OF THE LITERATURE ON THE TECHNOLOGY OF THE CARBIDES OF URANIUM. IT SUMMARIZES THE INFORMATION ON THEIR PREPARATION AND THEIR PHYSICAL BEHAVIOR IN ENVIRONMENTS RELATED TO THEIR APPLICATION AS NUCLEAR FUEL. IT ALSO DESCRIBES THE FABRICATION OF URANIUM CARBIDE PRODUCTS, AND THE COMPATIBILITY OF THESE PRODUCTS WITH CLADDING MATERIALS.

ABSTRACT 243

GIBBY R L

BNWL-435 P4 14 (1967)

THERMAL DIFFUSIVITY OF (U SUB 0.8 PU SUB 0.2) N

THE THERMAL DIFFUSIVITY OF A SINTERED UN-20 WT.% PUN SAMPLE WAS MEASURED FROM 105 TO 1575 DEG C. FROM THIS DATA, THERMAL CONDUCTIVITY OF (U SUB 0.8 PU SUB 0.2) N WAS CALCULATED AND CORRECTED TO 100% THEORETICAL DENSITY.

ABSTRACT 244

GIBBY R L

BNWL-768 P5 15

THERMAL DIFFUSIVITY OF (U,PU)N

THE THERMAL DIFFUSIVITY OF A MIXED URANIUM-PLUTONIUM NITRIDE SAMPLE WAS MEASURED FROM 200 TO 1600 DEG C. THERMAL CONDUCTIVITY WAS CALCULATED FROM DIFFUSIVITY DATA USING UN HEAT CAPACITY DATA.

ABSTRACT 245

GIBBY R L

BNWL-842 P5 14 (1968)

THERMAL DIFFUSIVITY AND CONDUCTIVITY OF (U SUB 0.8 PU SUB 0.2)N

THERMAL DIFFUSIVITY OF A MORE DENSE AND MORE PURE CARBOTHERMIC MIXED-NITRIDE SAMPLE WAS MEASURED IN THE TEMPERATURE RANGE OF 100 TO 1600 DEG C. THERMAL CONDUCTIVITY WAS THEN CALCULATED FROM THE DIFFUSIVITY DATA.

ABSTRACT 246

GILLAM E

ACTA CRYST 15, 1183 (1962)

A GEOMETRICAL RELATIONSHIP BETWEEN UC SUB 2 (TETRAGONAL) AND U SUB 2 C SUB 3 (CUBIC)

ALL THE URANIUM-CARBON COMPOUNDS CAN BE REGARDED AS STRUCTURES CONTAINING CARBON ATOMS ARRANGED IN THE INTERSTICES OF APPROXIMATELY SIMILAR NETWORKS OF URANIUM ATOMS.

ABSTRACT 247

GINGERICH K A

CHEM PHYS 51 (1969)

VAPORIZATION OF UN AND HEAT OF SUBLIMATION OF URANIUM

THE VAPORIZATION OF URANIUM MONONITRIDE UN HAS BEEN INVESTIGATED BY THE KNUDSEN EFFUSION TECHNIQUE IN COMBINATION WITH A MASS SPECTROMETER. THE VAPORIZATION OCCURS INCONGRUENTLY BY PREFERENTIAL LOSS OF NITROGEN FORMING THE TWO-PHASE SYSTEM NITROGEN-SATURATED LIQUID URANIUM-URANIUM-SATURATED NONSTOICHIOMETRIC URANIUM MONONITRIDE. THE VAPOR PRESSURES OF U AND N SUB 2 HAVE BEEN OBTAINED BY SILVER CALIBRATION OVER THE TWO-PHASE SYSTEM UN SUB 0.4 -UN SUB 0.9 IN THE TEMPERATURE RANGE 1910- 2230 DEG K. THE ENTHALPIES ΔH DEG 298 FOR THE SIMPLIFIED REACTION (1) $UN(S) = U(G) + 0.5 N SUB 2 (G)$ AND ITS PARTIAL REACTIONS (2) $UN(S) = U(L) + 0.5 N SUB 2 (G)$ AND (3) $U(L) = U(G)$ HAVE BEEN OBTAINED FROM SECOND- AND THIRD-LAW TREATMENTS. THE EXPERIMENTAL THIRD LAW VALUE OF PARTIAL REACTION (3) OF 130.7 $\pm$ 2.2 KCAL/MOLE MAY BE CONSIDERED AN UPPER VALUE FOR THE HEAT OF VAPORIZATION OF URANIUM METAL. THE THIRD-LAW ENTHALPY OF PARTIAL REACTION (2) OF 68.8 $\pm$ 0.4 KCAL/MOLE IS IN GENERAL AGREEMENT WITH LITERATURE DATA FOR THIS REACTION. THE SELECTED VALUE FOR THE ENTHALPY OF REACTION (1) OF ΔH DEG 298 = 200.3 $\pm$ 4.0 KCAL MOLE** -1 YIELDS WITH APPROPRIATE LITERATURE DATA A HEAT OF ATOMIZATION ΔH SUB 298 = 313.3 $\pm$ 4.5 KCAL/MOLE FOR SOLID UN, AND A HEAT OF VAPORIZATION ΔH SUB 298 = 127.9 $\pm$ 4.9 KCAL/MOLE FOR URANIUM. THE DIFFERENCE OF 2.8 KCAL/MOLE BETWEEN THIS VALUE AND THE DIRECTLY MEASURED VALUE FOR PARTIAL REACTION (3) IS ATTRIBUTED TO AN ACTIVITY DECREASE OF URANIUM IN NITROGEN-SATURATED LIQUID URANIUM THAT IS IN EQUILIBRIUM WITH THE UN PHASE.

ABSTRACT 248

GIULIANI S

EUR-3644J (1967)

MEASUREMENT OF THE THERMAL CONDUCTIVITY OF NUCLEAR MATERIALS BETWEEN 100 AND 500 DEG C

AN APPARATUS HAS BEEN DEvised FOR MEASUREMENT OF THE THERMAL CONDUCTIVITY OF SOLID MATERIALS AT 100 TO 500 DEG C WITH AN ERROR OF 6.5%. RESULTS WERE OBTAINED FOR UC, SAP, MAGNOX, GRAPHITE, AND IMPREGNATED GRAPHITE. IN CASE OF GRAPHITES MEASUREMENTS WERE PERFORMED BEFORE AND AFTER IRRADIATION.

ABSTRACT 249

GODFREY T G

ORNL-TM-1595 (1966)

AN EXPLANATION OF THE ANOMALOUS HEAT CAPACITY OF URANIUM DICARBIDE.

PUBLISHED ENTHALPY DATA ON UC SUB 2 INDICATE A HEAT CAPACITY OF 32 CAL /MOLE/DEG AT 2000 DEG K. THREE LINES OF EVIDENCE INDICATE THAT THE MEASUREMENTS ARE OF ACCEPTABLE ACCURACY. FIRST, METALLOGRAPHIC EVIDENCE INDICATES THAT A PHASE CHANGE TAKES PLACE OVER A RANGE OF TEMPERATURES BELOW APPROXIMATELY 2000 DEG K. SECOND, HIGH-TEMPERATURE X-RAY DATA INDICATE AN UNUSUAL BEHAVIOR IN THE LATTICE PARAMETERS OF THE UC SUB 2 BELOW 2000 DEG K. THIRD, USE OF THE ENTHALPY MEASUREMENTS WITH OTHER PUBLISHED INFORMATION COMPLETES A THERMODYNAMIC CYCLE IN THE U-C-O SYSTEM. A NON-ZERO S SUB 0 DEG K IS SHOWN TO BE A REASONABLE ASSUMPTION.

ABSTRACT 250

GODFREY T G

ORNL-TM-1596 (1966)

THERMODYNAMIC FUNCTIONS OF NUCLEAR MATERIALS: UC, UC SUB 2, UO SUB 2, THO SUB 2, AND UN.

THE THERMODYNAMIC FUNCTIONS, $H_{SUB T} - H_{SUB 298}$, $C_{SUB P}$, $S_{SUB T}$, AND $(F_{SUB T} - H_{SUB 298})/T$, OF FIVE COMPOUNDS OF NUCLEAR INTEREST (UC, UC SUB 2, UO SUB 2, THO SUB 2, AND UN) HAVE BEEN CALCULATED FROM LITERATURE DATA AND TABULATED AT 100 DEG INCREMENTS. ESTIMATES OF ACCURACY ARE INCLUDED. THE FIT OF THE ORIGINAL ENTHALPY DATA TO THE CALCULATED CURVE IS SHOWN GRAPHICALLY IN EACH CASE.

ABSTRACT 251

GOMOZOV L I

METALLOVEDENIE STRUCTURE AND SVOISTVA STALEI I SPLAVOV METALLIDY NOVYE METODY ISSLEDOVANIYA, P342 (1971)

STABILITY AND DEFORMATION OF ZRC, NBC, UC-UC SUB 2, AND UO SUB 2 AT HIGH TEMPERATURES

INVESTIGATED THE MECHANICAL PROPERTIES UNDER COMPRESSION OF UC, UC-UC SUB 2, AND UC + 4 AT. % SIC. PERFORMED EXPERIMENTS UP TO 2000 DEG C AND HAVE DISCUSSED DEFORMATION MECHANICS AND DEFORMATION RATES.

ABSTRACT 252

GOTZMANN O

EUR-4892 (1972)

FUEL-CLADDING COMPATIBILITY OF STAINLESS STEELS WITH GAS AND SODIUM BONDED URANIUM PLUTONIUM CARBIDES

AN ASSESSMENT IS MADE OF THE COMPATIBILITY OF STAINLESS STEELS WITH GAS AND SODIUM-BONDED URANIUM CARBIDE-PLUTONIUM CARBIDE FUELS BY CONSIDERING COMPATIBILITY RESULTS, THERMODYNAMIC DATA AND PHASE RELATIONSHIPS. THE FUEL STABILIZATION IS CONSIDERED BOTH ON THE BASIS OF THE CARBON POTENTIAL OF THE FUEL AND THE BUFFERING CARBIDES, AND ON THEIR LOCATION IN THE APPROPRIATE PHASE DIAGRAM. THE INFLUENCE OF THE RADIAL TEMPERATURE GRADIENT AND BURNUP ON THE CARBON POTENTIAL OF THE FUEL IS DISCUSSED. FINALLY, CLAD CARBURIZATION, CARBON ACTIVITY AND SOLUBILITY IN STEEL AND SODIUM, AND ITS EFFECT ON THE MECHANICAL PROPERTIES OF THE STEEL ARE CONSIDERED WITH SPECIAL ATTENTION TO CARBON TRANSFER AND THE EFFECTS OF OXYGEN DISSOLVED IN THE SODIUM.

ABSTRACT 253

GOTZMANN O

KFK-435 (1966)

COMPARISON OF COMPATIBILITY OF THE NUCLEAR FUELS UN, UC, AND UO SUB 2 WITH METALS

THE COMPATIBILITY OF THE NUCLEAR FUELS UN, UC, AND UO SUB 2 WITH AL, BE, STAINLESS STEEL, AND NI-ALLOYS, TI, V, CR, ZR, MO, NB, TA, AND W IS REVIEWED.

ABSTRACT 254

GOTZMANN O

PROCEEDINGS OF IAEA SYMP ON FUEL AND FUEL ELEMENTS FOR FAST REACTORS,
JULY 2-6, (1973)

COMPARISON OF IN-PILE COMPATIBILITY BEHAVIOR OF OXIDE AND CARBIDE FUEL PIN
ACCORDING TO SIMULATION TESTS

THE COMPATIBILITY BEHAVIOR OF OXIDE AND CARBIDE FUELS WITH A STAINLESS STEEL CLADDING IS DISCUSSED ON THE BASIS OF RESULTS OBTAINED SO FAR. TO EVALUATE THE DIFFERENCE IN COMPATIBILITY BEHAVIOR OF THESE TWO TYPES OF REACTOR FUEL UNDER REACTOR CONDITION, A SERIES OF OUT-OF-PILE EXPERIMENTS WAS CARRIED OUT, ADDING VARIOUS FISSION-PRODUCT ELEMENTS TO THE FUELS TO SIMULATE THE CHEMICAL STATE AFTER A PERIOD OF IRRADIATION. FROM THE RESULTS OF THESE TESTS THE CONCLUSION CAN BE DRAWN THAT FISSION PRODUCTS PLAY NO ROLE IN THE COMPATIBILITY BEHAVIOR OF CARBIDE FUELS WHEREAS THE COMPATIBILITY BEHAVIOR OF AN OXIDE FUEL IS DECISIVELY INFLUENCED BY FISSION PRODUCTS. IT IS TO BE EXPECTED THAT THE ONLY INTERACTION BETWEEN A CARBIDE FUEL AND THE CLADDING IS THE CARBURIZATION OF THE CLADDING MATERIAL. THIS CARBURIZATION LEADS TO A REDUCTION IN DUCTILITY OF THE STAINLESS STEEL CLADDING WHICH CAN BE TESTED OUT OF PILE.

ABSTRACT 255

GRAHAM L J

NUCLEAR METALLURGY AIME 10,409 (1964)

COMPOUNDS OF INTEREST IN NUCLEAR REACTOR TECHNOLOGY

THE THREE ELASTIC CONSTANTS, C_{11} , C_{12} AND C_{44} , FOR URANIUM CARBIDE WERE MEASURED BETWEEN 4.2 AND 300 DEG K. BETWEEN 4.2 AND ABOUT 50 DEG K, THE ELASTIC PROPERTIES OF UC FIT THE FOLLOWING EXPRESSIONS: $C_{11} = 3.296 \times 10^{12} (1 - 2.4 \times 10^{-4} T^2)$ DYNES/CM², $(C_{11} - C_{12})/2 = 1.200 \times 10^{12} (1 - 3 \times 10^{-4} T^2)$ DYNES/CM², $C_{44} = 0.6430 \times 10^{12} (1 + 2.0 \times 10^{-4} T^2)$ DYNES/CM². BOTH THE T^2 DEPENDENCE AND THE LARGE TEMPERATURE COEFFICIENTS SUGGEST A LARGE ELECTRONIC CONTRIBUTION FROM THE DISPLACEMENT OF THE FERMI SURFACE BY ELASTIC STRAIN AND A STRONG ANISOTROPY OF THE SHAPE OF THE FERMI SURFACE. THE DEBYE TEMPERATURE EVALUATED AT THE ABSOLUTE ZERO OF TEMPERATURE IS $\theta_D = 330.0$ DEG K, COMPARED WITH A VALUE OF 320 $\pm$ 10 DEG K COMPUTED FROM THE LOW TEMPERATURE SPECIFIC HEAT DATA OF COMBARIEU AND COWORKERS.

ABSTRACT 256

GRANDO C

FAST REACTOR FUEL ELEMENT TECHNOLOGY P 771-84

UNRESTRAINED SWELLING AND FISSION GAS RELEASE OF FAST REACTOR FUELS

THE TRULY UNRESTRAINED SWELLING AND FISSION GAS RELEASE CHARACTERISTICS OF VARIOUS TYPES OF POTENTIAL FAST REACTOR FUELS WERE MEASURED IN INSTRUMENTED EXPERIMENTS. THE EXPERIMENTS WERE IRRADIATED IN THE DOUGLAS UNITED NUCLEAR IRRADIATION TESTING FACILITY TO BURNUPS OF 4.9×10^{20} AND 7.0×10^{20} FISSIONS/CM³. RESULTS OF THE UNRESTRAINED SWELLING TESTS WERE: 1. THE MIXED CARBIDES SWELLED AT A $\Delta V/V$ OF APPROX 2.4% PER 10^{20} FISSIONS/CM³ AT 1300 DEG C. IN COMPARISON, THE RESTRAINED SWELLING RATE OF CARBIDES AT TYPICAL LMFBR TEMPERATURE GRADIENTS HAS BEEN FOUND TO RANGE BETWEEN 0.6 AND 0.9% $\Delta V/V$ PER 10^{20} FISSIONS/CM³. 2. AT TEMPERATURES OF 1300 DEG C, THE UNRESTRAINED SWELLING RATE OF THE MIXED CARBIDES IS APPROX 1.6 TIMES AS GREAT AS THAT OF THE MIXED OXIDES. 3. THE MIXED-OXIDE UNRESTRAINED SWELLING RATE AT 1600 DEG C IS APPROX 1.7 TIMES GREATER THAN THAT AT 1300 DEG C. THE TESTS CONFIRM THAT UNRESTRAINED SWELLING RATES OF

ABSTRACT 256 (CONT'D)

BOTH OXIDES AND CARBIDES ARE CONSIDERABLY HIGHER THAN SWELLING RATES OF FUELS RESTRAINED BY CLADDING. RESULTS OF THE FISSION GAS RELEASE TESTS SHOW THAT, AT 1300 DEG C, AN AVERAGE RELEASE OF 18% OF THEORETICAL WAS RECORDED FOR THE 84% OF THEORETICALLY DENSE MONOCARBIDE, WHILE FUEL MATERIALS WITH DENSITIES OF >90% RELEASED LESS THAN 8% OF THEORETICAL AT THE SAME OPERATING TEMPERATURE.

ABSTRACT 257

GREEN J L

BULL AM CERAM SOC 46, 893 (1967)

CRYSTALLOGRAPHY AND MAGNETIC ORDERING IN PLUTONIUM CARBIDES BY NEUTRON DIFFRACTION

NEUTRON DIFFRACTION STUDIES WERE CARRIED OUT ON CARBON SATURATED PLUTONIUM MONOCARBIDE AND PLUTONIUM SESQUICARBIDE. ROOM TEMPERATURE DATA ON PU SUB 2C SUB 3 WERE USED TO ACCURATELY DEFINE ATOMIC POSITION PARAMETERS, WHILE LOW TEMPERATURE INVESTIGATIONS OF PUC SUB 0.91 AND PU SUB 2C SUB 3 WERE USED TO LOCATE AND DESCRIBE POSSIBLE MAGNETIC ORDERING TRANSFORMATIONS IN THE CATION LATTICES.

ABSTRACT 258

GREEN J L

J APPL PHYS 41, 5121 (1970)

THERMAL EXPANSION AND PHASE EQUILIBRIA OF THE CARBON-SATURATED PLUTONIUM CARBIDES

AN X-RAY DIFFRACTOMETER FURNACE HAS BEEN DEVELOPED FOR USE IN THE STUDY OF THE HIGH-TEMPERATURE PROPERTIES OF REFRACTORY COMPOUNDS OF PLUTONIUM. THE FURNACE DESIGN IS BASED ON A RESISTANCE HEATED STRIP WHICH SERVES AS THE SAMPLE SUPPORT. THE MECHANICS OF THE SUPPORT SYSTEM ARE SUCH THAT THE LOCATION OF THE SCATTERING CENTER OF THE SAMPLE IS MAINTAINED THROUGHOUT THE TEMPERATURE RANGE OF THE INSTRUMENT, I.E., ROOM TEMPERATURE TO 2500 DEG C. THE THERMAL EXPANSION CHARACTERISTICS OF CARBON SATURATED PU SUB 2C SUB 3 AND PUC SUB 2 WERE DETERMINED. A LEAST-SQUARES FIT OF THE LATTICE DIMENSION DATA FOR PU SUB 2C SUB 3 IN THE TEMPERATURE INTERVAL FROM ROOM TEMPERATURE TO 1600 DEG C YIELDED $a/a \text{ SUB } 0 = (1.29 \pm 0.02 \times 10^{-5}) (T - 25) + (2.07 \pm 0.14 \times 10^{-9}) (T - 25)^2$, WHERE a IS THE LATTICE DIMENSION IN Å, AND T IS THE TEMPERATURE IN DEG C. A LEAST-SQUARES FIT OF THE LATTICE DIMENSION DATA FOR FCC PUC SUB 2 IN THE TEMPERATURE INTERVAL FROM 1660 DEG C TO 2000 DEG C YIELDED $a/a \text{ SUB } 0 = (17.9 \pm 1.6 \times 10^{-6}) (T - 1660)$.

ABSTRACT 259

GREEN J L

J NUCL MATER 23, 231 (1967)

A LOW TEMPERATURE MAGNETIC TRANSITION IN PLUTONIUM MONOCARBIDE

LOW TEMPERATURE NEUTRON DIFFRACTION INDICATED AN ANTIFERROMAGNETIC TRANSITION AT 100 DEG K

ABSTRACT 260

GREEN J L

J NUCL MATER 34, 281 (1970)

CRYSTALLOGRAPHIC AND MAGNETIC ORDERING STUDIES OF PU CARBIDES USING NEUTRON DIFFRACTION

NEUTRON DIFFRACTION STUDIES WERE CARRIED OUT ON POLYCRYSTALLINE SAMPLES OF CARBON-SATURATED PUC SUB 1-X AND PU SUB 2C SUB 3. IN BOTH, THE TARGETS WERE PREPARED FROM MATERIAL THAT WAS HIGHLY ENRICHED IN ^{240}Pu TO MINIMIZE THE FAST NEUTRON BACKGROUND DUE TO THE THERMAL FISSION OF ^{239}Pu . A MAGNETIC TRANSITION WAS OBSERVED TO OCCUR IN PUC SUB 1-X AT APPROXIMATELY 100 DEG K. THE ORDERED STRUCTURE WAS FOUND TO BE COMPOSED OF FERROMAGNETIC LAYERS COUPLED ANTIFERROMAGNETICALLY. THE PLANES OF CONSTANT SPIN ARE THE (001) PLANES AND THE SPIN VECTORS ARE ALIGNED PERPENDICULAR TO THE (001) PLANES. NO LOW TEMPERATURE MAGNETIC ORDERING WAS OBSERVED IN PU SUB 2C SUB 3. ROOM TEMPERATURE DIFFRACTION DATA WERE USED TO COMPUTE THE CRYSTAL POSITIONAL PARAMETERS FOR THIS COMPOUND: X SUB C=0.2896 $\pm$ 0.0005, X SUB PU=0.0492 $\pm$ 0.0005, AND THE THERMAL PARAMETER: B=0.69 $\pm$ 0.06 $\text{\AA}^2$. THE C-C BOND LENGTH CALCULATED FROM THESE DATA IS 1.39 $\text{\AA}$. USING ROOM TEMPERATURE DATA FOR BOTH COMPOUNDS, THE COHERENT SCATTERING AMPLITUDE OF PURE ^{240}Pu WAS FOUND TO BE 0.38×10^{-12} CM.

ABSTRACT 261

GROBNER P

AEC-TR-5010 (1954)

A DIAGRAM FOR THE TEMPERATURE DEPENDENCE OF THE FREE ENERGY OF CARBIDES

A DIAGRAM, SHOWING THE RELATIONSHIP OF THE FREE ENERGY AND TEMPERATURE, WAS CONSTRUCTED FOR VARIOUS CARBIDES. THE DIAGRAM PERMITS THE EVALUATION OF THE THERMODYNAMIC STABILITY OF CARBIDES AT VARIOUS TEMPERATURES.

ABSTRACT 262

GROSS P

THERMO NUCL MATER, P653 (1962)

HEATS OF FORMATION OF URANIUM SILICIDES AND NITRIDES.

THE STANDARD HEATS OF FORMATION OF THE URANIUM SILICIDES U SUB 3 SI SUB 2, USI, USI SUB 2, AND USI SUB 3 WERE DETERMINED BY MEASURING THE HEATS EVOLVED IN THE DIRECT COMBINATION OF THE ELEMENTS. THE HEATS OF FORMATION OF THE LAST THREE WERE CHECKED BY MEASURING THE HEATS OF REACTION OF TELLURIUM WITH THE PREFORMED COMPOUNDS AND COMPARING THEM WITH THOSE OBTAINED FROM REACTING EQUIVALENT QUANTITIES OF THE UNCOMBINED ELEMENTS WITH TELLURIUM. THE HEAT OF FORMATION OF URANIUM MONONITRIDE (UN) WAS DETERMINED BY MEASURING THE HEAT EVOLVED IN THE REACTION BETWEEN AN EXCESS OF URANIUM POWDER AND A KNOWN AMOUNT OF NITROGEN. THE HEAT OF FORMATION OF URANIUM SESQUINITRIDE (U SUB 2 N SUB 3) WAS DETERMINED BY MEASURING THE HEAT EVOLVED IN THE REACTION OF AN EXCESS OF URANIUM MONONITRIDE WITH A MEASURED AMOUNT OF NITROGEN. EXPERIMENTS ON THE DISSOCIATION PRESSURE OF URANIUM SESQUINITRIDE ARE REPORTED.

ABSTRACT 263

GROSSMAN L N

GEST-2015 (1963)

ELECTRICAL CONDUCTIVITY, THERMAL CONDUCTIVITY, AND THERMAL EMISSION FOR FUEL-BEARING CARBIDES: UC SUB 2, UC, U SUB 0.5 ZR SUB 0.5 C, AND THC SUB 2

THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, TOTAL HEMISPHERICAL EMITTANCE (E SUB T), AND NORMAL SPECTRAL EMITTANCE (E SUB 0.65 U) DATA WERE OBTAINED FROM ROD SPECIMENS OF UC SUB 2, UC, U SUB 0.5 ZR SUB 0.5 C, AND THC SUB 2 IN THE TEMPERATURE RANGE 1100 TO 2400 DEG K. THE RESULTS ARE PRESENTED IN GRAPHS AND TABLES.

ABSTRACT 264

GROSSMAN L N

J AM CERAM SOC 46, 264 (1963)

HIGH-TEMPERATURE THERMOPHYSICAL PROPERTIES OF URANIUM MONOCARBIDE

THERMAL CONDUCTIVITY (K), ELECTRICAL RESISTIVITY (P), TOTAL HEMISPHERICAL EMITTANCE (E SUB T), AND NORMAL SPECTRAL EMITTANCE (E SUB 0.65 U) OF DENSE, ARC-CAST URANIUM MONOCARBIDE (5.3 WT. % TOTAL CARBON) WERE MEASURED IN THE TEMPERATURE RANGE 1150 TO 2050 DEG K. THE RESULTS WERE AS FOLLOWS: K, $0.057 \text{ CAL/S-CM-DEG}$, $1200 < T < 2050 \text{ DEG K}$, PROBABLE ERROR # 0.002; P, $20.4 * 10^{*-6} + 114.8T * 10^{*-9} \text{ OHM-CM}$, $1175 < T < 2050 \text{ DEG K}$, PROBABLE ERROR # $1.7 * 10^{*-6}$; E SUB T, 0.42, $1250 < T < 1980 \text{ DEG K}$, PROBABLE ERROR # 0.02; E SUB 0.65, $0.539 - 0.02T * 10^{*-3}$, $1150 < T < 1890 \text{ DEG K}$, PROBABLE ERROR # 0.02. EXPERIMENTAL METHODS ARE DISCUSSED AND ERROR SOURCES ARE ANALYZED. URANIUM MONOCARBIDE EXHIBITED TYPICAL METALLIC BEHAVIOR IN ITS THERMOPHYSICAL PROPERTIES.

ABSTRACT 265

GROSSMAN L N

TID-7676, P101 (1963)

THERMOPHYSICAL PROPERTIES OF SOME CARBIDES AT HIGH TEMPERATURES

FOUR THERMOPHYSICAL PROPERTIES (THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, TOTAL HEMISPHERICAL THERMAL EMITTANCE, AND NORMAL SPECTRAL THERMAL EMITTANCE AT 0.65UM) MAY BE MEASURED SIMULTANEOUSLY ON AN APPARATUS DESIGNED AND BUILT PARTIALLY UNDER THIS PROGRAM. THE APPARATUS IS USEFUL IN THE TEMPERATURE RANGE FROM THE ONSET OF MEASURABLE THERMAL EMISSION (ABOUT 1000 DEG K) TO AN UPPER LIMIT SET BY SUBLIMATION OR DECOMPOSITION OF THE SPECIMEN. THE APPARATUS HAS BEEN USED TO SPECIMEN TEMPERATURES OF OVER 2500 DEG K IN THE PRESENT INVESTIGATION. TABLE I SUMMARIZES ALL THERMOPHYSICAL PROPERTY EXPERIMENTS UNDERTAKEN FOR THIS PROGRAMME, TOGETHER WITH THE DEGREE OF SUCCESS REALIZED. TABLE II PRESENTS THE VALUES OBTAINED FOR THE VARIOUS PROPERTIES AND THE TEMPERATURE RANGE OVER WHICH THE VALUES ARE VALID. THE ERROR LIMITS REPORTED IN TABLE II ARE 95% CONFIDENCE LIMITS, VALID OVER THE TEMPERATURE RANGE REPORTED. ELECTRICAL RESISTIVITY AND THERMAL CONDUCTIVITY VALUES ARE GIVEN FOR FULLY DENSE MATERIAL. SOME DATA OUTSIDE OF THE TEMPERATURE RANGES INDICATED APPEAR IN THE TEXT, AS WELL AS SOME DATA FOR THC AND YB SUB 6.

ABSTRACT 266

GUINAN M
J NUCL MATER 43, 205 (1972)
ELASTIC PROPERTIES OF UN AT 298 DEG K

SINGLE CRYSTAL, ADIABATIC ELASTIC CONSTANTS WERE DETERMINED AT 250 DEG C.

ABSTRACT 267

GUINET P
COMPT REND HEBO SEANC ACAD SCI PARIS 261, 1312 (1965)
BINARY SYSTEM URANIUM-URANIUM MONOCARBIDE

A SATURATION METHOD (BLUM ET AL.) WAS USED TO DETERMINE THE LIQUIDS OF THE SYSTEM U-UC BY A SERIES OF ISOTHERMAL STAYS AT TEN GRADUATED TEMPERATURES BETWEEN 1500 AND 2400 DEG . THE SOLIDUS CURVE WAS DETERMINED BY ESTABLISHMENT OF A LIQUID-SOLID EQUILIBRIUM, AND THE EUTECTIC TEMPERATURE (117 DEG) BY DIFFERENTIAL THERMAL ANALYSIS. THE DIAGRAM IS OF THE SIMPLE TYPE WITH THE EUTECTIC REMOVED FROM THE U SIDE AND HAS A ZONE OF EXISTENCE OF SUB-STOICHIOMETRIC MONOCARBIDE WHOSE MINIMUM C CONTENT IS 4.36% FOR A TEMPERATURE OF 2150 DEG . THE LIQUIDUS AND SOLIDUS HAVE A COMMON HORIZONTAL TANGENT AT THE COMPOSITION 4.8%, IMPOSED BY THE CHARACTER OF THE DEFINITE MONOCARBIDE COMPOUND. THE RADIUS OF CURVATURE AT THIS POINT SUGGESTS APPRECIABLE DISSOCIATION OF THE LIQUID MONOCARBIDE.

ABSTRACT 268

GUYTON J L
TRANS AM NUCL SOC 9, 39 (1966)
PREPARATION AND PROPERTIES OF PLUTONIUM CARBONITRIDE

CONSIDERED THREE POSSIBLE METHODS OF PREPARING THE CARBONITRIDE. ALSO LISTED DECOMPOSITION TEMPERATURES AS A FUNCTION OF PUN CONTENT AND N SUB 2 PRESSURE. DATA ON DENSITY AND SOLUBILITY IN DIFFERENT INORGANIC ACIDS IS ALSO GIVEN. CORROSION STUDIES WERE MADE IN AIR AS WELL AS IN WATER IN THE TEMPERATURE RANGE OF 200 - 320 DEG C.

ABSTRACT 269

HAHN R D
NAA-SR-7696 (1963)
STUDY OF URANIUM CARBIDE AND CLADDING MATERIALS FOR HIGH-TEMPERATURE SODIUM-COOLED REACTORS.

IRRADIATION EXPERIMENTS WERE CONDUCTED TO DETERMINE THE IRRADIATION CHARACTERISTICS OF URANIUM MONOCARBIDE, EXPOSED TO HIGH-TEMPERATURE APPROX 2000 DEG F), HIGH HEAT FLUX (APPROX 10^{+6} BTU/H-FT²), HIGH BURNUP (APPROX 25000 MWD/MTU) OPERATION. HYPERSTOICHIOMETRIC URANIUM CARBIDE FUELS HAVE SUSTAINED MAXIMUM CONDITIONS OF BURNUP AND AVERAGE CENTRAL TEMPERATURE OF 24000 AND 10000 MWD/MTU AT 1550 AND 2150 DEG F, RESPECTIVELY. HYPOSTOICHIOMETRIC URANIUM CARBIDE FUELS WERE EXPOSED TO CONDITIONS OF 1800 DEG F AVERAGE CENTRAL TEMPERATURE FOR A BURNUP OF APPROX 7000 MWD/MTU. FISSION GAS RELEASE, IN GENERAL, WAS LOW. VALUES FOR FUEL DIMENSIONAL INCREASE WERE SCATTERED, DUE TO THERMAL OR MECHANICAL EFFECTS OVER THE FUEL COLUMN LENGTHS, AND COULD NOT BE CORRELATED WITH BURNUP OR AVERAGE FUEL CENTRAL TEMPERATURES. THE FUEL DENSITY DECREASE PROFILE OF THE FUEL LENGTH WAS SIMILAR TO THE BURNUP PROFILE. HYPERSTOICHIOMETRIC UC/NA OR (NAK) TYPE 304 STAINLESS STEEL SYSTEMS SHOW

ABSTRACT 269 (CONT'D)

EXCESSIVE CLADDING CARBURIZATION AT FUEL SURFACE TEMPERATURES AS LOW AS 1000 DEG F FOR AN ACCEPTABLE REACTOR RESIDENCE HYPOSTOICHIOMETRIC UC/NA TYPE 304 STAINLESS STEEL SYSTEMS ARE COMPATIBLE AT 1200 AND 1600 DEG F UNDER ISOTHERMAL CONDITIONS FOR AT LEAST 6400 AND 3000 H, RESPECTIVELY. NIOBIUM AND ZIRCONIUM ALLOYS HAVE SHOWN PROMISE AS CLADDING MATERIALS FOR THE UTILIZATION OF HYPERSTOICHIOMETRIC URANIUM MONOCARBIDE. CUT-OF-PILE TEST HAVE SHOWN THAT ZIRCONIUM AND NIOBIUM ALLOYS ARE COMPATIBLE WITH HYPERSTOICHIOMETRIC UC TO 1600 DEG F. ZIRCONIUM ALLOYS ARE STRENGTH ABOVE 1150 DEG F. NIOBIUM, WHILE SATISFACTORY FROM A STRENGTH STANDPOINT AT 1600 DEG F, MAY BE LIMITED BY NUCLEAR CONSIDERATIONS.

ABSTRACT 270

HALL A R

AERE-R-7326 (1973)

SECONDARY COMPRESSIVE CREEP OF SINTERED HYPERSTOICHIOMETRIC UC AND (U,Pu) C AND THE EFFECT OF NICKEL ADDITIONS

COMPRESSIVE CREEP BEHAVIOR OF SINTERED HYPERSTOICHIOMETRIC UC AND (U,Pu)C WAS STUDIED IN THE TEMPERATURE RANGE OF 1000 TO 1400 DEG C. GRAIN SIZES VARIED FROM 8 TO 16 U, CARBON CONTENTS FROM 4.83 TO 5.40 WT % C, AND SOME SPECIMENS CONTAINED NI ADDED AS A SINTERING AID. IN GENERAL, THE CREEP BEHAVIOR WAS CHARACTERIZED BY A LOW STRESS EXPONENT OF 1 TO 3, AND BY AN ACTIVATION ENERGY IN THE RANGE OF 107 TO 155 KCALS/MOLE.

ABSTRACT 271

HALL A R

J NUCL MATER 37, 314 (1970)

ELASTIC MODULI AND INTERNAL FUNCTION OF SOME URANIUM CERAMICS

AN APPARATUS HAS BEEN DEVELOPED IN WHICH THE RESONANT FREQUENCIES OF THIN PRISMATIC BARS CAN BE MEASURED IN VACUUM OVER A WIDE TEMPERATURE RANGE. THIS HAS BEEN USED TO MEASURE THE YOUNG'S MODULUS, SHEAR MODULUS AND INTERNAL FRICTION OF THE FOLLOWING MATERIALS: HYPOSTOICHIOMETRIC UC, YOUNG'S MODULUS, SHEAR MODULUS AND INTERNAL FRICTION TO 725 DEG C. HYPERSTOICHIOMETRIC UC, YOUNG'S MODULUS AND INTERNAL FRICTION TO 1350 DEG C. STOICHIOMETRIC UO₂, YOUNG'S MODULUS, SHEAR MODULUS AND INTERNAL FRICTION TO 1250 DEG C. UN, YOUNG'S MODULUS AND INTERNAL FRICTION TO 1420 DEG C. IT IS CONCLUDED THAT THE TEMPERATURES AT WHICH THE YOUNG'S MODULUS-TEMPERATURE CURVES BEGIN TO DEVIATE FROM LINEARITY CORRESPOND TO THE LOWEST TEMPERATURES AT WHICH PLASTIC DEFORMATION CAN TAKE PLACE. THE VALUES FOR THE MATERIALS TESTS ARE: HYPO. UC, 600 DEG C; HYPER. UC, 1000 DEG C; UO₂ SUB 2.00, 1000 DEG C; AND UN, 1200 DEG C. IT IS SUGGESTED THAT THE PEAKS FOUND IN THE INTERNAL FRICTION SPECTRA ARE ATTRIBUTABLE TO GRAIN BOUNDARY RELAXATION PROCESSES.

ABSTRACT 272

HANSON L A

NAA-SR-9161 (1964)

REPROCESSING OF URANIUM CARBIDE BY A NITRIDE-CARBIDE CYCLE, 2: KINETICS OF NITRIDE CONVERSION TO CARBIDE

THE RECONVERSION OF URANIUM NITRIDE-CARBON MIXTURES (OBTAINED BY REACTING UC WITH NITROGEN) TO URANIUM CARBIDE HAS BEEN INVESTIGATED AS ONE STEP IN A NITRIDE-CARBIDE CYCLE FOR UC FUEL REPROCESSING. REACTION RATES WERE DETERMINED BY MEASURING THE EVOLUTION OF NITROGEN FROM SAMPLES HEATED IN VACUUM IN A THERMOGRAVIMETRIC BALANCE. THE REACTION OF $U_{2N_3} + C$ OCCURS IN TWO STEPS; BY DECOMPOSITION TO UN, THEN BY CONVERSION TO UC. THE KINETICS OF THE DECOMPOSITION OF URANIUM SESQUINITRIDE, WITHOUT CARBON PRESENT, TO URANIUM MONONITRIDE WAS STUDIED FOR COMPARISON WITH THE $U_{2N_3} + C$ DECOMPOSITION. COMPARISON OF THE RESULTS INDICATE THE SESQUINITRIDE CONTAINING CARBON DECOMPOSED AT A MUCH LOWER RATE WITH A HIGHER ACTIVATION ENERGY. THE ACTIVATION ENERGIES FOR THE REACTIONS STUDIED WERE (1) 90.6 ± 11.8 KCAL/MOL FOR THE DECOMPOSITION OF $U_{2N_3} + C$ TO $UN + C$ BY A LINEAR RATE LAW, (2) 64.4 ± 7.7 KCAL/MOL FOR THE DECOMPOSITION OF U_{2N_3} TO UN BASED ON A LINEAR RATE LAW, AND (3) 31.3 ± 1.1 KCAL/MOL FOR CONVERSION OF $UN + C$ TO UC BY A PARABOLIC RATE LAW.

ABSTRACT 273

HARBOURNE B L

PROCEEDINGS OF THE CONFERENCE ON FAST REACTOR FUEL ELEMENT TECHNOLOGY; 869-894, ANS, (1971)

THE IRRADIATION BEHAVIOR OF SODIUM-BONDED MIXED CARBIDE FUEL PINS

EXPERIMENTAL FUEL PINS CONTAINING (U,Pu)C FUEL SODIUM BONDED TO STAINLESS-STEEL CLADDING HAVE BEEN IRRADIATED IN BOTH THERMAL AND FAST FLUX ENVIRONMENTS. THE FUELS HAD ADDITIONS OF CR OR FE, OR WERE SLIGHTLY HYPOSTOICHIOMETRIC. THE ADDITIONS WERE INTENDED TO IMPROVE SWELLING RESISTANCE AND COMPATIBILITY. BURNUPS UP TO 5.5 AT.% AT RATINGS UP TO 30 KW/FT WERE ACHIEVED WITHOUT FAILURE. FRAGMENTATION OF THE FUEL EARLY IN LIFE RESULTED IN CLADDING QUALITY EVEN WHEN THE AVAILABLE BOND VOLUME HAD NOT BEEN COMPLETELY FILLED BY FUEL SWELLING. THE CR-MODIFIED FUEL SWELLED LEAST; THE FE-MODIFIED FUEL SWELLED MOST. THE DIFFERENCES IN SWELLING BEHAVIOR ARE ATTRIBUTED TO THE CHARACTERISTICS AND AMOUNTS OF SECOND PHASES. THE NATURE OF THE FUEL-CLADDING REACTION VARIED BETWEEN FUEL TYPES, BUT WAS SIMILAR IN EXTENT. NEITHER ADDITIVE SEEMED TO SUPPRESS CARBON TRANSFER TO THE CLADDING. THERE IS SLIGHT EVIDENCE OF THE LOSS-OF-BOND INTEGRITY IN ONE PIN, BUT APART FROM THIS THESE EXPERIMENTS DEMONSTRATE THE VIABILITY OF THE SODIUM-BONDED CARBIDE FUEL PIN TO MODERATE BURNUPS.

ABSTRACT 274

HARNESS J B

BRIT J APPL PHYS 15, 963 (1964)

THE SPECIFIC HEAT OF SOME URANIUM AND THORIUM CARBIDES BETWEEN 1.8 DEG K AND 4.2 DEG K

URANIUM CARBIDE (UC), THORIUM CARBIDE (THC) AND UC-THC SOLID SOLUTIONS EXHIBIT TEMPERATURE VARIATIONS OF SPECIFIC HEAT IN THE HELIUM TEMPERATURE RANGE WHICH ARE CHARACTERISTIC OF METALS. THE FORM OF COMMON RIGID ENERGY BAND OF UC AND UC-THC MIXED CARBIDES HAVE BEEN DEDUCED BETWEEN THE FERMI LIMITS OF UC-15% THC.

ABSTRACT 275

HARPER S A
NATURE 219, 151 (1968)
HIGH TEMPERATURE STRUCTURE OF PUC SUB 2

REPORTED X-RAY DIFFRACTION DATA AND LATTICE PARAMETER OF PUC SUB 2 AT
1710 DEG C.

ABSTRACT 276

HARRINGTON L C
CNLM-4318 (1962)
HEAT CAPACITY AND ENTHALPY OF URANIUM MONOCARBIDE FROM 0 TO 1200 DEG C

HEAT CAPACITY AND ENTHALPY OF URANIUM MONOCARBIDE WERE MEASURED FROM 0 TO
1200 DEG C. THE MEASURED DATA WAS APPROPRIATELY FITTED TO POLYNOMIALS IN
TEMPERATURE BY THE METHOD OF LEAST SQUARES.

ABSTRACT 277

HARRINGTON L C
CNLM-4461 (1963)
HEAT CAPACITY AND ENTHALPY OF URANIUM MONONITRIDE FROM 0 TO 1200 DEG C
(32 TO 2200 DEG F).
PRATT AND WHITNEY AIRCRAFT, MIDDLETOWN, CONN. CONNECTICUT ADVANCED NUCLEAR
ENGINEERING LAB.

HEAT CAPACITY AND ENTHALPY OF URANIUM MONONITRIDE WERE MEASURED FROM 0 TO
1200 DEG C. THE MEASURED DATA AFTER POLYNOMIAL FIT WERE COMPARED WITH
THOSE REPORTED BY BMI IN BMI-X-10019.

ABSTRACT 278

HARRINGTON L C
PWAC-426 (1964)
THE ENTHALPY AND HEAT CAPACITY OF URANIUM MONOCARBIDE TO 1200C.

THE ENTHALPY OF URANIUM MONOCARBIDE WAS MEASURED IN THE RANGE 0-1204 DEG
C USING AN ICE CALORIMETER. DETERMINATIONS WERE MADE FROM FIVE ELEVATED
TEMPERATURES TO 0 DEG C. THE ACCURACY OF THESE MEASUREMENTS IS ESTIMATED
TO BE 4%. THE HEAT CAPACITY WAS CALCULATED FROM THESE DATA. THESE
MEASURED VALUES FOR ENTHALPY AND CALCULATED VALUES FOR HEAT CAPACITY ARE
COMPARED WITH VALUES FOUND IN THE LITERATURE. THE MEASUREMENTS OF THE
ENTHALPY OF PLATINUM-20% RHODIUM FROM 0 TO 1538 DEG C ARE ALSO PRESENTED.
THESE MEASUREMENTS WERE NEEDED TO CORRECT THE OBSERVATIONS FOR THE HEAT
CONTENT OF THE PLATINUM-20% RHODIUM CAPSULE IN WHICH THE SPECIMEN WAS
SEALED WHILE HEAT CONTENT MEASUREMENTS WERE BEING MADE.

ABSTRACT 279

HARRIS P S

AERE-R-5353

THE VOLATILITY OF PLUTONIUM CARBIDES, PART 1

THE TRANSPIRATION METHOD HAS BEEN USED TO MEASURE THE VOLATILITY OF PLUTONIUM CARBIDES IN THE 'PUC' + PU SUB 2 C SUB 3 AND 'PUC SUB 2' (OR PU SUB 2 C SUB 3) + GRAPHITE DIPHASIC REGIONS. THE TOTAL VOLATILITIES ARE GIVEN BY $\log P(\text{ATM}) = 4.686 - 18,091/T$ (1761 TO 1907 DEG K) AND $\log P(\text{ATM}) = 3.618 - 18,732/T$ (2017 TO 2472 DEG K) RESPECTIVELY. ARGUMENTS ARE PRESENTED WHICH SUGGEST THAT THE MAJOR SPECIES PRESENT IS Pu(g) , AND FREE ENERGIES OF FORMATION OF CARBON-SATURATED 'PUC', PU SUB 2 C SUB 3 AND 'PUC SUB 2', CALCULATED ON THIS ASSUMPTION, ARE GIVEN. THEY ARE APPRECIABLY MORE STABLE THAN SOME OF THE PREVIOUS DATA SUGGESTED, THE FREE ENERGIES OF FORMATION OF CARBON-SATURATED 'PUC' AND PU SUB 2 C SUB 3 AT 123 DEG K BEING APPROX -13.0 AND -35.8 KCAL RESPECTIVELY, AND THAT OF 'PUC SUB 2' AT 2273 DEG K, -19.8 KCAL.

ABSTRACT 280

HARRISON J D L

PLUTONIUM 1970 AND OTHER ACTINIDES, P518

FACTORS AFFECTING THE HARDNESS OF URANIUM MONONITRIDE AT ELEVATED TEMPERATURE

THE VICKERS PYRAMID HARDNESS NUMBERS (V.H.N.) OF UN PREPARED FROM FOUR DIFFERENT PURITY GRADES OF URANIUM METAL HAVE BEEN MEASURED AT TEMPERATURES BETWEEN 20 AND 1400 DEG C, USING HOT-HARDNESS MACHINES AT O.R.N.L. AND A.E.R.E. THE GRADES OF METAL WERE: COMMERCIAL, ELECTRO-DEPOSITED (SERVICES U.H.P., FRANCE) AND TWO BATCHES DEPLETED IN **235U. SPECIMENS WERE FABRICATED FROM UN PRODUCED BY REACTION OF NITROGEN WITH FINE METAL POWDER, THE RESULTING UN POWDER BEING COLD-PRESSED AND SINTERED TO APPROX 95% DENSITY. THE VARIATION OF V.H.N. WITH TEMPERATURE DID NOT FOLLOW THE BEHAVIOR INDICATED BY OTHER WORKERS, NAMELY $\log(V.H.N.) \sim (-T \text{ DEG})$. FOR ALL GRADES, THERE WAS A SIMILAR DECREASE IN HARDNESS AS THE TEMPERATURE ROSE TO 600 DEG C, WITH $\log(V.H.N.) \sim 1/T$ DEG K. ABOVE 700 DEG C, THERE WAS A CONSIDERABLE DIFFERENCE BETWEEN THE PURE AND IMPURE MATERIALS. FOR THE FORMER, BETWEEN 600 DEG C AND 700 DEG C THERE WAS AN INCREASE (BY AN ORDER OF MAGNITUDE) IN THE PROPORTIONALITY CONSTANT FOR $\log(V.H.N.) \sim 1/T$ DEG K, WHICH LED TO RAPID SOFTENING AS THE TEMPERATURE ROSE TO 1400 DEG C. FOR THE IMPURE MATERIAL, THE RELATIONSHIP BETWEEN HARDNESS AND TEMPERATURE WAS COMPLEX ABOVE 700 DEG C, AND THE RATE OF SOFTENING WITH INCREASE IN TEMPERATURE WAS SLOWER THAN FOR PURE UN. IT IS SUGGESTED THAT THE FACTOR CONTROLLING HARDNESS CHANGES AT APPROX 700 DEG C, WITH IMPURITIES IMPARTING MORE RESISTANCE TO DEFORMATION ABOVE THIS TEMPERATURE.

ABSTRACT 281

HAUSMER H H

REUTVE TYROL AUSTRIA METALLWERK PLANSEE (1961)

BIBLIOGRAPHY ON URANIUM CARBIDES

SOME OF THE PHYSICAL PROPERTIES OF UC ARE LISTED, AND A BIBLIOGRAPHY OF 209 REFERENCES, MOST WITH APPENDED ABSTRACTS, IS PRESENTED ON URANIUM CARBIDES

ABSTRACT 282

HAYES B A

PWAC-480 (1965)

THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF URANIUM MONOCARBIDE

THE THERMAL CONDUCTIVITY OF 95% DENSE URANIUM CARBIDE WITH 860 PPM OXYGEN AND 520 PPM NITROGEN WAS FOUND TO BE 0.175 ± 0.005 W/CM DEG C IN THE TEMPERATURE RANGE 1100 TO 1600 DEG C. THE EFFECT OF INCREASING THE COMBINED OXYGEN AND NITROGEN IMPURITY LEVEL FROM 1380 TO 2180 PPM WAS MINOR; HOWEVER, A GENERAL LOWERING OF THE THERMAL CONDUCTIVITY WAS OBSERVED WHEN THE IMPURITY LEVEL INCREASED FROM 1380 PPM TO 4000 PPM. THE PORTION OF THE THERMAL CONDUCTIVITY DUE TO ELECTRONS, ESTIMATED FROM ELECTRIC RESISTIVITY DATA AND THE WEIDEMANN-FRANZ RELATIONSHIP, WAS FOUND TO BE ALMOST 100% AT TEMPERATURES ABOVE 1000 DEG C. CONSIDERABLE AGREEMENT WITH PREVIOUS RESULTS WAS FOUND. A STUDY OF ALL DATA INDICATES THAT THE THERMAL CONDUCTIVITY OF URANIUM CARBIDE DOES NOT VARY SIGNIFICANTLY WITH TEMPERATURE IN THE RANGE 1000 TO 2000 DEG C.

ABSTRACT 283

HAYES B A

PWAC-481 (1965)

THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF URANIUM MONONITRIDE. PRATT AND WHITNEY AIRCRAFT, MIDDLETOWN, CONN. CONNECTICUT ADVANCED NUCLEAR ENGINEERING LAB.

THE THERMAL CONDUCTIVITY OF URANIUM MONONITRIDE, MEASURED IN THE TEMPERATURE RANGE 900 TO 1650 DEG C, WAS QUITE TEMPERATURE-DEPENDENT BELOW 1200 DEG C. HOWEVER, IT WAS RELATIVELY TEMPERATURE-INDEPENDENT ABOVE 1200 DEG C. AT 1650 DEG C THE THERMAL CONDUCTIVITY WAS 0.26 W/CM-DEG C. THE ELECTRONIC HEAT CONDUCTION WAS ESTIMATED FROM ELECTRICAL RESISTIVITY MEASUREMENTS AND THE WEIDEMANN-FRANZ RELATIONSHIP. THERMAL AND ELECTRICAL PROPERTIES OF UN WERE COMPARED WITH THOSE OF UC.

ABSTRACT 284

HAYWARD B R

NAA-SR-11450

TECHNICAL PROGRESS DURING FISCAL YEAR 1965

IN GENERAL, THE RESULTS SHOWED THAT, WHERE OPERATING TEMPERATURES ARE MAINTAINED WITHIN THE LSGR REFERENCE RANGE (1600 TO 1800 DEG F), THE OPERATIONAL BEHAVIOR OF THE HYPOSTOICHIOMETRIC UC-304 STAINLESS STEEL CLAD SYSTEM IS EXCELLENT TO PEAK BURN UPS OF AT LEAST 10.07×10^{20} FISSIONS/CC (31,000 MWD/MTU). UNDER THESE CONDITIONS, FUEL SWELLING AND FISSION GAS RELEASE WERE WELL WITHIN CURRENT LSGR DESIGN CRITERIONS. X-RAY DIFFRACTION MEASUREMENTS WERE CARRIED OUT ON QUENCHED HYPOSTOICHIOMETRIC UC (4.5 WT% C) SPECIMENS. THE OBSERVED REDUCTION IN THE LATTICE PARAMETER OF THE CARBIDE PHASE (FROM 4.961 TO 4.949 Å) WAS THE RESULT OF URANIUM SOLUTION. OXYGEN CONTAMINATION IS A FACTOR WHICH VERY LIKELY CAUSED PERTURBATIONS IN THE EXPERIMENTS AS IT HAS AN EFFECT SIMILAR TO THAT OF FREE URANIUM AND LOWERS THE LATTICE PARAMETER OF UC. THERMAL CONDUCTIVITIES OF URANIUM CARBIDE FUEL WERE MEASURED FROM 4.0 TO 4.8 WT% C AND THE TEMPERATURE RANGE OF ROOM TEMPERATURE TO 1200 DEG C. COMPATIBILITY TESTS OF UC WERE RUN WITH TYPES 316 AND 347 STAINLESS STEELS AND HASTELLOY-N. MICROHARDNESS DATA FOR HYPER AND HYPO-UC WAS COMPARED.

ABSTRACT 285

HEBEISEN J C

BMI-1895 (1971)

COMPATIBILITY OF NITRIDE REACTOR FUELS WITH AUSTENITIC STAINLESS STEELS
RATTELLE MEMORIAL INSTITUTE

THE COMPATIBILITY OF UN AND (UN,PU)_N FUELS WITH AUSTENITIC STAINLESS STEEL CLADDING UNDER SIMULATED LIQUID-METAL FAST-BREEDER-REACTOR (LMFBR) CONDITIONS WAS EVALUATED USING COMPATIBILITY COUPLES HEATED IN BOTH SODIUM-BONDED AND PRESSURE-CONTACTED CAPSULES FOR TIMES FROM 1,000 TO 10,000 HR AT TEMPERATURES FROM 700 TO 1000 DEG C. STOICHIOMETRIC MONONITRIDE FUELS WERE COMPATIBLE WITH AUSTENITIC STAINLESS STEEL CLADDINGS FOR AT LEAST 10,000 HR AT 700 DEG C AND 1,000 HR AT 1000 DEG C. HOWEVER, SEVERAL FACTORS HAD AN ADVERSE EFFECT ON THE COMPATIBILITY. OXYGEN CONTAINED IN THE CLADDING OR CAPSULE ENVIRONMENT READILY REACTED WITH THE FUEL TO RELEASE NITROGEN; THE NITROGEN SO FORMED DIFFUSED INTO THE CLADDINGS, WITH THE FORMATION OF NITRIDE PRECIPITATES. NONSTOICHIOMETRIC FUELS ALSO REACTED WITH THE STAINLESS STEELS. THE FREE METAL PRESENT IN HYPOSTOICHIOMETRIC FUELS INITIATED MELTING REACTIONS IN SEVERAL CAPSULES HEATED AT 1000 DEG C, AND THE SESQUINITRIDE PHASE PRESENT IN HYPERSTOICHIOMETRIC URANIUM NITRIDE FUELS DECOMPOSED TO UN, WITH THE FORMATION OF CHROMIUM NITRIDE PRECIPITATES IN THE CLADDING. THE RATE OF CLADDING NITRIDATION IN CAPSULES CONTAINING HYPERSTOICHIOMETRIC UN AND A SODIUM BOND WAS SLIGHT (<1 MIL AFTER 10,000 HR AT 700 DEG C), AND WAS CONTROLLED BY THE RELEASE OF NITROGEN FROM THE FUEL; FOR UN FUELS THIS IS THE DIFFUSION RATE OF NITROGEN THROUGH THE MONONITRIDE PHASE. HYPERSTOICHIOMETRIC MIXED NITRIDE CONTAINING THE OXIDE PHASE IN INTIMATE ASSOCIATION WITH THE SESQUINITRIDE DID NOT REACT WITH STAINLESS STEEL CLADDING IN 10,000 HR AT 700 DEG C OR 1,000 HR AT 1000 DEG C. THIS INERT BEHAVIOR IS THOUGHT TO BE RELATED TO THE STABILIZING EFFECT THE OXIDE PHASE HAS ON THE SESQUINITRIDE.

ABSTRACT 286

HEBEISEN J C

TRANS AM NUCL SOC 12, 595 (1969)

COMPATIBILITY OF MIXED NITRIDES WITH LMFBR CLADDINGS (IRRADIATION TESTS)

(U SUB 0.8 PU SUB 0.2)**N FUELS CONTAINED IN THE SPECIMENS WERE BOTH SODIUM- AND HELIUM - BONDED TO TYPE 304 AND TYPE-304L STAINLESS-STEEL CLADDINGS. ON THE BASIS OF METALLOGRAPHIC OBSERVATIONS, NITRIDING OF THE CLADDING AND FISSION PRODUCT REACTIONS WITH THE CLADDING DO NOT APPEAR TO PRESENT MAJOR COMPATIBILITY PROBLEMS.

ABSTRACT 287

HENNECKE J F A

J APPL CRYST 2, 301 (1969)

THE LATTICE PARAMETER AND X-RAY POWDER PATTERN OF U SUB 2C SUB 3

THE X-RAY POWDER DIFFRACTION PATTERN AND A PRECISE DETERMINATION OF THE LATTICE PARAMETER OF U SUB 2C SUB 3 (A SUB 0=8.0899#0.0002A) ARE GIVEN. FURTHER ANALYSIS INDICATES THAT U SUB 2C SUB 3 APPEARS TO BE A STOICHIOMETRIC COMPOUND.

ABSTRACT 288

HENNEY J

AERE-R-4176 (1963)

SOME EFFECTS OF OXYGEN AND NITROGEN AS IMPURITIES ON EQUILIBRIA IN THE URANIUM-CARBON SYSTEM

THE URANIUM CARBIDE PHASES THAT ARE IN EQUILIBRIUM WITH EXCESS GRAPHITE IN THE TEMPERATURE RANGE 1000-1,700 DEG C WERE FOUND TO DEPEND ON THE CONCENTRATION OF OXYGEN AND NITROGEN IMPURITIES IN THE SPECIMEN AND HENCE ON THE FURNACE ATMOSPHERE DURING ANNEALING. WHEN THESE IMPURITIES ARE PRESENT (0.01-1% IN THE SPECIMEN), THE EQUILIBRIUM PHASES ARE FOUND TO BE A MIXTURE OF A TETRAGONAL UC SUB 2 PHASE CONTAINING A SMALL AMOUNT OF OXYGEN BUT DEFICIENT IN CARBON, AND A PRECIPITATE OF A CUBIC UC SUB (1-X) N SUB X SOLID SOLUTION. REDUCTION OF THE OXYGEN AND NITROGEN TO A VERY LOW LEVEL (<100 PPM) BY ANNEALING IN A VACUUM OF APPROX 10⁻⁵ MM HG IS ACCOMPANIED BY A TRANSFORMATION TO U SUB 2 C SUB 3 AND CARBON SHOWING THAT, IN THE PURE U-C BINARY SYSTEM, U SUB 2 C SUB 3 IS THE STABLE PHASE IN CONTACT WITH GRAPHITE FROM 1,000-1,700 DEG C.

ABSTRACT 289

HENNEY J

AERE-R-4661 (1966)

THE EFFECTS OF OXYGEN ON PHASE EQUILIBRIA IN THE URANIUM-CARBON SYSTEM

A SERIES OF EXPERIMENTS HAVE BEEN CARRIED OUT IN WHICH URANIUM, CARBON, AND UO SUB 2 POWDERS WERE REACTED TO PRODUCE OXYGEN SATURATED CARBIDES. THE RESULTS HAVE SHOWN THAT THE DECOMPOSITION TEMPERATURE OF U SUB 2 C SUB 3 TO GIVE UC AND UC SUB 2 IS REDUCED FROM ABOUT 1800 DEG C TO 1625 DEG C WHEN UO SUB 2 IS PRESENT, AND THAT UC SUB 2 CAN CONTAIN UP TO APPROX 2 W/O DISSOLVED OXYGEN AT ABOUT 1500 DEG C. TENTATIVE ISOTHERMAL SECTIONS OF THE U-C-O SYSTEM AT 1500 DEG C AND 1700 DEG C ARE GIVEN

ABSTRACT 290

HENNEY J

TRANS BR CERAM SOC 62,955 (1963)

EFFECTS OF OXYGEN AND NITROGEN IMPURITIES ON EQUILIBRIUMS IN THE URANIUM-CARBON SYSTEM

THE U CARBIDE PHASES WHICH ARE IN EXCESS GRAPHITE AT 1000-1700 DEG C DEPEND ON THE CONCENTRATION OF O AND N IMPURITIES IN THE SPECIMEN AND HENCE ON THE FURNACE ATMOSPHERE DURING ANNEALING.

ABSTRACT 291

HENRY J L

J AM CERAM SOC 53, 335 (1970)

HOT HARDNESS, THERMAL DIFFUSIVITY, AND ELECTRICAL RESISTIVITY OF URANIUM OXYCARBIDES

SEVERAL PREDOMINANTLY SINGLE-PHASE URANIUM OXYCARBIDE COMPOSITIONS WERE EXAMINED TO DETERMINE THE EFFECT OF OXYGEN CONTENT ON THE HOT HARDNESS, THERMAL DIFFUSIVITY, THERMAL CONDUCTIVITY, AND ELECTRICAL RESISTIVITY. LITTLE DIFFERENCE WAS NOTED IN HOT HARDNESS OVER THE LOW-TEMPERATURE RANGE; HOWEVER, INCREASED OXYGEN CONTENT APPEARS TO REDUCE THE HARDNESS ABOVE 700 DEG C. THERMAL DIFFUSIVITY AND THERMAL CONDUCTIVITY ARE REDUCED BY INCREASED OXYGEN CONTENT. THIS DECREASE IS MOST PRONOUNCED AT LOWER

ABSTRACT 291 (CONT'D)

TEMPERATURES, AND THE TEMPERATURE DEPENDENCE VARIES SIGNIFICANTLY WITH OXYGEN CONTENT. THE THERMAL DIFFUSIVITY OF OXYCARBIDES HAVING SMALL PERCENTAGES OF OXYGEN DECREASES WITH INCREASING TEMPERATURE, WHEREAS THAT OF OXYCARBIDES WITH GREATER OXYGEN CONTENT INCREASES VERY SLIGHTLY. THE THERMAL CONDUCTIVITY DATA ARE IN FAIR AGREEMENT WITH THOSE REPORTED FOR THE MONOCARBIDE. ELECTRICAL RESISTIVITY IS INCREASED BY INCREASED OXYGEN CONTENT AND SHOWS A POSITIVE TEMPERATURE DEPENDENCE. THE DATA INDICATE THAT ELECTRONIC CONDUCTIVITY AT 1500 DEG C ACCOUNTS FOR APPROXIMATELY 85% OF THE TOTAL THERMAL CONDUCTION AT THE 2 AT% OXYGEN LEVEL AND APPROXIMATELY 95% OF THE TOTAL AT THE 16 AT% OXYGEN LEVEL.

ABSTRACT 292

HENRY J L

NP-14592 (1964)

INVESTIGATION OF THE PSEUDO-TERNARY SYSTEM UC-UN-UO

A STUDY IS BEING CONDUCTED OF THE SUBLIQUIDUS PHASE RELATIONSHIPS IN THE PSEUDO-TERNARY SYSTEM UC-UN-UO. SINGLE PHASE SOLID-SOLUTION AREAS WITHIN THE SYSTEM MAY OFFER ATTRACTIVE POSSIBILITIES FOR HIGH TEMPERATURE REACTOR FUELS. PRELIMINARY DATA INDICATE A SINGLE PHASE AREA APPROXIMATELY BOUNDED BY THE COMPOSITIONS UC-UIC SUB 0.65 O SUB 0.351-UN. COMPOSITIONS EXTERNAL TO THIS AREA CONTAIN FREE URANIUM AND URANIUM DIOXIDE. UC AND UN FORM A CONTINUOUS SERIES OF SOLID SOLUTIONS WHEREAS THE SOLUBILITY OF UO IN UC IS LIMITED TO ABOUT 35 MOLE%. THE SOLUBILITY OF UO IN UN APPEARS TO BE VERY SMALL, PERHAPS AS LOW AS 1 OR 2 MOLE %.

ABSTRACT 293

HENRY J L

RI-6968 (1967)

PHASE RELATIONS IN THE URANIUM MONOCARBIDE REGION OF THE SYSTEM URANIUM-CARBON-OXYGEN AT 1700 DEG C
BUREAU OF MINES

THE MONOCARBIDE REGION OF THE TERNARY SYSTEM U-C-O HAS BEEN INVESTIGATED AT 1,700 DEG C AS THE FIRST PHASE OF A MORE EXTENSIVE STUDY OF A PORTION OF THE FOUR-COMPONENT SYSTEM U-C-O-N. AN AREA BOUNDED BY THE FOLLOWING COMPOSITIONAL LIMITS IN ATOMIC PERCENT WAS STUDIED: U, 44 TO 55; C, 30 TO 60; O, 0.2 TO 20. COMPACTS COMPOSED OF MIXTURES OF URANIUM, GRAPHITE, AND URANIUM DIOXIDE POWDERS WERE SINTERED AT 1,700 DEG C UNDER AN EQUILIBRIUM PRESSURE OF CARBON MONOXIDE TO PRODUCE URANIUM OXYCARBIDE SPECIMENS HAVING A VARIETY OF COMPOSITIONS. SINTERED SPECIMENS WERE EVALUATED BY X-RAY, CHEMICAL ANALYSIS, AND CERAMOGRAPHIC TECHNIQUES. SOLID-SOLUTION BOUNDARIES AND PHASE RELATIONS HAVE BEEN ESTABLISHED, AND THE EFFECTS OF COMPOSITION ON THE LATTICE PARAMETER AS WELL AS THE DECOMPOSITION PRESSURE HAVE BEEN INVESTIGATED. OXYGEN CAN BE SUBSTITUTED FOR CARBON IN STOICHIOMETRIC URANIUM MONOCARBIDE TO THE EXTENT OF ABOUT 17 ATOMIC PERCENT AT 1,700 DEG C. THE COMPOSITION RANGE OF THE OXYCARBIDE SOLID SOLUTION EXTENDS FROM ABOUT 48 TO 51 ATOMIC PERCENT URANIUM IN THE LOW OXYGEN REGION. ABOVE 10 ATOMIC PERCENT OXYGEN THE COMPOSITION RANGE NARROWS TO LESS THAN 1 ATOMIC PERCENT URANIUM. CARBON MONOXIDE EXISTS AS A GASEOUS PHASE IN EQUILIBRIUM WITH ALL COMPOSITIONS WHICH CONTAIN OXYGEN. FIVE SEPARATE PHASE FIELDS WERE FOUND BOUNDING THE SOLID-SOLUTION AREA. OTHER PHASES WITHIN THIS PORTION OF THE SYSTEM INCLUDE URANIUM, URANIUM DIOXIDE, URANIUM DICARBIDE, AND URANIUM SESQUICARBIDE.

ABSTRACT 293 (CONT'D)

DECOMPOSITION PRESSURES OF OXYCARBIDE COMPOSITIONS AT 1,700 DEG C HAVE BEEN FOUND TO VARY FROM A FEW MICRONS FOR STOICHIOMETRIC AND URANIUM-RICH COMPOSITIONS TO 35 TORR FOR CARBON-OXYGEN-RICH SPECIMENS. LATTICE PARAMETERS WERE FOUND TO DEPEND UPON THE U TO C + O RATIO AS WELL AS UPON THE EXTENT OF SUBSTITUTION OF OXYGEN INTO THE STOICHIOMETRIC MONOCARBIDE LATTICE.

ABSTRACT 294

HERBST R J

TRANS AM NUCL SOC 9,17 (1966)

COMPATIBILITY OF MODIFIED MONOCARBIDE FUELS WITH STAINLESS STEEL

AN EXPERIMENTAL PROGRAM IS DESIGNED TO DEMONSTRATE THE PROPOSED IMPROVEMENT IN COMPATIBILITY OF HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE BY MODIFICATION WITH FE AND CR SUB 23 C SUB 6. IMPROVED COMPATIBILITY HAS BEEN DEMONSTRATED FOR IRON MODIFIED COMPOSITIONS IN SODIUM AND INERT-GAS ENVIRONMENTS IN TESTS AT 830 DEG C FOR TIMES AS GREAT AS 1200 H. COMPATIBILITY TESTING OF CR SUB 23 C SUB 6 MODIFIED HYPOSTOICHIOMETRIC URANIUM CARBIDES IS CONTINUING.

ABSTRACT 295

HILBERT R F

PROC ON THE CONF ON FAST REACTOR FUEL ELEMENT TECH P753 (1971)

SWELLING OF UC AND UN AT HIGH TEMPERATURES

THE EXTERNAL SWELLING BEHAVIOR OF UN WAS FOUND TO BE SUPERIOR TO THAT OF UC IN IRRADIATION TESTS OF W-25 WT% RECLAD SPECIMENS AT TEMPERATURES RANGING FROM 1200 TO 1700 DEG C. IN AGREEMENT WITH DATA WHICH INDICATE THAT INERT-GAS DIFFUSION AND SELF-DIFFUSION ARE MORE RAPID IN UC THAN IN UN, FISSION GAS BUBBLES AND EXTERNAL FUEL VOLUME INCREASES WERE LARGER IN UC THAN IN UN. THE USE OF UNIFORMLY DISTRIBUTED POROSITY SIGNIFICANTLY REDUCED THE SWELLING OF UN AND TO A LESSER EXTENT REDUCED SWELLING OF UC.

ABSTRACT 296

HIMMELSTEIN P K

EURAE-1066 (1964)

DEVELOPMENT OF PROCESSES FOR FABRICATION OF URANIUM CARBIDES AND CERMETS ON UC BASIS

THE COPPER CRUCIBLE OF THE TIP CASTING FURNACE WAS IMPROVED TO SUPPLY ENOUGH CURRENT FOR URANIUM CARBIDE MELTING. URANIUM CARBIDE RODS WERE MELTED AND CAST IN THE CENTRIFUGAL CASTING FURNACE. CHEMICAL ANALYSES AND MICROSECTIONS WERE MADE OF ALL UC RODS, THE DENSITIES WERE ASCERTAINED AND CORROSION TESTS WERE PERFORMED. WITH THE AID OF AN ULTRASONIC DRILLING MACHINE, SAMPLES WERE PREPARED FOR THERMAL CONDUCTIVITY, DILATOMETER, ELEVATED TEMPERATURE HARDNESS, AND XENON DIFFUSION MEASUREMENTS. THE THERMAL CONDUCTIVITY RESULTS FOR STOICHIOMETRIC UC SAMPLES WERE BETWEEN 0.04 AND 0.06 CAL/CM S DEG C. IMPACT TESTS ON UC RODS WERE CONTINUED.

ABSTRACT 297

HIRSCH H J

J NUCL MATER 45, 123 (1972/73)

ACTINIDE DIFFUSION IN URANIUM MONOCARBIDE

URANIUM SELF-DIFFUSION HAS BEEN INVESTIGATED IN URANIUM CARBIDE OF CONTROLLED COMPOSITIONS, UC SUB 1.07 AND UC SUB 0.96, WITHIN A TEMPERATURE RANGE BETWEEN 1700 AND 2300 DEG C. THE RESPECTIVE TEMPERATURE FUNCTIONS ARE: UC SUB 0.96: $D = 3.6 \cdot 10^{12} \exp \{(-107\#3)/RT\}$; 1700 DEG C < T < 2300 DEG C UC SUB 1.07: $D = 4.0 \cdot 10^{14} \exp \{(-106\#1.5)/RT\}$; 1700 DEG C < T < 2050 DEG C $D = 9.0 \cdot 10^{12} \exp \{(-174\#6)/RT\}$; 2050 DEG C < T < 2300 DEG C COMPARATIVE MEASUREMENTS OF ACTINIDE DIFFUSION (PA, PU, AM) IN UC SUB 1.07 YIELDED QUITE SIMILAR RESULTS, THE DEVIATIONS BETWEEN THE RESPECTIVE ACTIVATION ENERGIES BEING WITHIN THE RANGE OF EXPERIMENTAL ERRORS. FROM THE CHANGE IN ACTIVATION ENERGIES IN THE HYPERSTOICHIOMETRIC MATERIAL AT 2050 DEG C IT IS CONCLUDED THAT THE PHASE-BOUNCARY BETWEEN UC SUB 1+X AND B-UC SUB 2 DOES NOT AGREE WITH THE PRESENTLY ACCEPTED U-C PHASE DIAGRAM.

ABSTRACT 298

HUGH M

SYMP THERMOPHYSIC PROPERTIES 380 (1970)

HIGH-TEMPERATURE SPECIFIC HEAT OF METALS AND CERAMICS

THE HIGH TEMPERATURE SPECIFIC HEAT OF LEAD, MOLYBDENUM, UO SUB 2, US, UN, AND UC WERE EVALUATED FROM ROOM TEMPERATURE UP TO WITHIN TEN DEGREES OF THEIR MELTING POINTS. IT WAS FOUND IN ALL CASES THAT THE SPECIFIC HEAT CAN BE EXPRESSED AS $C \text{ SUB } P = 3RF (Q \text{ SUB } D/T) + BT + DT^{**3}$ IN THIS EQUATION, THE FIRST TERM IS DUE TO THE VIBRATIONAL CONTRIBUTION, THE SECOND TERM CONTAINS THE ELECTRONIC CONTRIBUTION, AND THE THIRD TERM IS DUE TO THE ANHARMONICITY OF THE VIBRATIONS. IN THE CASES WHERE NO ELECTRONIC CONTRIBUTION IS PRESENT, SUCH AS IN UO SUB 2, B EQUALS ZERO. THE CONTRIBUTION OF VACANCIES TO THE SPECIFIC HEAT IS QUITE NEGLIGIBLE AND WITHIN THE EXPERIMENTAL ERROR OF HIGH TEMPERATURE SPECIFIC HEAT MEASUREMENTS.

ABSTRACT 299

HOOKIN D J

AERE-R-5173 (1966)

COMPATIBILITY STUDIES BETWEEN ARC CAST (U SUB 0.8 PU SUB 0.15) C AND TYPE 316L STAINLESS STEEL

ARC CAST (U SUB 0.85 PU SUB 0.15)C WITH CARBON CONTENTS OF 4.72 TO 5.06 WT % IS COMPATIBLE WITH TYPE 316L STAINLESS STEEL AT TEMPERATURES UP TO 900 DEG C. HOWEVER SOME CARBURIZATION OF THE STEEL WAS OBSERVED AND THIS IS BELIEVED TO BE DUE TO A GAS PHASE ORIGINATING FROM HYDROLYSIS OF THE CARBIDE BY ITS OWN ABSORBED MOISTURE. WHEN A SODIUM BOND IS INTRODUCED GROSS CARBURIZATION OF THE STEEL IS OBSERVED FOR HYPERSTOICHIOMETRIC CARBIDES, THE RATE OF CARBURIZATION DEPENDING PRIMARILY ON THE MC SUB 2 CONTENT OF THE CARBIDE. FOR CERMETS OF MIXED CARBIDE DISPERSED IN A STEEL MATRIX SOME REACTION WAS OBSERVED AT TEMPERATURE AS LOW AS 700 DEG C.

ABSTRACT 300

HODKIN D J

AERE-R-5276 (1966)

COMPATIBILITY STUDIES OF URANIUM AND URANIUM-PLUTONIUM OXYCARBIDES WITH TYPE 316L STEEL

NO INTERDIFFUSION BETWEEN THE OXYCARBIDES AND TYPE 316L STEEL HAS BEEN OBSERVED. SLIGHT CARBURIZATION OF THE STEEL DOES OCCUR DUE TO A GAS PHASE RESULTING FROM REACTION BETWEEN THE OXYCARBIDES AND ADSORBED MOISTURE.

ABSTRACT 301

HOEKSTRA E K

RCN-183 (1972)

FAST REACTOR PROGRAMME FOURTH QUARTER

ATTEMPT WAS MADE TO INVESTIGATE THE RELATIONSHIP BETWEEN THE LATTICE PARAMETER AND COMPOSITION OF URANIUM CARBONITRIDE. THE RESEARCH ON THE THERMODYNAMIC PROPERTIES OF U(C,N) BY MEANS OF EMF MEASUREMENTS IS BEING CONTINUED. WITH THE METHOD ADOPTED, AND ELUCIDATION OF THE PHASE DIAGRAM PU SUB N SUB 2 - X AT ABOUT 1000 DEG C WAS NOT POSSIBLE.

ABSTRACT 302

HOEKSTRA E K

RCN-187 (1973)

FAST REACTOR PROGRAMME 1ST QUARTER 1973 PROGRESS REPORT

AS PART OF THE PROGRAMME TO DEVELOP U(CN) FUELS, THERMAL EXPANSION MEASUREMENTS WERE MADE AS A FUNCTION OF C/N RATIO UP TO 1300 DEG C. THE LINEAR EXPANSION WAS 1.3% OVER THE RANGE 20 TO 1300 DEG C FOR UC SUB 0.5 -N SUB 0.5 AND UC SUB 0.8 N SUB 0.2.

ABSTRACT 303

HOEKSTRA E K

RCN-190

FAST REACTOR PROGRAMME SECOND QUARTER

IT WAS FOUND THAT SMALL AMOUNTS OF METAL IMPURITIES SUCH AS AL, FE AND SI HAVE AN IMPORTANT INFLUENCE ON THE LOCATION OF THE MEASURED POINTS IN THE RELATIONSHIP BETWEEN THE LATTICE PARAMETER AND COMPOSITION. FOR UC-UN SYSTEM, THE P SUB N SUB 2 - X SECTION OF THE PHASE DIAGRAM AT 1800 DEG C HAS BEEN EXAMINED. ALSO, THE EQUILIBRIUM COMPOSITIONS AND PRESSURES WERE INVESTIGATED FOR SEVERAL TEMPERATURES IN THE RANGE OF 1800 TO 2200 DEG C.

ABSTRACT 304

HOENIG C L

J AM CERAM SOC 54, 391 (1971)

PHASE EQUILIBRIA, VAPOR PRESSURE AND KINETIC STUDIES IN THE URANIUM-NITROGEN SYSTEM

URANIUM MONONITRIDE WAS STUDIED IN AN AUTOMATIC RECORDING BALANCE-FURNACE SYSTEM CAPABLE OF HIGH VACUUM OR PRECISELY CONTROLLED GAS PRESSURE. THE DECOMPOSITION PRESSURE OF U SUB 2N SUB 3, WHICH WAS MEASURED AT 1483 AND 1607 DEG K, AGREED WITH VALUES IN THE LITERATURE. URANIUM SESQUINITRIDE COMPOSITIONS WERE SUBSTOICHIOMETRIC AT THE U-RICH BOUNDARY, WITH COMPOSITIONS OF UN SUB 1.48#0.01 AT 1483 DEG K AND 130 TORR N SUB 2 AND

ABSTRACT 304 (CONT'D)

UN SUB 1.45#0.01 AT 1607 DEG K AND 700 TORR N SUB 2. UN HAS VERY NARROW COMPOSITION LIMITS (UN SUB 0.995 TO UN SUB 0.997) FROM 1100 DEG TO 2450 DEG K AT N SUB 2 PRESSURES BELOW 700 TORR. IN VACUUM AT 1538 DEG K, THE COMPOSITION IS UN SUB 0.9954#0.0001. VAPORIZATION RATES FOR SINGLE-PHASE UN WERE STUDIED BY THE KNUDSEN AND LANGMUIR METHODS USING TEMPERATURES FROM 1900 DEG TO 2860 DEG K AND N SUB 2 PRESSURES FROM 10**-4 TO 130 TORR. THE ENTHALPY OF VAPORIZATION (ΔH SUB 298) FOR THE REACTION $UN(S) = U(G) + 1/2 N_2(G)$ WAS 199#1 KCAL/MOL AT 10**-3 TO 1.0 TORR N SUB 2. THE LANGMUIR DATA INDICATED AN EVAPORATION COEFFICIENT OF 0.3 FOR U FROM 10**-4 TO 1.0 TORR N SUB 2. A UN PELLET (95.0% OF THEORETICAL DENSITY) WAS TESTED FOR SPALLING AND CRACKING BY REPEATED CYCLING BETWEEN THE UN AND U SUB 2N SUB 3 PHASE REGIONS AT 130 TORR N SUB 2. AT 1131 DEG K, THE NITRIDING RATE TO FORM U SUB 2N SUB 3 WAS 5.2×10^{-3} MG/MIN, CM**2 IN 130 TORR N SUB 2, AFTER EXTENSIVE NITRIDING AND DENITRIDING (19 CYCLES FOR TIMES TO 69H), THE BULK VOLUME EXPANSION OF THE PELLET WAS 8.5%. THE SURFACE WAS NOT FRIABLE OR POWDERY AND THE OVERALL STRUCTURAL INTEGRITY WAS SOUND.

ABSTRACT 305

HOFFMAN P

KFK-1832 (1973)

INVESTIGATIONS ON THE REACTION BEHAVIOR OF AUSTENITIC STEELS WITH SIMULATED FISSION PRODUCTS IN THE PRESENCE OF UC

ONE OF THE PROBLEMS IN THE OPERATION OF A FAST BREEDER REACTOR IS THE CLADDING ATTACK BY THE FUEL WHEN USING OXIDE PINS. FISSION PRODUCTS ARE INVOLVED IN ALL THE CHEMICAL REACTIONS BETWEEN FUEL AND CLADDING THAT GIVE RISE TO SERIOUS CONSIDERATIONS. THE SITUATION IS SOMEWHAT DIFFERENT WHEN CARBIDE PINS ARE USED AS THE RESULTS DESCRIBED IN THIS PAPER INDICATE. FISSION PRODUCT ELEMENTS WERE MIXED TO STOICHIOMETRIC AND OVER-STOICHIOMETRIC UC BOTH AS SINGLE ELEMENTS AND IN GROUP IN AMOUNTS CORRESPONDING TO 10 AND 20 AT % BURNUP. THESE MIXTURES WERE ANNEALED IN CONTACT WITH VARIOUS CLADDING MATERIALS. THEREBY IT WAS FOUND THAT NO SPECIFIC FISSION PRODUCT REACTIONS WITH THE CLADDING ARE TO BE EXPECTED IN A CARBIDE PIN. AMONG THOSE FISSION PRODUCT ELEMENTS WHICH HAVE PROVEN THEMSELVES AS VERY REACTIVE WITH THE CLADDING MATERIAL WHEN MIXED TO OXIDE FUEL, I.E. CESIUM, IODINE, TELLURIUM AND SELENIUM, ONLY IODINE REACTS WITH THE CLADDING MATERIAL IN THE PRESENCE OF CARBIDE FUEL. HOWEVER, SINCE IODINE IS BONDED TO CESIUM DURING REACTOR OPERATION, IT IS NOT ABLE TO TAKE PART IN THE CLADDING ATTACK BECAUSE CESIUM IODIDE DOES NOT REACT WITH A STEEL CLADDING IN THE PRESENCE OF CARBIDE FUEL. AN INCREASE IN CARBON POTENTIAL OF THE CARBIDE FUEL DURING IRRADIATION IS NOT TO BE EXPECTED. THE PRESENCE OF FISSION PRODUCTS SEEMS TO REDUCE THE CARBURIZATION OF THE CLADDING.

ABSTRACT 306

HOM A

J NUCL MATER 48, 157 (1973)

FISSION-ENHANCED SELF-DIFFUSION OF URANIUM IN UC SUB 2 AND UC

IN-PILE SELF-DIFFUSION MEASUREMENTS IN STOICHIOMETRIC UC SUB 2 SINTERS AND SINGLE CRYSTALS AND IN ARC-CAST STOICHIOMETRIC UC HAVE BEEN PERFORMED USING THE THIN LAYER CONDITION AND **233U AS TRACER. THE NOMINAL IRRADIATION TEMPERATURE WAS 900 DEG C. THE RESULTING DIFFUSION

ABSTRACT 306 (CONT'D)

COEFFICIENTS D OF 1.5×10^{-16} CM²/SEC FOR UO SUB 2 AND 2.2×10^{-17} CM²/SEC FOR UC FOR A FISSION RATE S OF 1×10^{13} F/CM³/SEC REPRESENT RADIATION ENHANCED DIFFUSION AND ARE HIGHER BY FACTORS OF 10^3 TO 10^4 THAN (EXTRAPOLATED) COEFFICIENTS OF THERMAL DIFFUSION. THE DATA ARE OF IMMEDIATE RELEVANCE FOR UNDERSTANDING AND PREDICTING SUCH IMPORTANT QUANTITIES AS IN-PILE SINTERING AND DENSIFICATION, DIFFUSION CONTROLLED CREEP AND FISSION GAS BEHAVIOR IN THE OUTER ZONES OF THE FUEL. THEY ARE AT THE UPPER LIMIT OF EXPECTED VALUES.

ABSTRACT 307

HOLDEN R B

TRANS AM NUCL SOC 11, 511 (1968)

A FUNDAMENTAL STUDY OF THE COMPATIBILITY OF STAINLESS STEEL AND MIXED CARBIDE FUEL

THE THERMODYNAMIC COMPATIBILITY WITH RESPECT TO CARBON TRANSPORT WAS MEASURED FOR THREE U-PU CARBIDE COMPOSITIONS IN CONTACT WITH STAINLESS STEEL. THE RESULTS INDICATE THAT (U SUB 0.85 PU SUB 0.15) -C SINGLE-PHASE IS THERMODYNAMICALLY COMPATIBLE WITH THE REFERENCE STAINLESS STEEL AT 800 DEG C, WHEREAS MC + 14 VOL% M SUB 2 C SUB 3 AND SINGLE PHASE (U SUB 0.85 PU SUB 0.15) SUB 2 C SUB 3 ARE NOT.

ABSTRACT 308

HOLLECK H

J NUCL MATER 32, 1 (1969)

THERMODYNAMIC OF MULTI-COMPONENT SYSTEMS CONTAINING UC AND PUC A REVIEW

ISOTHERMAL AND CONCENTRATION SECTIONS OF THE PHASE DIAGRAMS OF TERNARY AND QUATERNARY SYSTEMS U-M-C, PU-M-C, U-PU-M-C, U-M SUB 1-M SUB 2-C, AND PU-M SUB 1-M SUB 2-C ARE DESCRIBED. THE MISCIBILITY OF UC AND PUC WITH OTHER BINARY CARBIDES IS DISCUSSED AND THE FREE ENTHALPIES OF MIXING ARE GIVEN. THE TERNARY AND QUATERNARY CARBIDES AND THEIR LATTICE CONSTANTS ARE COMPILED. THE FREE ENTHALPIES OF FORMATION OF THESE COMPOUNDS ARE ESTIMATED FROM THE PHASE DIAGRAMS.

ABSTRACT 309

HOLLEY C E JR

J NUCL MATER 51, 36 (1974)

THERMODYNAMIC PROPERTIES OF ACTINIDE CARBIDES

THIS PAPER IS A SURVEY OF THE LITERATURE ON THE THERMODYNAMIC PROPERTIES OF THE ACTINIDE CARBIDES SINCE THE REVIEW OF HOLLEY AND STORMS(1967). FOR URANIUM SESQUICARBIDE AND PLUTONIUM MONOCARBIDE THERE ARE SUFFICIENT NEW DATA TO PERMIT COMPUTATION OF THE RELEVANT THERMODYNAMIC FUNCTIONS AS A FUNCTION OF TEMPERATURE.

ABSTRACT 310

HOLLEY C E JR

THERM NUCL MATER (1967)

ACTINIDE CARBIDES: A REVIEW OF THERMODYNAMIC PROPERTIES

IN THIS PAPER WE TRY TO GIVE AN INDICATION OF THE PRESENT STATE OF KNOWLEDGE OF THERMODYNAMIC PROPERTIES OF THE ACTINIDE CARBIDES AND TO POINT OUT THOSE AREAS IN WHICH FURTHER WORK IS NEEDED

ABSTRACT 311

HOLT J B

J AM CERAM SOC 52, 631 (1969)

NITROGEN DIFFUSION IN URANIUM NITRIDE AS MEASURED BY ALPHA PARTICLE ACTIVATION OF ^{15}N

A NEW TECHNIQUE, BASED ON THE NUCLEAR ACTIVATION REACTION $^{15}\text{N}(\alpha, n)^{18}\text{F}$, WAS USED TO MEASURE NITROGEN SELF-DIFFUSION COEFFICIENTS IN UN. TEMPERATURES WERE 1700 DEG C TO 2000 DEG C AND N SUB 2 PRESSURES 7 TO 603 TORR. THE DIFFUSION COEFFICIENTS WERE IN FAIR AGREEMENT WITH THOSE OBTAINED BY THE GASEOUS EXCHANGE METHOD IN AN INDEPENDENT STUDY. NO FUNDAMENTAL SIGNIFICANCE WAS ATTACHED TO THE ACTIVATION ENERGY BECAUSE UN IS NON-STOICHIOMETRIC UNDER THESE CONDITIONS, AND THE RELATION BETWEEN COMPOSITION AND N SUB 2 PRESSURE IS UNKNOWN. THE RESULTS ARE COMPATIBLE WITH NITROGEN INTERSTITIAL DIFFUSION.

ABSTRACT 312

HONDA T

J NUCL SCI AND TECHNOL 6, 221 (1969)

POROSITY DEPENDENCE OF ELASTIC MODULUS OF URANIUM NITRIDE

ROOM TEMPERATURE ELASTIC MODULUS WAS MEASURED AS A FUNCTION OF POROSITY FOR SPECIMENS HAVING 3 TO 30 VOL. % POROSITY. THE MODULUS DECREASED LINEARLY BY A FACTOR OF TWO. AGREEMENT WITH OTHER DATA IS GOOD.

ABSTRACT 313

HCRSPOLL J M

PROCEEDINGS OF IAEA SYMP ON FUEL AND FUEL ELEMENTS FOR FAST REACTORS JULY 2-6, (1973)

FUEL MATERIALS FOR FAST REACTORS

STUDIES ARE PRESENTED OF THE EFFECTS OF COMPOSITIONAL VARIATIONS IN MIXED URANIUM-PLUTONIUM OXIDE AND CARBIDE FUELS ON THEIR PHYSICAL AND CHEMICAL PROPERTIES AND THEIR RELEVANCE TO IRRADIATION BEHAVIOR. THE MAJOR PARAMETERS CONSIDERED ARE COMPOSITION (O/M RATIO IN OXIDE, C/O/M RATIO IN CARBIDES), ADDITIVES AND IMPURITIES ARISING FROM FUEL FABRICATION OPERATIONS AND COMPOSITIONAL CHANGES RESULTING FROM NEUTRON IRRADIATION. THEORETICAL AND EXPERIMENTAL DATA ARE GIVEN ON THERMAL DIFFUSIVITY AND CREEP, ON FUEL-CLAD REACTION, AND ON VAPORIZATION, SEGREGATION AND MASS TRANSFER PHENOMENA IN FUEL ELEMENTS.

ABSTRACT 314

HOUYVET A

DP-REPORT 69

THE PRESENT STATUS OF THE SYSTEM U-TH-C

FROM FUSION EXPERIMENTS OF URANIUM IN GRAPHITE CRUCIBLES, A ROUGH ESTIMATE OF THE VALUE OF THE GLOBAL DIFFUSION COEFFICIENT OF U AND C IN UC AND UC SUB 2 IS GIVEN BETWEEN THE TEMPERATURE RANGE OF 1600 TO 1980 DEG C. ALSO LISTED ARE THE PROPERTIES SUCH AS DENSITY, MELTING POINT, CRYSTAL STRUCTURE, HARDNESS, HEAT OF FORMATION, FREE ENERGY OF FORMATION, THERMAL EXPANSION, ELECTRICAL RESISTIVITY, THERMAL CONDUCTIVITY HEAT CAPACITY ETC FOR UC, U SUB 2 C SUB 3 AND UC SUB 2. URANIUM-CARBON CONSTITUTIONAL DIAGRAM IS ALSO GIVEN.

ABSTRACT 315

HUBBARD W N

TID-15554 (1962)

THERMOCHEMICAL STUDIES AT ARGONNE NATIONAL LABORATORY.

ACTIVITIES IN A PROGRAMME TO OBTAIN THERMODYNAMIC DATA ON COMPOUNDS OF INTEREST IN HIGH-TEMPERATURE CHEMISTRY ARE REPORTED. RECENT DETERMINATIONS WERE MADE CONCERNING THE HEATS OF FORMATION OF UN, ZRH SUB 2, AND ZRD SUB 2 USING OXYGEN BOMB CALORIMETRY. OTHER RESULTS OBTAINED BY FLUORINE BOMB CALORIMETRY ON TIF SUB 4, HFF SUB 4, AND SIF SUB 4 ARE ALSO REPORTED.

ABSTRACT 316

HUBER E J JR

J CHEM THERMO 1, 579 (1969)

ENTHALPY OF FORMATION OF URANIUM SESQUICARBIDE

THE ENTHALPY OF FORMATION OF URANIUM SESQUICARBIDE HAS BEEN DETERMINED BY MEANS OF OXYGEN BOMB CALORIMETRY AND FOUND TO BE ΔH DEG F (U SUB 2 C SUB 3, 298.15K) = (43.4 ± 1.8) KCAL/MOL.

ABSTRACT 317

HUBER E J JR

J PHYS CHEM 67, 1730 (1963)

THE HEAT OF FORMATION OF URANIUM DICARBIDE

AN INDIRECT EXPERIMENTAL DETERMINATION WAS MADE OF THE HEAT OF FORMATION OF URANIUM DICARBIDE, UC SUB 1.90, FROM MEASUREMENTS OF ITS HEAT OF COMBUSTION IN OXYGEN. CALCULATED VALUES OF THE HEATS OF FORMATION FOR THREE SERIES OF RUNS WERE -19.7 ± 2.0 , -18.6 ± 1.9 , AND -21.1 ± 1.4 KCAL/MOLE. THE VALUE ΔH SUB F = -21.1 ± 1.4 KCAL/MOLE WAS TAKEN FOR THE HEAT OF FORMATION OF UC SUB 1.90.

ABSTRACT 318

HUBER E J JR

LADC-5176 (1961)

SOME THERMODYNAMIC PROPERTIES OF THE ACTINIDE CARBIDES INCLUDING NEW MEASUREMENTS OF THE HEATS OF FORMATION OF SOME THORIUM, URANIUM AND PLUTONIUM CARBIDES

THE PRESENT STATE-OF-KNOWLEDGE ABOUT THE HEATS, FREE ENERGIES, AND ENTROPIES OF THE CARBIDES OF TH, U, AND PU IS REVIEWED, AND THE EXPERIMENTAL MEASUREMENT OF THE HEATS OF FORMATION OF ThC , U SUB 2 C SUB 3 , UC SUB 1.86 , AND PUC SUB 0.77 IS DESCRIBED. SOME DETAILED CALCULATIONS LEADING TO ESTIMATES OF THE FREE ENERGIES OF FORMATION AT DIFFERENT TEMPERATURES ARE APPENDED.

ABSTRACT 319

HUBER E J JR

THERMO NUCL MATER, P591 (1962)

THE THERMODYNAMIC PROPERTIES OF THE ACTINIDE CARBIDES INCLUDING NEW MEASUREMENTS OF THE HEATS OF FORMATION OF SOME THORIUM, URANIUM AND PLUTONIUM CARBIDES

THE CARBIDES OF THORIUM, URANIUM AND PLUTONIUM ARE BECOMING OF INCREASING TECHNICAL IMPORTANCE WITH THE DEVELOPMENT OF NUCLEAR REACTORS OF VARIOUS DESIGNS AS WELL AS FOR OTHER PURPOSES. THE CARBIDES OF THE OTHER ACTINIDE ELEMENTS ARE OF LITTLE PRACTICAL IMPORTANCE AS YET BUT ARE OF GREAT SCIENTIFIC INTEREST. IN THIS PAPER AN EFFORT IS MADE TO DESCRIBE THE PRESENT STATE KNOWLEDGE OF THE THERMODYNAMIC AND SOME RELATED PROPERTIES OF THE ACTINIDE CARBIDES. THESE WILL INCLUDE METHODS OF PREPARATION, PHASE DIAGRAMS, MELTING POINTS, CRYSTAL STRUCTURES, SPECIFIC HEATS, ENTROPIES, HEATS OF FORMATION, ENTROPIES OF FORMATION AND FREE ENERGIES OF FORMATION. RESULTS ON EXPERIMENTS WHICH ARE NOW IN PROGRESS ARE PRESENTED ON THE HEATS OF COMBUSTION OF ThC , U SUB 2 C SUB 3 , UC SUB 2 AND PUC AND THE HEATS OF FORMATION OF THESE COMPOUNDS CALCULATED FROM THEIR HEATS OF COMBUSTION. ALL RESULTS, NEW AND OLD, ARE DISCUSSED CRITICALLY FROM THE VIEWPOINT OF PURITY OF MATERIALS, ADEQUACY OF TECHNIQUE AND ACCURACY OF MEASUREMENTS AND SUGGESTED UNCERTAINTY INTERVALS TO BE ATTACHED TO THE NUMBERS WILL BE GIVEN. SUGGESTIONS ARE ALSO MADE FOR FUTURE INVESTIGATIONS. THE BINARY AND HIGHER CARBIDE SYSTEMS OF THE ACTINIDE CARBIDES ARE DISCUSSED TO THE EXTENT THAT INFORMATION ABOUT THEM IS AVAILABLE.

ABSTRACT 320

HUEBOTTER P R

ANL-MEMO (1973)

COMPARISON OF $(\text{U}, \text{PU})\text{C}$ AND $(\text{U}, \text{PU})\text{N}$ AS FAST REACTOR FUEL

AT THE OUTSET OF THE STUDY IT WAS DECIDED TO COMPARE CARBIDE WITH NITRIDE ON THE FOLLOWING BASES: 1. THERMAL PROPERTIES 2. NEUTRONIC PROPERTIES 3. COMPATIBILITY WITH Fe-Cr-Ni CLADDING MATERIALS 4. FABRICATION COST 5. IRRADIATION BEHAVIOR

ABSTRACT 321

MULTGREN P

SELECTED VALUES OF THE THERMODYNAMIC PROPERTIES OF BINARY ALLOYS (1973)
SELECTED VALUES OF THE THERMODYNAMIC PROPERTIES OF BINARY ALLOYS

LITERATURE REVIEW ON U-C SYSTEM. BESIDES PHASE DIAGRAM FOR U-C SYSTEM, THERMODYNAMIC PROPERTIES SUCH AS SPECIFIC HEAT, ENTHALPY, AND ENTROPY ARE GIVEN FROM 1 DEG TO 2600 DEG K FOR VARIOUS URANIUM CARBIDES.

ABSTRACT 322

IHARA S

J NUCL MATER 39, 311 (1971)

HIGH-TEMPERATURE THERMAL LATTICE EXPANSION OF MIXED CARBONITRIDE AND URANIUM CARBONITRIDE

THERMAL EXPANSION COEFFICIENTS OF URANIUM-20 AT.% CERIUM CARBONITRIDES WERE MEASURED BETWEEN THE TEMPERATURE RANGE FROM ROOM TEMPERATURE TO ABOUT 1600 DEG C OR ABOVE. THE VARIATION OF LATTICE PARAMETERS WAS MEASURED BY MEANS OF A HIGH-TEMPERATURE X-RAY DIFFRACTOMETER. IN EVERY CASE, THE OBSERVED MEAN EXPANSION COEFFICIENTS REMAINED CONSTANT BETWEEN ROOM TEMPERATURE AND ABOUT 1500 DEG C. THE CALCULATED MEAN EXPANSION WAS 9.95×10^{-6} , 9.55×10^{-6} , AND 8.92×10^{-6} DEG C, RESPECTIVELY, FOR C/N = 0.67, 0.55, AND 0.50. THE COEFFICIENTS OF URANIUM CARBONITRIDE AND URANIUM NITRIDE ALSO HAD A CONSTANT VALUE OF 9.17×10^{-6} AND 6.91×10^{-6} DEG C, RESPECTIVELY, OVER A WIDE TEMPERATURE RANGE.

ABSTRACT 323

IHARA S

J NUCL SCI TECHNOL (TOKYO) 10,106 (1973)

COMPATIBILITY STUDY FOR VANADIUM-BASE CLADDING MATERIALS WITH CERAMIC FUELS

REACTIVITY AND COMPATIBILITY STUDIES WERE CARRIED OUT ON SOME VANADIUM-BASE ALLOYS WITH CERAMIC FUEL MATERIALS, THE VANADIUM-BASE ALLOYS STUDIED WERE V-20% TI, V-15% TI-7.5% CR, AND V-5% CR. THE FUEL MATERIALS WITH WHICH THESE ALLOYS WERE PUT IN CONTACT WERE UC, UN, (U,CE) N AND (U,CE) (C,N). EXPERIMENTS WERE CARRIED OUT AT 700 AND 900 DEG C FOR BOTH 500 AND 1,000 H. WITHIN THE CONDITIONS STUDIED, V-5% CR SHOWED GOOD COMPATIBILITY WITH ALL OF THESE FUEL MATERIALS. AT 700 DEG C, NO DETECTABLE INTERACTION WAS OBSERVED BETWEEN ANY OF THE ALLOY/FUEL COMBINATIONS.

ABSTRACT 324

IMOTO S

CARBIDES IN NUCL ENERGY, HARWELL A10 (1963)

STUDIES ON URANIUM DICARBIDE AND URANIUM SESQUICARBIDE

EXPERIMENTS WERE CARRIED OUT TO DETERMINE THE COMPOSITION OF UC SUB 2 BY CARBON ANALYSIS, X-RAY DIFFRACTION METHODS AND METALLOGRAPHIC INVESTIGATION OF SINTERED URANIUM CARBIDES OF DIFFERING CARBON CONTENTS NEAR THE UC SUB 2 COMPOSITION. THE RESULTS SUGGEST THAT CUBIC UC SUB 2 IS MORE ACCURATELY REPRESENTED BY THE FORMULA UC SUB (1.86 # 0.02) (8.6 # 0.1 WT. % C). IT WAS FOUND THAT TETRAGONAL UC SUB 2 CONTAINED SLIGHTLY MORE CARBON THAN CUBIC UC SUB 2, AND CORRESPONDED TO THE FORMULA UC SUB 1.96 # 0.04. THE U-C PHASE DIAGRAM NEAR THE UC SUB 2 COMPOSITION WAS REVISED ON THE BASIS OF THESE RESULTS. THE KINETICS OF THE TRANSFORMATION

ABSTRACT 324 (CONT'D)

OF CUBIC UC SUB 2 TO TETRAGONAL UC SUB 2 SUGGEST THAT THIS IS A DIFFUSIONLESS MARTENSITIC TRANSFORMATION. EXPERIMENTS WERE PERFORMED TO STUDY THE CRITICAL TEMPERATURE BELOW WHICH THE DECOMPOSITION OF TETRAGONAL UC SUB 2 INTO U SUB 2 C SUB 3 + C TAKES PLACE. THIS TEMPERATURE WAS FOUND TO BE BETWEEN 1500 DEG AND 1600 DEG C. THE REACTION $UC + UC \text{ SUB } 2 = U \text{ SUB } 2 \text{ C SUB } 3$, TAKES PLACE SIMULTANEOUSLY IN CARBIDES OF SUITABLE COMPOSITION, AND WAS FOUND TO PROCEED MORE RAPIDLY THAN THE DECOMPOSITION REACTION BELOW THIS TEMPERATURE RANGE. THE FACTORS AFFECTING THESE TWO REACTIONS HAVE BEEN INVESTIGATED.

ABSTRACT 325

IMOTO S

J NUCL MATER 51, 106 (1974)

THERMODYNAMICS APPLIED TO COMPATIBILITY OF UN WITH NI, CR, AND FE

THE COMPATIBILITY OF UN WITH NI, CR AND FE HAS BEEN STUDIED FROM THE VIEWPOINT OF PHASE EQUILIBRIUM RELATIONSHIPS. THE FREE ENERGIES OF FORMATION OF UN SUB 5 AND U SUB 2 CR N SUB 3 HAVE BEEN DETERMINED FROM THE MEASUREMENT OF EQUILIBRIUM PRESSURES OF NITROGEN FOR THE REACTIONS, $U \text{ SUB } 2 \text{ N SUB } 3 + 10 \text{ NI} = 2U \text{ NI SUB } 5 + 3/2 \text{ N SUB } 2$ AND $U \text{ SUB } 2 \text{ CR N SUB } 3 = 2UN + 1/4 \text{ N SUB } 2$, RESPECTIVELY, AND THE VALUES ARE EXPRESSED BY $\Delta G(U \text{ NI SUB } 5) = -67650 + 22.9T$, $\Delta G(U \text{ SUB } 2 \text{ CR N SUB } 3) = -165900 + 54.64T$. COMBINATION OF THESE AND OTHER THERMODYNAMIC DATA WITH SOME ADDITIONAL EXPERIMENTAL WORK HAS GENERATED A LOG P VERSUS 1/T DIAGRAM WHICH SHOWS THE PHASE RELATIONSHIPS IN THE U-N-NI-CR SYSTEM, IT IS CONCLUDED THAT UN IS NOT COMPATIBLE WITH NI AND CR SIMULTANEOUSLY BUT, FOR PRACTICAL PURPOSES, IS COMPATIBLE WITH FE BELOW 1400 DEG C.

ABSTRACT 326

IMOTO S

THERMODYNAMICS, P533 (1966)

PREPARATION OF URANIUM MONONITRIDE BY THE REACTION OF URANIUM DIOXIDE WITH CARBON AND NITROGEN.

URANIUM MONONITRIDE HAS RECENTLY ATTRACTED INCREASING INTEREST AS A POTENTIAL HIGH-TEMPERATURE NUCLEAR FUEL. FOR LABORATORY USE THE MONONITRIDE HAS BEEN PREPARED FROM THE ELEMENTS, BUT A SUITABLE METHOD FOR INDUSTRIAL PRODUCTION WOULD INVOLVE THE REACTION OF URANIUM DIOXIDE WITH CARBON AND NITROGEN, FOLLOWING THE THEORETICAL EQUATION $UO_2 + 2C + 1/2N_2 = UN + 2CO$. HOWEVER, AS THE HYPOTHETICAL URANIUM MONOXIDE (UO) SHOWS AN APPRECIABLE SOLUBILITY IN BOTH UN AND UC, ONE OBTAINS NOT THE PURE MONONITRIDE BUT A SOLID SOLUTION OF THE COMPOSITION UN SUB 1-X-Y C SUB X O SUB Y. THE RESULTS OF THERMODYNAMIC CALCULATIONS ARE PRESENTED, AND THESE SHOW THE RANGE OF THE ONE-PHASE REGION AS A FUNCTION OF TEMPERATURE AND PARTIAL PRESSURES OF CO AND N SUB 2 AS WELL AS THE MAXIMUM OBTAINABLE PURITY OF UN UNDER DIFFERENT CONDITIONS. ASSUMPTIONS FOR THE NON-REGULAR BEHAVIOR OF THE SOLID SOLUTION ARE DISCUSSED. ANALOGOUS CALCULATIONS HAVE BEEN CARRIED OUT FOR THE SOLID SOLUTIONS UN SUB 1-X C SUB X AND VALUES FOR THE STABILITY RANGE AND THE EXPECTED PURITIES HAVE BEEN OBTAINED. EXPERIMENTAL RESULTS ARE PRESENTED WHICH ARE IN GOOD AGREEMENT WITH THE CALCULATED VALUES.

ABSTRACT 327

INOUE H

J AMER CERAM SOC 51, 6 (1968)

EQUILIBRIUM NITROGEN PRESSURES AND THERMODYNAMIC PROPERTIES OF UN.

PRESSURES OF NITROGEN OVER UN(S) + U(1) WERE MEASURED AT 1300 AND 1500 DEG C. THESE DATA, COUPLED WITH LITERATURE DATA, EXTEND THE MEASURED RANGE OF PRESSURES TO NEARLY 11 ORDERS OF MAGNITUDE AND 1550 CENTIGRADE DEGREES. THE BEST VALUE OF ΔH DEG SUB 298, F UN FROM THE AVAILABLE DATA IS TAKEN TO BE -69.6#1.0 KCAL/MOLE. THE SECOND AND THIRD LAW CALCULATIONS AGREE SATISFACTORILY.

ABSTRACT 328

INTERNATIONAL ATOMIC ENERGY AGENCY VIENNA

IAEA TECH REP SER NO 14 (1963)

THE URANIUM-CARBON AND PLUTONIUM-CARBON SYSTEMS: A THEORETICAL ASSESSMENT

THERMODYNAMIC DATA REPORTED BY VARIOUS LABORATORIES ON U-C AND PU-C SYSTEMS ARE REPORTED. EFFORTS WERE MADE TO RESOLVE VARIOUS DISCREPANCIES. SECTIONS ARE INCLUDED ON PREPARATION OF URANIUM CARBIDES, PHASE DIAGRAMS, HEAT CAPACITIES AND THERMAL PROPERTIES OF THE ACTINIDE CARBIDES, HEAT OF FORMATION OF THE URANIUM CARBIDES, VAPORIZATION STUDIES, HIGH-TEMPERATURE EQUILIBRIUM MEASUREMENTS AND THE PU-C SYSTEM.

ABSTRACT 329

IVANOV V E

THERMO NUCL MATER, P735 (1962)

THE VAPOR PRESSURE OF URANIUM COMPOUNDS

VAPOR PRESSURE MEASUREMENTS WERE CARRIED OUT ON USN SUB 3 AT 1025 DEG AND ON UO SUB 2 AT 1650-1930 DEG FROM RATES OF EVAPORATION FROM A CYLINDRICAL CRUCIBLE. DATA WERE GIVEN BY USN SUB 3 $\log P$ (MM) = $9067 - (17233/T)$, UC $\log P$ (MM) = $21306 - (49200/T)$, AND UO SUB 2 $\log P$ (MM) = $12096 - (32150/T)$. HEATS OF SUBLIMATION: USN SUB 3 78.8 AND UO SUB 2 143 KCAL/MOLE.

ABSTRACT 330

JACOBY W R

WCAP-3791-3 (1967)

COMPATIBILITY OF STABILIZED HYPOSTOICHIOMETRIC URANIUM-PLUTONIUM MONOCARBIDE FUELS WITH STAINLESS STEEL

UNSTABILIZED, FE-STABILIZED, AND CR SUB 23 C SUB 6-STABILIZED HYPOSTOICHIOMETRIC (U SUB 0.8 PU SUB 0.2) FUEL PELLETS WERE FABRICATED AND CHARACTERIZED. COMPATIBILITY COUPLES OF STABILIZED AND UNSTABILIZED FUEL PELLETS VERSUS TYPE-304 STAINLESS STEEL PELLETS WERE TESTED FOR A MINIMUM OF 1000 HOURS AT 800 DEG C IN BOTH HE AND NA ENVIRONMENTS. NO FUEL-CLADDING INTERACTIONS WERE OBSERVED AT TERMINATION OF THE TESTS ON THE BASIS OF METALLOGRAPHIC EVALUATION.

ABSTRACT 331

JAKESOVA L

ATOMIC ENERGY REV 1, 3 (1963)

CARBIDES, NITRIDES AND SILICIDES OF URANIUM AS PROMISING NUCLEAR FUEL

NEW FORMS OF NUCLEAR FUEL - CARBIDES, MONONITRIDE AND SILICIDES OF URANIUM - ARE OPENING UP NEW WAYS OF DEVELOPING HIGH-TEMPERATURE REACTORS. THE REVIEW DISCUSSES THE CHEMICAL, PHYSICAL AND MECHANICAL PROPERTIES OF THESE COMPOUNDS; TECHNIQUES FOR OBTAINING AND COMPACTING UC, UC SUB 2, UN AND URANIUM SILICIDES, AND THEIR BASIC CERMETS; WAYS IN WHICH THEY ARE USED IN REACTORS; AND POSSIBLE FUEL-ELEMENT CANNING MATERIALS. RESISTANCE TO RADIATION IS EVALUATED ON THE BASIS OF THE STUDIES CARRIED OUT. FINAL JUDGEMENT ON THE MERITS AND DRAWBACKS OF THESE MATERIALS WILL HAVE TO AWAIT THE RESULT OF FURTHER INVESTIGATION. THIS IS PARTICULARLY THE CASE WITH THE NITRIDES AND SILICIDES.

ABSTRACT 332

JOHNSON G K

J CHEM THERMO 1, 89 (1969)

THE ENTHALPIES OF FORMATION OF PUO SUB 2 AND PUN

THE ENERGIES OF COMBUSTION IN OXYGEN OF X-PLUTONIUM METAL AND PLUTONIUM MONONITRIDE WERE MEASURED IN A BOMB CALORIMETER. THE STANDARD ENTHALPIES OF FORMATION ΔH SUB F (298.15K), OF PUO SUB 2 (C) AND PUN(C) WERE CALCULATED TO BE $-(1055.85 \pm 0.72)$ KJ/MOL (-252.35 ± 0.17) KCAL/MOL AND $-(299.2 \pm 2.6)$ KJ/MOL (-71.51 ± 0.62) KCAL/MOL, RESPECTIVELY.

ABSTRACT 333

JOHNSON G K

J CHEM THERMO 2, 617 (1970)

THE ENTHALPY OF FORMATION OF PUC

THE ENERGY OF COMBUSTION IN OXYGEN OF A SPECIMEN OF ARC-MELTED PLUTONIUM MONOCARBIDE (PUC SUB (0.878 $\pm$ 0.003)) WAS MEASURED IN A BOMB CALORIMETER. THE STANDARD ENTHALPY OF FORMATION, ΔH SUB F DEG (PUC SUB (0.878 $\pm$ 0.003, C, 298.15K) WAS CALCULATED TO BE $-(11.41 \pm 0.68)$ KCAL/MOL.

ABSTRACT 334

JOHNSON G K

J CHEM THERMO 6, 219 (1974)

THE ENTHALPY OF FORMATION OF PLUTONIUM SESQUICARBIDE

THE ENERGY OF COMBUSTION IN OXYGEN OF A SAMPLE OF PLUTONIUM SESQUICARBIDE HAVING A COMPOSITION PUC SUB 1.467 $\pm$ 0.009 WAS MEASURED IN A BOMB CALORIMETER. THE STANDARD ENTHALPY OF FORMATION, ΔH SUB F (PUC SUB 1.467 $\pm$ 0.009), 299.15K WAS DETERMINED TO BE $-(19.80 \pm 0.97)$ KCAL/MOLE.

ABSTRACT 335

JOHNSON K D B

AERE-R-4260 (1964)

REPORT OF A HIGH-TEMPERATURE REACTOR FUEL DISCUSSION GROUP

THE RESULTS OF A DISCUSSION GROUP ON REQUIREMENTS FOR FUTURE RESEARCH AND DEVELOPMENT IN HIGH-TEMPERATURE REACTOR FUELS, BASED MAINLY ON COATED FUEL MATERIAL, ARE PRESENTED. PARTICULAR EMPHASIS IS PLACED ON GRAPHITE-MODERATED SYSTEMS HAVING CARBIDE-BASED FUEL; OXIDES ARE CONSIDERED IN LESS DETAIL. PHASE STABILITY, THERMAL CONDUCTIVITIES, DIFFUSION, AND FISSION-PRODUCT RETENTION CHARACTERISTICS OF SEVERAL FUELS ARE DISCUSSED. URANIUM-THORIUM-GRAPHITE, URANIUM-THORIUM-CARBON, PYROLYTIC GRAPHITES, URANIUM DICARBIDES, AND CARBIDE COATINGS ARE DISCUSSED.

ABSTRACT 336

JOHNSON K W R

TRANS AM NUCL SOC 12,591 (1969)

THE THERMAL CONDUCTIVITY OF (U,PU)C

MEASUREMENTS WERE MADE WITH A COMPARATIVE TYPE APPARATUS IN THE TEMPERATURE RANGE 100 TO 1000 DEG C, TO EXAMINE THE EFFECT OF POROSITY ON THERMAL CONDUCTIVITY OF PURE, SINGLE-PHASE U SUB 0.8 PU SUB 0.2 C. THE DENSITIES AND THE LATTICE PARAMETERS WERE ALSO DETERMINED FOR EACH SPECIMEN.

ABSTRACT 337

JORDAN K R

ANL-7120, P301 (1965)

COMPATIBILITY OF MODIFIED CARBIDE FUELS WITH STAINLESS STEEL

THE POSSIBILITY THAT THE COMPATIBILITY OF LIQUID-METAL-BONDED NON-STOICHIOMETRIC MIXED MONOCARBIDE (U,PU)C FAST BREEDER REACTOR FUELS WITH STAINLESS STEEL MIGHT BE IMPROVED BY ADDITIONS OF FE, CR, UFE SUB 2, OR CR SUB 23 C SUB 6 WAS STUDIED. THE POLYPHASE COMPOSITIONS RESULTING FROM HEAT TREATMENT INCLUDED NO LOW-MELTING EUTECTIC FORMERS OR UNSTABLE HIGHER CARBIDES. MODIFIED COMPOSITIONS WERE SUCCESSFULLY PELLETIZED BY COLD PRESSING AND SINTERING. IMPROVED COMPATIBILITY WAS EXPERIMENTALLY DEMONSTRATED IN AIR AND LIQUID METAL ENVIRONMENTS BETWEEN CONTACT-BONDED, IRON-MODIFIED, INITIALLY HYPOSTOICHIOMETRIC UC AND TYPE 316 STAINLESS STEEL. EXPERIMENTS WITH GAS- AND NA-BONDED CR SUB 23 C SUB 6 -MODIFIED COMPOSITIONS ARE IN PROGRESS.

ABSTRACT 338

KAMIMOTO M

J PHYS CHEM SOLIDS 35, 393 (1974)

THERMAL CONDUCTIVITY OF URANIUM CARBON NITRIDE (UC SUB 1-X N SUB X) FROM 100 DEG. TO 1000 DEG. K

THE THERMAL DIFFUSIVITIES OF UC SUB 1-X N SUB X OF SEVERAL COMPOSITIONS WERE MEASURED FROM 100 TO 1000 DEG K BY A LASER FLASH METHOD. THE THERMAL CONDUCTIVITY WAS SEPARATED INTO ELECTRONIC AND PHONON COMPONENTS BY ASSUMING THE CONSTANT LORENZ NUMBER. THE PHONON CONDUCTIVITY SHOWED AN ANOMALOUS BEHAVIOR AGAINST COMPOSITION AT LOW TEMPERATURES. THE TOTAL THERMAL CONDUCTIVITY OF UC SUB 1-X N SUB X SHOWED A MINIMUM ABOVE 300 DEG K AT AN INTERMEDIATE COMPOSITION WHICH MOVED TO HIGHER CARBON CONTENT

ABSTRACT 338 (CONT'D)

WITH INCREASING TEMPERATURE. THIS BEHAVIOR WAS EXPLAINED BY THE TEMPERATURE DEPENDENCE OF THE LATTICE AND ELECTRONIC COMPONENTS.

ABSTRACT 339

KATSURA M

J NUCL MATER 36, 169 (1970)

CONSIDERATION ON THE IDEALITY OF THE UC-UN SOLID SOLUTIONS

THE MONOCARBIDES AND MONONITRIDES OF URANIUM AND PLUTONIUM AS WELL AS THEIR SOLID SOLUTIONS COULD OBTAIN CERTAIN IMPORTANCE AS FUEL FOR HIGH-POWER REACTORS. FROM THE THERMOCHEMICAL POINT OF VIEW THE QUESTION WHETHER THE MIXED CARBONITRIDE CRYSTAL SHOWS IDEAL, REGULAR OR ABNORMAL BEHAVIOR IS OF DECISIVE IMPORTANCE. IN THE PRESENT PAPER THE PUBLISHED DATA ON MEASUREMENTS OF EQUILIBRIUM BETWEEN UC-UN SOLID SOLUTIONS AND NITROGEN, CARBON AND URANIUM ARE STUDIED CRITICALLY WITH THE AID OF A NEW METHOD OF CALCULATION. THE ADVANTAGE OF THIS METHOD IS THAT IT ENABLES THE ENTHALPY OF MIXING TO BE DETERMINED AS A FUNCTION OF THE TEMPERATURE AND THE SOLID SOLUTION COMPOSITION DIRECTLY FROM THE RELEVANT UC SUB 1-X N SUB X MEASUREMENT DATA, INSTEAD OF THOSE RELATING TO THE PURE UC AND UN COMPONENTS. THE PAPER ALSO DISCUSSES THE IDEAL BEHAVIOR OF THE SOLID SOLUTION SERIES ON THE BASIS OF MOLECULAR VOLUMES, WHICH ARE CALCULATED FROM THE PUBLISHED DATA. BOTH THEORETICAL CONSIDERATIONS LEAD TO THE CONCLUSION THAT THE UC SUB 1-X N SUB X SOLID SOLUTIONS DO NOT SHOW IDEAL BEHAVIOR.

ABSTRACT 340

KATSURA M

J NUCL MATER 51, 63 (1974)

INFLUENCE OF ENERGETICALLY ACTIVE CARBON ON THERMODYNAMICS AND PHASE RELATIONSHIP OF U-C-N SYSTEM

THE REACTIONS OF UN WITH GRAPHITE AND OF UN WITH ACTIVE CARBON HAVE BEEN INVESTIGATED AT 1300 DEG C AND 1400 DEG C UNDER A VARIETY OF PRESSURES OF NITROGEN GAS. RESULTS SHOW THAT, AT FIXED PRESSURE, NITROGEN CONTENT OF THE EQUILIBRIUM UC-UN SOLID SOLUTION FORMED IN THE PRESENCE OF GRAPHITE IS HIGHER THAN IN THE EQUILIBRIUM UC-UN SOLID SOLUTION FORMED IN THE PRESENCE OF ACTIVE CARBON. A BRIEF THERMODYNAMIC ARGUMENT EXPLAINS THE RESULT IN TERMS OF THE DIFFERING CHEMICAL POTENTIALS BETWEEN GRAPHITE AND ACTIVE CARBON.

ABSTRACT 341

KATSURA M

J NUCL SCI TECHNOL TOKYO 1, 22 (1964)

ON THE FORMATION OF UC SUB 1-X N SUB X

FROM THE KNOWN VALUES OF THE FREE ENERGY OF FORMATION OF SEVERAL URANIUM COMPOUNDS IN THE TERNARY SYSTEM U-C-N, THE CONDITION OF STABLE EXISTENCE, OF THE SOLID SOLUTION BETWEEN UC AND UN, UC SUB 1-X N SUB X, WAS DETERMINED; AND SEVERAL TERNARY SECTIONS WERE OBTAINED AT CONSTANT TEMPERATURE AND CONSTANT NITROGEN PRESSURE. IN ORDER TO EXAMINE THE RESULTS, SOME EXPERIMENTS WERE CARRIED OUT UNDER DIFFERENT CONDITIONS OF TEMPERATURE AND NITROGEN PRESSURE. FROM THESE RESULTS IT IS CONCLUDED THAT THE STABLE COMPOUNDS WHICH EXIST IN TERNARY SYSTEM U-C-N CHANGE FROM

ABSTRACT 341 (CONT'D)

LARGER TO SMALLER VALUE OF $(\log P(N \text{ SUB } 2))/T$ IN THE FOLLOWING ORDER: U SUB 2 N SUB 3 AND CARBON, UC SUB 1-X N SUB X AND CARBON, UC SUB 1-X N SUB X AND CARBON, AND UC SUB 1-X N SUB X, UC SUB 2 AND METALLIC URANIUM. UNDER THE CONDITION OF HIGH TEMPERATURE AND LOW PRESSURE, THAT IS, A VERY SMALL VALUE OF $(\log P(N \text{ SUB } 2))/T$, THE RANGE OF RANGE OF STABLE EXISTENCE OF THE SOLID SOLUTION, UC SUB 1-X N SUB X, IS VERY SMALL.

ABSTRACT 342

KATSURA M

J NUCL SCI TECHNOL TOKYO 3, 194 (1966)

U-C-N SYSTEM

STATISTICAL THERMODYNAMICS WERE USED TO DERIVE THERMODYNAMIC FUNCTIONS FOR THE U-C-N SYSTEM. SYSTEM COMPONENTS WERE REACTED AT 1250-1400 DEG C TO VERIFY THE CALCULATIONS. A HEAT OF MIXING TERM (-1.3 KCAL/MOLE FOR SOLID SOLUTION MIXING BETWEEN UC AND UN) IS REQUIRED TO FIT CALCULATED VALUES TO EXPERIMENTAL.

ABSTRACT 343

KATSURA M

TECHNOLOGY REP OSAKA UNIV 14, 590 (1964)

THE SYSTEM U-C-N

A THERMODYNAMIC STUDY WAS MADE IN ORDER TO CONSTRUCT QUALITATIVELY THE EQUILIBRIUM PHASE DIAGRAM OF THE SYSTEM U-C-N. FOR THE KNOWN VALUES OF THE FREE ENERGY OF FORMATION OF SEVERAL U COMPOUNDS IN THE SYSTEM U-C-N THE STABILITY OF THE SOLID SOLUTION BETWEEN UC AND UN, UC SUB 1-X N SUB X, WAS DETERMINED, AND SEVERAL TERNARY SECTIONS WERE OBTAINED AT CONSTANT TEMPERATURE AND CONSTANT PRESSURE OF N GAS. TO EVALUATE THESE RESULTS EXPERIMENTS WERE CARRIED OUT UNDER SEVERAL DIFFERENT CONDITIONS OF TEMPERATURE AND N PRESSURE. GOOD AGREEMENT BETWEEN THE CALCULATED AND EXPERIMENTAL RESULTS WAS FOUND.

ABSTRACT 344

KATZ S

J NUCL MATER 6, 1728 (1962)

HIGH TEMPERATURE REACTIONS BETWEEN REFRACTORY URANIUM COMPOUNDS AND METALS.

SOLID-SOLID REACTIONS OF VARIOUS METALS (AL, CR, FE, MO, NB, NI, TH, TI, V, ZR, AND 304 STAINLESS STEEL) WITH REFRACTORY URANIUM COMPOUNDS (UC, UC SUB 2, AND UN) WERE INVESTIGATED AT ELEVATED TEMPERATURES, THE RATES OF GROWTH OF REACTION ZONES WERE MEASURED, AND THE PRODUCTS OF REACTION OF SOME OF THE MORE REACTIVE SYSTEMS WERE IDENTIFIED.

ABSTRACT 345

KELLER D L

BMI-X-10027 (1963)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1962.

EURAEC-10027, BATTELLE MEMORIAL INST., COLUMBUS, OHIO AND UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

THE THERMAL DIFFUSIVITY OF UN WAS MEASURED TO OBTAIN THERMAL CONDUCTIVITY ABOVE 1000 DEG C. IN THESE TESTS A SMALL SPECIMEN IS GIVEN A PULSE OF HEAT WITH A LASER. INITIAL RESULTS SHOW GOOD AGREEMENT WITH THERMAL CONDUCTIVITY VALUES OBTAINED BY A LONGITUDINAL HEAT-FLOW METHOD. AT HIGH TEMPERATURE, SURFACE OXIDATION OF THE UN CAUSES A LARGE DROP IN THERMAL DIFFUSIVITY. STUDIES ON MELTING AND CASTING OF UN HAVE CENTRED AROUND DEVELOPING CONSUMABLE-ELECTRODE PROCEDURES. MINOR ADDITIONS OF IRON, NICKEL, AND PERHAPS NIOBIUM HAVE IMPROVED THE QUALITY OF CONSUMABLE-ELECTRODE-MELTED UN BY REDUCING THE AMOUNT OF VOIDS AND HIGH NITRIDE ACCUMULATIONS. EFFECTS OF ARC DISTANCE AND ARC VOLTAGE, SPECIMEN DIAMETER, AND HEARTH GEOMETRY ON THE QUALITY OF MELTED AND CAST UN WERE STUDIED. THE EQUILIBRIUM NITROGEN PRESSURE AT 800 DEG C WAS DETERMINED FOR A SERIES OF COMPOSITIONS BETWEEN U SUB 2 N SUB 3 AND UN SUB 2. ON THE BASIS OF VARIATIONS IN NITROGEN PRESSURE WITH COMPOSITIONS IT IS CONCLUDED THAT A SOLID-SOLUTION REGION EXISTS BETWEEN U SUB 2 N SUB 3 AND UN SUB 2.

ABSTRACT 346

KELLER D L

BMI-X-10041 (1963)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1963. FURAEC-651, BATTELLE MEMORIAL INST., COLUMBUS, OHIO AND UNITED STATES- EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

A STUDY WAS MADE OF THE TWO-PHASE IMPURITY INCLUSIONS THAT FREQUENTLY APPEAR IN HOT ISOSTATICALLY PRESSED UN BUT AT A LEVEL NOT IDENTIFIABLE BY X-RAY ANALYSIS. IT APPEARS THAT THE IMPURITIES ARE CARRIED THROUGH THE VARIOUS PROCESSING STEPS, PERHAPS FROM THE ORIGINAL U METAL. EQUILIBRIUM COMPOSITIONS IN THE U SUB 2 N SUB 3 -UN SUB 2 REGION WERE DETERMINED AS A FUNCTION OF N PRESSURE OVER A TEMPERATURE RANGE OF 700 TO 850 DEG C. FROM THESE MEASUREMENTS THE PARTIAL MOLAR FREE ENERGY OF DISSOCIATION, THE PARTIAL MOLAR ENTHALPY, AND THE PARTIAL MOLAR ENTROPY WERE CALCULATED. STUDIES WERE ALSO MADE ON THE DETERMINATION OF URANIUM ACTIVITY IN UN, THE U LIQUIDUS LINE IN EQUILIBRIUM WITH UN, AND THE VAPOR PRESSURE OF UN. IN UN MELTING STUDIES, CONSUMABLE ARC-MELTING TECHNIQUES SHOW CONSIDERABLE PROMISE FOR PRODUCING HIGH- QUALITY UN SPECIMENS. A UN SPECIMEN WAS TESTED FOR MEASURING THE COMPOSITIONAL CHANGES THAT OCCUR AS A RESULT OF THERMAL GRADIENTS. SPECIMENS WERE ALSO PREPARED FOR UN COMPATIBILITY STUDIES IN NA-K, H SUB 2 O, AND THERPHENYL AND AGAINST STAINLESS STEEL, ZIRCALLOY-2, AND AL.

ABSTRACT 347

KELLER D L

BMI-X-10053 (1963)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, APRIL-JUNE 1963. FURAEC-795, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM

ABSTRACT 347 (CONT'D)

POWDER-METALLURGY AND MELTING TECHNIQUES HAVE BEEN DEVELOPED FOR PREPARING DENSE UN BODIES. SINTERING STUDIES IN A NITROGEN ATMOSPHERE PRODUCED LITTLE DENSIFICATION AT TEMPERATURES UP TO 2250 DEG C WITH THREE DIFFERENT TYPES OF UN POWDER. BOTH POLYCRYSTALLINE AND SINGLE-CRYSTAL UN BODIES WERE PREPARED BY CONSUMABLY MELTING URANIUM IN A NITROGEN ATMOSPHERE. GRAIN SEPARATION OBSERVED IN POLYCRYSTALLINE MATERIAL WAS NEARLY ELIMINATED BY ISOSTATIC HOT PRESSING AT 1500 DEG C AFTER MELTING. THE SOLUBILITY OF UN IN LIQUID URANIUM WAS DETERMINED AT TEMPERATURES BETWEEN 1350 AND 2400 DEG C AT 1 ATM OF NITROGEN. ON THE BASIS OF RESULTS TO DATE IN THE URANIUM-NITROGEN PHASE STUDIES, A TENTATIVE URANIUM-NITROGEN PRESSURE-TEMPERATURE DIAGRAM HAS BEEN CONSTRUCTED. INITIAL COMPATIBILITY STUDIES OF UN WITH ALUMINIUM, ZIRCONIUM, AND STAINLESS STEEL WERE CARRIED OUT OVER A RANGE OF TEMPERATURES. REACTIONS WERE OBSERVED IN ALL CASES BUT TO A SIGNIFICANTLY VARYING EXTENT. CORROSION OF UN, BOTH CAST AND POWDER-METALLURGY SPECIMENS, WAS MEASURED IN PURE OXYGEN. THE CAST MATERIAL SHOWED A LINEAR WEIGHT GAIN WITH TIME AT 300, 400, AND 450 DEG C. THE UN PREPARED BY POWDER METALLURGY SHOWED A MUCH ACCELERATED ATTACK AT 300 DEG C.

ABSTRACT 348

KELLER D L

BMI-X-10061 (1963)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, JULY - SEPTEMBER 1963. EURAEC-845, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-JOINT RESEARCH AND DEVELOPMENT PROGRAM.

URANIUM MONONITRIDE WAS FABRICATED BY BOTH POWDER AND MELTING TECHNIQUES. THE PROBABLE SOURCE OF THE HIGH OXYGEN CONTENT IN URANIUM MONONITRIDE FABRICATED BY POWDER TECHNIQUES WAS TRACED TO THE POWDER PREPARATION PROCESS. TENTATIVE PRESSURE-TEMPERATURE DIAGRAMS FOR THE URANIUM-NITROGEN SYSTEM WERE CONSTRUCTED. A SOLID SOLUTION WAS FOUND BETWEEN U_{2N} AND $UN_{2.5}$. STOICHIOMETRIC $UN_{2.5}$ EXISTS ONLY AT VERY HIGH PRESSURES. SEVERAL TYPES OF UN, PREPARED BY VARIOUS FABRICATION TECHNIQUES, ARE NOW BEING IRRADIATED. THE COMPATIBILITY OF UN WITH ALUMINIUM, ZIRCALOY-2, AND TYPE 304 STAINLESS STEEL WAS CHECKED TO MAXIMUM TEMPERATURES OF 600, 900, AND 1350 DEG C, RESPECTIVELY. A TENTATIVE REACTION-RATE CURVE WAS DERIVED FOR THE UN-ZIRCALOY-2 SYSTEM. STOICHIOMETRIC UN IS RESISTANT TO CORROSION BY WATER AT 300 DEG C; HYPERSTOICHIOMETRIC AND HYPOSTOICHIOMETRIC UN ARE NOT. WEIGHT GAIN-VERSUS-TIME CURVES FOR UN EXPOSED TO DRY OXYGEN AND CARBON DIOXIDE WERE OBTAINED.

ABSTRACT 349

KELLER D L

BMI-X-10073 (1964)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1963. EURAEC-957, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

FABRICATION STUDIES REVEALED THAT THE GRAIN SIZE OF CAST UN CAN BE SIGNIFICANTLY DECREASED BY DECREASING THE COOLING PROFILE DURING THE

ABSTRACT 349 (CONT'D)

SOLIDIFICATION PROCESS. ALLOY ADDITIONS OF BOTH ZRN AND TIN WERE MADE IN UN BY THE CONSUMABLE-ELECTRODE MELTING PROCESS. A EUTECTIC COMPOSITION WAS FOUND IN THE UN-TIN SYSTEM AT DILUTE ALLOY ADDITIONS. THE ELECTRODE MELTING WAS MORE UNIFORM AND THE CASTING SOUNDER IN THIS SYSTEM. THE DECOMPOSITION STUDIES OF UN WERE EXTENDED TO NITROGEN PRESSURES OF 25-100 ATM. A UN-NITROGEN REACTION FORMING LIQUID EFFECTIVELY LOWERS THE MELTING POINT OF UN AT HIGH NITROGEN PRESSURES. THE VAPOR PRESSURE OF URANIUM OVER UN WAS MEASURED BY KNUDSEN EFFUSION-CELL TECHNIQUES, AND AN EQUATION WAS DEVELOPED. THE IRRADIATION OF 20 SPECIMENS OF UN IS UNDER WAY. CORROSION OF HYPOSTOICHIOMETRIC, STOICHIOMETRIC, AND HYPERSTOICHIOMETRIC UN WAS STUDIED IN WATER, NAK, SANTOWAX R, AND AIR. NO ATTACK WAS NOTED IN NAK AT 800 DEG C. THE COMPATIBILITY OF UN WITH ALUMINIUM, STAINLESS STEEL, AND ZIRCALOY-2 WAS STUDIED TO TIMES OF 1600 H.

ABSTRACT 350

KELLER D L

BMI-X-10083 (1964)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1964. EURAEC-1033, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

METHODS OF FABRICATING URANIUM MONONITRIDE AND URANIUM NITRIDE-TITANIUM NITRIDE SYSTEMS BY BOTH POWDER-METALLURGY AND MELTING AND CASTING TECHNIQUES ARE DEVELOPED AND DISCUSSED. THESE MATERIALS ARE CHARACTERIZED WITH RESPECT TO DENSITY, GRAIN SIZE, HOMOGENEITY, AND CHEMICAL PURITY. CHEMICAL COMPATIBILITY OF URANIUM NITRIDES WITH WATER, CARBON DIOXIDE, WATER-SATURATED AIR, AND NICKEL IS EVALUATED AT 100 - 900 DEG C. THE EFFECTS ON URANIUM MONONITRIDE OF IRRADIATIONS TO PEAK BURNUPS ARE DETERMINED. DECOMPOSITION MEASUREMENTS OF URANIUM MONONITRIDE ARE REPORTED DOWN TO 10^{-7} ATM.

ABSTRACT 351

KELLER D L

BMI-X-10092 (1964)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, APRIL-JUNE 1964. EURAEC-1136, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

HOT-HARDNESS, THERMAL-CONDUCTIVITY, AND ELECTRIC-RESISTIVITY DATA WERE OBTAINED ON CAST UN FOR COMPARISON WITH THE PREVIOUS MEASUREMENTS MADE ON MATERIAL FABRICATED BY POWDER TECHNIQUES. THE DATA CONFIRMED THE EARLIER MEASUREMENTS. ADDITIONAL TESTS WERE COMPLETED TO DETERMINE THE CHEMICAL COMPATIBILITY OF UN WITH STAINLESS STEEL, ZIRCALOY-2, NICKEL, CHROMIUM, ZIRCONIUM, AND IRON. THE EFFECTS ON UN OF IRRADIATIONS TO PEAK BURNUPS, EXCEEDING 3.5 AT. % OF THE URANIUM AT SURFACE TEMPERATURES TO 550 DEG C WERE DETERMINED. IRRADIATION OF 20 ADDITIONAL UN SPECIMENS TO BURNUPS OF ABOUT 5 AT. % OF THE URANIUM AT SURFACE TEMPERATURES OF 500 - 700 DEG C WERE TERMINATED.

ABSTRACT 352

KELLER D L

BMI-X-10100 (1964)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, JULY - SEPTEMBER 1964.

EURAE-1232, BATTELLE MEMORIAL INST., COLUMBUS, OHIO. WORK PERFORMED UNDER UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

ACTIVITIES IN A PROGRAMME TO EVALUATE UN FABRICATION METHODS ARE REPORTED. INVESTIGATIONS OF UN PROPERTIES AND IRRADIATION BEHAVIOR ARE ALSO REPORTED. PROGRESS IS REPORTED ON MELTING AND CASTING OF UN, POSTIRRADIATION EXAMINATION OF UN SAMPLES, AND COMPATIBILITY STUDIES.

ABSTRACT 353

KELLER D L

BMI-X-178 (1961)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, JULY-SEPTEMBER 1961. EURAE-169, BATTELLE MEMORIAL INST, COLUMBUS, OHIO.

CALCULATED WIEDEMANN-FRANZ-LORENZ RELATIONS BETWEEN THE THERMAL AND ELECTRICAL CONDUCTIVITIES OF UN ARE GIVEN FOR TEMPERATURES OF 200 TO 800 DEG C. LINEAR THERMAL EXPANSION COEFFICIENT DATA ARE GIVEN FOR UN AT 20 TO 1600 DEG C AND FIT THE EQUATION, $L_{SUB 7} = L_{SUB 0} (1 + (7.1T + 0.0032T^{**2} - 0.86*10^{**6}T^{**3}) * 10^{**6})$. MEASUREMENTS OF THE DYNAMIC ELASTIC MODULUS AND HARDNESS OF UN ARE REPORTED. LATTICE CONSTANT VALUES OF UN ARE PRESENTED AT VARYING OXYGEN AND CARBON CONTENTS. THE IRRADIATION PROGRAMME OF UN SAMPLES IS DESCRIBED.

ABSTRACT 354

KELLER D L

BMI-X-186 (1962)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT, OCTOBER-DECEMBER 1961. EURAE-260, BATTELLE MEMORIAL INST., COLUMBUS, OHIO AND UNITED STATES- EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.

WORK IN THE PROGRAMME SHOWED THAT UN POWDER CAN BE HOT PRESSED FROM 95 TO 98% OF THEORETICAL DENSITY AND SUCH MATERIAL IS BEING USED FOR PROPERTY MEASUREMENTS. THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF UN WERE DETERMINED AT 200 TO 800 DEG C. THE CONDUCTIVITY OF UN AT 750 TO 800 DEG C IS SIMILAR TO THAT OF UC. THE WATER-CORROSION RESISTANCE OF UN IS, HOWEVER, SIGNIFICANTLY SUPERIOR TO UC: AFTER 168 H IN 500 DEG F DEIONIZED AND DEGASSED WATER A UN SPECIMEN SHOWED A WEIGHT LOSS AS LOW AS 77 MG PER CM². THE SOLUBILITY OF H IN UN WAS DETERMINED AT 300 TO 800 DEG C. THERMAL EXPANSION AND MODULUS OF ELASTICITY WERE DETERMINED, AS WELL AS HOT HARDNESS TO 2000 DEG F. IN UN MELTING AND CASTING STUDIES BUTTONS WERE PREPARED UNDER N PRESSURES RANGING FROM 10 TO 20 ATM WITH COMPOSITIONS VARYING BETWEEN 5.6 TO 6.8 WT. % N. THE HIGHER N CONTENT OVER THAT PREVIOUSLY OBTAINED IS ATTRIBUTED IN PART TO THE SHAPE OF THE CRUCIBLE, WHICH PROVIDES FOR A MORE UNIFORM MELT TEMPERATURE. THE FIRST THREE OF SIX IRRADIATION CAPSULES CONTAINING UN SPECIMENS WERE DISCHARGED FROM THE MTR. EVALUATION OF THESE SPECIMENS IS JUST BEGINNING.

ABSTRACT 355

KELLER D L

BMI-1488 (1960)

PROGRESS ON THE DEVELOPMENT OF UC-TYPE FUELS

TRANSVERSE RUPTURE STRENGTHS (BEND STRENGTH) OF CARBIDES CONTAINING 4.8 AND 5 W/O C WERE MEASURED. THE FORMER GAVE AVERAGE VALUES OF 15,000 PSI, WHILE THE LATTER GAVE AVERAGE VALUES OF 10,000 PSI. A STRENGTH VERSUS C WT % PLOT GAVE A PEAK IN STRENGTH AT 7 A/O C. COMPRESSIVE STRENGTHS FOR 4.8 W/O C AVERAGED OUT AT 51,000 PSI ($E = 29.5 \times 10^{11}$ PSI) AND 7.0 W/O C THE AVERAGE WAS 65,700 PSI ($E = 29.0 \times 10^{11}$ PSI).

ABSTRACT 356

KELLER D L

BMI-1767 PC-3 (1966)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING MARCH, 1966

INITIAL SINTERING STUDIES WERE CONDUCTED ON NOMINAL (U SUB 0.8 PU SUB 0.2)N POWDERS WHICH WERE PREPARED USING A HYDRIDE- NITRIDE-VACUUM OUTGAS CYCLE ON ARC-CAST BUTTONS OF URANIUM-20 W/O PLUTONIUM. THE THERMAL CONDUCTIVITY OF UNIRRADIATED UN - 20 W/O PUN IN THE TEMPERATURE RANGE OF 200 TO 1000 DEG C WAS CALCULATED FROM THERMAL DIFFUSIVITY DATA. THREE COMPATIBILITY BOTTLES MADE OF MOLYBDENUM AND CONTAINING PELLETS OF UN, UN - 20 W/O PUN, AND PUN IN CONTACT WITH SODIUM, WERE HEATED FOR 100 HR AT 1200 DEG C; THESE WERE REMOVED FROM THE FURNACES AND EXAMINED METALLOGRAPHICALLY.

ABSTRACT 357

KELLER D L

BMI-1778 (1966)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JUNE 1966

RESEARCH RESULTS ARE PRESENTED ON RADIATION EFFECTS ON 347 STAINLESS STEEL BEHAVIOR OF INTERSTITIAL ELEMENTS ON CR-V ALLOYS, EXPLOSIVE WELDING OF ZIRCALOY-AL TUBING, THERMAL STABILITY OF SOL-GEL, THO SUB 2 -PUO SUB 2 PARTICLES IN VARIOUS ATMOSPHERES, DEVELOPMENT OF FUEL PLATES FOR AARR, ROOM-TEMPERATURE STABILITY OF UN-PUN IN O SUB 2 AND VACUUM, THERMAL CONDUCTIVITY OF IRRADIATED UN, COMPATIBILITY UN-PUN FUELS WITH 300-SERIES STAINLESS STEELS, RADIATION DAMAGE IN UN-PUN FUELS, SMOKE PHOTOMETER DEVELOPMENT, AND CORROSION OF FLUORIDE-VOLATILITY PROCESS CONSTRUCTION MATERIALS.

ABSTRACT 358

KELLER D L

BMI-1784 PA-10 (1966)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY THROUGH SEPTEMBER, 1966

A SERIES OF EXPERIMENTS WAS INITIATED TO DETERMINE THE EFFECT OF CARBON ON SINTERABILITY OF NOMINAL (U SUB 0.8 PU SUB 0.2) N POWDERS. IN AN EFFORT TO ARRIVE AT SOME BASE CARBON CONTENT THAT WOULD YIELD HYPOSTOICHIOMETRIC AND HYPERSTOICHIOMETRIC (U,PU)CN, DEPENDING UPON THE N SUB 2 PRESSURE OVER THE MELT, THE DATA OBTAINED FROM A SERIES OF PLUTONIUM CARBONITRIDES PREPARED WITH CARBON CONTENTS RANGING FROM LESS THAN 1 TO 1.7 W/O WERE EVALUATED. AN ANALYSIS OF AVAILABLE THERMODYNAMIC DATA WAS COMPLETED AND THE RESULTS OF SOME EARLIER WEIGHT-LOSS

ABSTRACT 358 (CONT'D)

EXPERIMENTS OF PUN WERE INTERPRETED IN LIGHT OF THESE THERMODYNAMIC DATA. SAMPLES CONTAINING (U SUB 0.8 PU SUB 0.2) N SODIUM BONDED WITH NB-1 W/O ZR AND TYPE 304 STAINLESS STEEL WERE EXAMINED AFTER BEING HEATED FOR 1000 HR. AT 1000 DEG C. THERMAL DIFFUSIVITY OF UN SAMPLES WAS MEASURED IN THE TEMPERATURE RANGE OF 225 TO 985 DEG C. THE EFFECT OF IRRADIATION ON THERMAL DIFFUSIVITY OF UN WAS ALSO STUDIED. AN EVALUATION OF THE THERMODYNAMIC POTENTIAL FOR FUEL-CLADDING INTERACTION WAS COMPLETED TO SERVE AS A GUIDANCE FOR THE EXPERIMENTAL PHASE OF THE PROGRAM.

ABSTRACT 359

KELLER D L

BMI-1826 (1968)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCT.-DEC. 1967

A STUDY OF MIXED UN-PUN FUELS IS CONDUCTED FOR USES IN THERMAL REACTOR APPLICATION. EFFECTS INVOLVING PREPARATION OF MATERIALS, PROPERTY DETERMINATION, IRRADIATION STUDIES, AND SUPPORTIVE STUDIES ARE REPORTED. THE CASTING OF URANIUM-PLUTONIUM CARBONITRIDES IS ALSO BEING STUDIED.

ABSTRACT 360

KELLER D L

BMI-1837 (1968)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JANUARY-MARCH 1968

THE EFFECT OF U SUB 2 N SUB 3 ON THE SINTERABILITY OF MECHANICALLY MIXED PUN-UN POWDERS AND THE EFFECT OF INCREASED BALL-MILLING TIME ON POWDER SINTERABILITY WERE STUDIED. MECHANICALLY MIXED UN AND PUN RESIST SINTERING DENSIFICATION MORE THAN PREALLOYED NITRIDE POWDERS AND INCREASING THE BALL-MILLING TIME FROM 32 TO 64 HR INCREASES SINTERED DENSITY VERY LITTLE. ARC MELTING AND CASTING TECHNIQUES FOR PREPARING SINGLE-PHASE OR HYPERSTOICHIOMETRIC MIXED (U,PU)CN FUELS WERE STUDIED AND SPECIMENS IN A SERIES OF FUELS PREPARED FROM A CHARGE WITH A 2.5 WT % C CONTENT WERE ANALYZED BY CHEMICAL AND METALLOGRAPHIC TECHNIQUES. DETERMINATION OF THE PLUTONIUM ACTIVITY IN SOLID-SOLUTION (U,PU)N WAS BEGUN AND WEIGHT-LOSS MEASUREMENTS WERE MADE AT 2020, 2050, 2120, AND 2130 DEG K AND THE PLUTONIUM VAPOR PRESSURES WERE CALCULATED FOR THESE TEMPERATURES. A MICRO-KJELDAHL PROCEDURE WAS USED FOR DETERMINATION OF NITROGEN IN (U,PU)N. RESULTS OF THESE ANALYSES SHOW THE EFFECTS OF VARYING THE ORDER OF CONTACT WITH THE DISSOLUTION MEDIUM ON NITROGEN CONTENT. RESEARCH ON THE COMPATIBILITY OF PUN-UN FUELS WITH TYPES 304 AND 316 STAINLESS STEELS, ORNL STAINLESS STEEL ALLOY, INCONEL 625, AND INCOLOY 800 WITH SODIUM BONDING IS SUMMARIZED. THERMAL DIFFUSIVITY MEASUREMENTS FOR (U,PU)N AT 300 TO 1100 DEG C WERE MADE. LINEAR THERMAL EXPANSION OF (U,PU)N WAS MEASURED AT 20 TO 1175 DEG C

ABSTRACT 361

KELLER D L

BMI-1845 PA-60 (1968)

ANNUAL REPORT

ALTERNATIVE SYNTHESIS PROCESSES FOR THE PREPARATION OF MIXED URANIUM-PLUTONIUM NITRIDE FUELS WERE STUDIED. VAPORIZATION BEHAVIOR OF PUN WAS STUDIED IN THE TEMPERATURE RANGE OF 1885 DEG K TO 2130 DEG K. FROM THIS HEAT OF FORMATION OF PUN AT 298 DEG K WAS CALCULATED. VAPORIZATION BEHAVIOR OF (U SUB 0.8 PU SUB 0.2)N WAS ALSO STUDIED IN THE TEMPERATURE RANGE OF 1960 TO 2130 DEG K. COMPATIBILITY STUDIES WERE MADE FOR UN, U SUB 2 N SUB 3, PUN AND (U,PU)N SAMPLES IN CONTACT WITH TYPE 304, 316 AND ORNL STAINLESS STEELS, INCOLOY 800, INCONEL 625 AND VANADIUM. THERMAL DIFFUSIVITIES OF MIXED NITRIDES WERE DETERMINED BOTH AS A FUNCTION OF STOICHIOMETRY FOR THE (U SUB 0.8 PU SUB 0.2)N COMPOSITION AND AS A FUNCTION OF URANIUM-PLUTONIUM RATIO IN THE TEMPERATURE RANGE OF 300 TO 1100 DEG C. SIMILAR MEASUREMENTS WERE MADE FOR (U SUB 0.5 PU SUB 0.5)N AND PUN SAMPLES. LINEAR THERMAL EXPANSION OF (U SUB 0.5 PU SUB 0.5)N WAS MEASURED IN THE TEMPERATURE RANGE OF 20 TO 1175 DEG C; THIS WAS THEN COMPARED WITH UN DATA.

ABSTRACT 362

KELLER D L

BMI-1878, P36

URANIUM-PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS

STUDIES ARE BEING CONDUCTED TO EVALUATE THE POTENTIAL OF MIXED UN-PUN FUELS FOR FAST BREEDER APPLICATIONS. THE PROGRAM IS DIVIDED INTO EFFORTS INVOLVING THE PREPARATION OF MATERIALS BY GAS-SOLID REACTIONS, PROPERTY DETERMINATIONS, IRRADIATION STUDIES, AND SUPPORTING STUDIES. PHYSICAL PROPERTIES OF IMPORTANCE FOR REACTOR DESIGN ARE BEING DETERMINED, INCLUDING VOLATILITY TENDENCIES, CONDUCTIVITY, EXPANSIVITY, AND CHEMICAL STABILITY OF THE FUELS IN CONTACT WITH POTENTIAL LMFBR CLADDING MATERIALS. THE RESISTANCE OF NITRIDE MATERIALS TO BOTH THERMAL AND FAST FLUX IRRADIATIONS WILL BE DETERMINED TO EVALUATE THE SUITABILITY OF THESE FUELS FOR APPLICATIONS INVOLVING LONG-TERM IRRADIATIONS. THE EVALUATION OF SODIUM BONDING OF THE FUEL TO THE CLADDING IS ANOTHER OBJECTIVE OF THE PROGRAM. NITRIDE FUEL WILL PROBABLY GROW AT A RATE OF ABOUT 0.5 VOL % PER 10^{20} FISSIONS PER CM³, TO MINIMIZE CLADDING DEFORMATION, THIS FUEL GROWTH CAN PROBABLY BE ACCOMMODATED MORE EFFECTIVELY IN THE ANNULUS BETWEEN THE FUEL AND THE CLADDING RATHER THAN IN THE POROSITY IN THE FUEL. TO MINIMIZE FUEL TEMPERATURES, ANOTHER DESIRABLE OBJECTIVE, THIS ANNULUS MUST BE FILLED WITH A GOOD HEAT-TRANSFER MATERIAL. EFFORT IS THUS DEVOTED TO STUDIES OF SODIUM BONDING AND FILM FORMATION IN CONTACT WITH NITRIDE FUELS AND THEIR CLADDINGS.

ABSTRACT 363

KELLER D L

BMI-1918, P A5 (1971)

PROGRESS ON DEVELOPMENT OF FUELS AND TECHNOLOGY FOR ADVANCED REACTORS DURING JULY 1970 THROUGH JUNE 1971

THE SELF-DIFFUSION OF NITROGEN IN UN WAS DETERMINED IN THE TEMPERATURE RANGE FROM 1640 TO 2080 K AND THE NITROGEN PRESSURE RANGE FROM 10^{-3} TO 10^{-1} ATM. THE RESULTS WERE CONSISTENT WITH 0 ^{1/2} DEPENDENCE. THE SELF-DIFFUSION COEFFICIENT OF NITROGEN IN (U,PU)N WAS FOUND TO BE THE SAME, WITHIN EXPERIMENTAL ERROR, AS THAT FOUND IN UN.

ABSTRACT 364

KELLER D L

EURAC-77 (1961)

DEVELOPMENT OF URANIUM MONONITRIDE.

QUARTERLY PROGRESS REPORT NO. 3 FOR PERIOD ENDING JUNE 30, BATTELLE MEMORIAL INST., COLUMBUS, OHIO AND UNITED STATES-EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM. 15P.

WORK IS BEING CARRIED OUT TO ESTABLISH THE FEASIBILITY OF UN AS A REACTOR FUEL MATERIAL. FABRICATION WAS COMPLETED ON ALL PLANNED IRRADIATION SPECIMENS. THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY WERE MEASURED IN VACUUM ON A UN SPECIMEN OVER THE TEMPERATURE RANGE 200 TO 800 DEG C. DENSE UN SPECIMENS WERE EXPOSED TO 500 DEG F DEIONIZED AND DEGASSED WATER FOR UP TO 14 DAYS. THE CHEMICAL CORROSION THAT OCCURRED WAS APPARENTLY A SURFACE REACTION, AND THE MATERIAL SHOWED FAIRLY GOOD RESISTANCE TO CORROSION. VALUES FOR THE SOLUBILITY OF H SUB 2 IN UN WERE MEASURED AT 1 ATM AND 300 TO 800 DEG C. MELTING AND CASTING OF UN WAS CARRIED OUT.

ABSTRACT 365

KELLER D L

PROGRESS ON HIGH TEMPERATURE FUELS TECHNOLOGY DURING FEB-APRIL (1970), QUARTERLY REPORT, TASK 6 BATTELLE MEMORIAL INST., (1970)

PROGRESS ON HIGH TEMPERATURE FUELS TECHNOLOGY DURING FEB-APRIL (1970) QUARTERLY REPORT, TASK 6, BATTELLE MEMORIAL INST., (1970)

THE GAS PRESSURE IN THE PLENUM OF A 90 PERCENT DENSE SPECIMEN OF UN SUB 2 OPERATING AT A SURFACE TEMPERATURE OF 1525 DEG C REMAINED CONSTANT AT 23 PSI TO A BURNUP OF 0.27×10^{20} FISSIONS PER CM³. AT THAT BURNUP THE PRESSURE BEGAN TO RISE AT A RATE INDICATING ESSENTIALLY 100 PERCENT GAS RELEASE TO A PRESSURE OF 42 PSI AT A BURNUP OF 0.63×10^{20} FISSIONS PER CM³. THE DELAY IN THE ONSET OF GAS RELEASE IS TENTATIVELY ASCRIBED TO A NEED FOR TIME TO DEVELOP CHANNEL-TYPE POROSITY SUITABLE FOR RELEASING FISSION GAS. A SECOND CAPSULE LOADING OF UN SPECIMENS IRRADIATED AT TEMPERATURES OF 1400 TO 1600 DEG C HAS SHOWN EXTERNAL VOLUME INCREASES OF LESS THAN 4 PERCENT AT A BURNUP OF ABOUT 2.1×10^{20} FISSIONS PER CM³. THIS MATERIAL WAS MAINTAINED NITROGEN-RICH WITH AN OVERPRESSURE OF NITROGEN GAS. BECAUSE OF THE SMALL VOLUME CHANGES, NO EXTERNAL EFFECT OF POROSITY OR OF GRAIN SIZE WAS DISTINGUISHABLE. HOWEVER, AS NOTED LAST QUARTER, MICROSTRUCTURAL EXAMINATION DISCLOSED A STRONG TENDENCY FOR POROSITY TO DEVELOP PREFERENTIALLY IN THE GRAIN BOUNDARIES OF THE UN. AN ISOLATED INSTANCE OF PREFERENTIAL SEPARATION OF THE GRAINS ALONG CIRCUMFERENTIAL GRAIN BOUNDARIES IS ATTRIBUTED TO A LACK OF RESTRAINT AND TO PREFERENTIAL DEFORMATION IN THE RADIAL DIRECTION. TENSILE CREEP TESTS OF UN SHOW AN ELONGATION TO FRACTURE OF 11% AT 1400 DEG C IN 344 HR AT 5000 PSI AND AN ELONGATION OF 4% AT 1700 DEG C IN 10 HR AT 1700 PSI. THIS COMPARES WITH THE BEHAVIOR OF UC WHICH SHOWED AN ELONGATION TO FRACTURE OF 37% AT 1400 DEG C IN 800 HR AT 5000 PSI AND AN ELONGATION OF 17% AT 1700 DEG C IN 7 HR AT 3000 PSI.

ABSTRACT 366

KELLY H J

USBM-RC-1205

INVESTIGATION OF THE SYSTEM UC-UN-UO.

PHASE STUDIES WERE MADE ON THE PSEUDOTERNARY SYSTEM UC-UN-UO NEAR THE SOLID SOLUTION REGION AT 1700 DEG C TO ESTABLISH PHASE BOUNDARIES AND THE EXTENT OF THE SOLID SOLUTION RANGE. RESULTS ARE DISCUSSED.

ABSTRACT 367

KEMPTER C P

J LESS-COMMON METALS 10, 294 (1966)

THE ISOTHERMAL COMPRESSIBILITY OF URANIUM MONOCARBIDE

THE LINEAR COMPRESSION OF A UC CYLINDER WAS MEASURED AT 1/2-KB INTERVALS TO 7 KB. FROM THE DATA, IT WAS CALCULATED THAT THE ISOTHERMAL COEFFICIENT OF VOLUME COMPRESSIBILITY AT 23 DEG C AND ATMOSPHERIC PRESSURE IS $6.9 \times 10^{-13} \text{ CM}^2/\text{DYN}$.

ABSTRACT 368

KENT R A

HIGH TEMP SCI 1, 176 (1969)

MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES: IV. THE VAPORIZATION OF PUN

A MASS SPECTROMETRIC-KNUDSEN EFFUSION STUDY HAS SHOWN THAT IN THE RANGE 1658-1976 DEG K, PLUTONIUM MONONITRIDE VAPORIZES CONGRUENTLY TO THE ELEMENTS ACCORDING TO THE REACTION $\text{PUN SUB 0.98 (S)} = \text{PU(G)} + 0.49 \text{N SUB 2(G)}$. THE PLUTONIUM PARTIAL PRESSURE IS GIVEN BY $\log P \text{ SUB PU (ATM)} = (6.445 \pm 0.055) - (21,958 \pm 98)/T \text{ DEG K}$. THE STANDARD HEAT AND ENTROPY OF FORMATION FOR PUN ARE CALCULATED TO BE $\Delta H \text{ SUB F, 298} = -71.2 \pm 2.5 \text{ KCAL/MOLE}$ AND $\Delta S \text{ SUB F, 298} = -19.9 \pm 2.0 \text{ EU}$.

ABSTRACT 369

KENT R A

LA-3902 (1968)

MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES. I. THE HEATS OF VAPORIZATION OF GOLD AND PLUTONIUM AND THE HEAT OF DECOMPOSITION OF PLUTONIUM MONONITRIDE

THE MASS SPECTROMETER-KNUDSEN CELL APPARATUS, CONSTRUCTED AND EMPLOYED TO MEASURE THE ENTHALPY OF VAPORIZATION OF GOLD, THE VAPOR PRESSURE AND ENTHALPY OF VAPORIZATION OF PLUTONIUM, AND THE PARTIAL PRESSURES AND ENTHALPIES OF FORMATION OF PU(G) AND N SUB 2 (G) ABOVE SOLID PUN, IS DESCRIBED. IN THE TEMPERATURE RANGE FROM 1426 TO 1658 DEG K, LIQUID PLUTONIUM VAPORIZES PREDOMINATELY TO THE MONOMER WITH THE VAPOR PRESSURE GIVEN BY THE LEAST-SQUARES EQUATION: $\log \text{ SUB 10 P(ATM)} = (4.924 \pm 0.120) - 17420 \pm 184/T \text{ DEG K}$. THE STANDARD ENTHALPY OF VAPORIZATION IS $\Delta H \text{ SUB 298 DEG K} = 83.0 \pm 0.5 \text{ KCAL/MOLE}$. IN THE TEMPERATURE RANGE FROM 1658 TO 1976 DEG K, PUN(S) DECOMPOSES INVARIANTLY ACCORDING TO THE REACTION, $\text{PUN(S)} = \text{PU(G)} + 1/2 \text{N SUB 2 (G)}$, WITH AN ENTHALPY OF REACTION $\Delta H \text{ SUB 298} = 156.1 \pm 2.5 \text{ KCAL/MOLE}$. THE PARTIAL PRESSURE OF PU(G) ABOVE SOLID PUN IS GIVEN BY: $\log \text{ SUB 10 P SUB PU(ATM)} = (6.436 \pm 0.055) - 21958 \pm 98/T \text{ DEG K}$. THE STANDARD ENTHALPY OF FORMATION OF SOLID PUN IS CALCULATED TO BE $\Delta H \text{ SUB F, 298} = -73.1 \pm 2.7 \text{ KCAL/MOLE}$.

ABSTRACT 370

KENT R A

PROC INT CONF MASS SPECTROSCOPY 1124 (1969)

MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES
THE PLUTONIUM-CARBON SYSTEM

A MASS SPECTROMETRIC-KNUDSEN EFFUSION STUDY OF THE VAPORIZATION OF THE PLUTONIUM-CARBON SYSTEM HAS SHOWN THE FOLLOWING: 1. THERE ARE THREE REGIONS TO THE PU-C PHASE DIAGRAM WHICH GIVE RISE TO INVARIANT BUT NOT CONGRUENT VAPORIZATION. (A) MONOCARBIDE PLUS SESQUICARBIDE (B) SESQUICARBIDE PLUS CARBON (C) DICARBIDE PLUS CARBON. 2. THE LOW CARBON SESQUICARBIDE PHASE BOUNDARY CURVES TO THE LEFT AT HIGH TEMPERATURES, PASSING THROUGH THE COMPOSITION PUC SUB 1.41 AT 1550#25 DEG C. 3. THE TRANSITION FROM SESQUICARBIDE TO DICARBIDE OCCURS AT 1660#10 DEG C. IN ADDITION, THE STANDARD HEAT AND ENTROPY OF FORMATION FOR THE MONO AND SESQUICARBIDE HAVE BEEN DETERMINED.

ABSTRACT 371

KENT R A

RECENT DEVELOPMENTS IN MASS SPECTROSCOPY, 1124 (1970)

MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES,
5: THE PLUTONIUM-CARBON SYSTEM

THERE ARE THREE REGIONS OF THE PU-C SYSTEM WHICH GIVE RISE TO INVARIANT BUT NOT CONGRUENT VAPORIZATION (PUC + PU SUB 2 C SUB 3, PU SUB 2 C SUB 3 + C, AND PUC SUB 2 + C); THE SESQUICARBIDE HAS A RANGE OF HOMOGENEITY AT 1550 DEG C; TRANSITION OF PU SUB 2 C SUB 3 TO PUC SUB 2 OCCURS AT 1660 DEG C; STANDARD HEAT AND ENTROPY OF FORMATION FOR PUC AND PU SUB 2 C SUB 3.

ABSTRACT 372

KENT R A

5TH US/JAPAN CERAM FUELS INFORMATION EXCHANGE, SEATTLE, S-11 (1970)

MASS SPECTROMETRIC STUDIES OF THE PLUTONIUM CARBIDES

VAPORIZATION BEHAVIOR OF THE PUC SYSTEM IS DISCUSSED. PU VAPOR PRESSURE OVER VARIOUS PU CARBIDE PHASES IS GIVEN FOR THE TEMPERATURE RANGE 1450 TO 2170 DEG K. STANDARD FREE ENERGIES, ENTROPIES, AND ENTHALPIES OF FORMATION WERE CALCULATED.

ABSTRACT 373

KERR W R

NAA-SR-MEMO-7208 (1962)

LITERATURE SURVEY-URANIUM MONONITRIDE.

A REVIEW IS GIVEN ON THE URANIUM-NITROGEN SYSTEM, INCLUDING THE CRYSTALLOGRAPHY OF ITS COMPOUNDS, METHODS OF SYNTHESIS AND FABRICATION, PHYSICAL AND CHEMICAL PROPERTIES, IRRADIATION PROPERTIES, AND COMPATIBILITY OF URANIUM MONONITRIDE WITH OTHER MATERIALS. TWENTY-NINE REFERENCES ARE GIVEN TO BOOKS, REPORTS, AND JOURNALS PUBLISHED FROM 1948 TO 1961.

ABSTRACT 374

KIKUCHI T

J NUCL MATER 45, 84 (1972/73)

POROSITY DEPENDENCE OF THERMAL CONDUCTIVITY OF UN

THERMAL DIFFUSIVITY OF SINTERED URANIUM MONONITRIDES OF VARIOUS DENSITIES 70-95% TO WERE MEASURED OVER THE TEMPERATURE RANGE FROM 300 TO 1400 DEG . THE CURVE OF THERMAL DIFFUSIVITY VERSUS POROSITY AT EACH TEMPERATURE EXHIBITED A BREAK AT POROSITY NEAR 0.1. THERMAL CONDUCTIVITY OBTAINED FROM THERMAL DIFFUSIVITY WAS FOUND TO BE WELL FITTED TO A SET OF THE SIMPLIFIED MAXWELL-EUCKEN EQUATIONS. THE COEFFICIENT B IN THE EQUATION WAS OBTAINED AS 1.60- 1.86 FOR THE POROSITY RANGE ABOVE 0.10 AND THAT FOR THE SMALLER POROSITY RANGE VARIED FROM 1.38 AT 300 DEG C TO -0.09 AT 1300 DEG C. THE POROSITY DEPENDENCE OF THERMAL CONDUCTIVITY OF THE POROUS MATERIAL IS DISCUSSED, TAKING ACCOUNT OF THE EFFECT OF PORE CONDUCTION IN A SIMILAR WAY AS CONDUCTED BY MARINO. THE CALCULATED RESULT FOR THE LARGER POROSITY IS IN AGREEMENT WITH THE EXPERIMENTAL ONES, WHEREAS THAT FOR THE SMALLER POROSITY IS NOT WHOLLY CONSISTENT WITH THE EXPERIMENTS.

ABSTRACT 375

KIKUCHI T

JAERI-3517 (1969)

PHYSICAL PROPERTIES OF CARBIDE FUELS AND THEIR EVALUATION

PHYSICAL PROPERTIES OF CARBIDE, NITRIDE AND SIMILAR COMPOUNDS HAVING CRYSTAL STRUCTURE NaCl TYPE ARE REVIEWED, AND SOME PROBLEMS ASSOCIATED WITH POWER AND BURN-UP OF A FAST BREEDER REACTOR ARE POINTED OUT. THERMAL CONDUCTIVITY AND SWELLING OF THESE COMPOUNDS ARE DISCUSSED. CHEMICAL BONDING, GROWTH OF FISSION GAS BUBBLE AND CREEP ARE ALSO DISCUSSED.

ABSTRACT 376

KILLEY N M

J BRIT NUCL ENERGY SOC 10, 65 (1971)

CREEP OF URANIUM AND URANIUM-PLUTONIUM MONOCARBIDES IN COMPRESSION

THE CREEP BEHAVIOR OF SINTERED URANIUM CARBIDE WITH AND WITHOUT NICKEL ADDITIONS HAS BEEN STUDIED IN A VACUUM OF BETTER THAN 10^{-5} TORR AND COMPARED WITH PREVIOUS RESULTS FOR CAST UC. THE EFFECT OF TEMPERATURE ON SLIGHTLY HYPOSTOICHIOMETRIC MATERIAL (4.75-4.80 WT % C) OVER THE RANGE 930-1200 DEG C IS REPORTED, AND THE EFFECTS OF BOTH TEMPERATURE AND STRESS ARE REPORTED FOR HYPERSTOICHIOMETRIC MATERIAL (4.84-5.4 WT % C) OVER THE RANGES 1000-1300 DEG C AND 16-70 MN/M². IT IS EVIDENT THAT THE CREEP BEHAVIOR OF SINTERED UC CAN BE RELATED TO THAT OF CAST MATERIAL OF SIMILAR COMPOSITION DESPITE DIFFERENCES OF GRAIN SIZE, POROSITY AND STRAIN RATE. THE DEFORMATION OF SINTERED CARBIDE CONTAINING APPROX= 15% PLUTONIUM CARBIDE HAS BEEN STUDIED AS A FUNCTION OF CARBON EQUIVALENT WITHIN THE RANGE 4.9-4.6 WT %. TESTS WERE CONDUCTED IN A VACUUM OF 1×10^{-6} TORR USING NOMINAL STRESSES IN THE RANGE 3-30 MN/M² AND TEMPERATURES IN THE RANGE 950-1150 DEG C. THE DEFORMATION IS CHARACTERIZED BY LOW ACTIVATION ENERGIES AND BY LARGE AMOUNTS OF 'PRIMARY' CREEP, THE AMOUNT OF STRAIN TO REACH CONSTANT RATES INCREASING WITH DECREASING CARBON CONTENT.

ABSTRACT 377

KILLEY N M

J NUCL MATER 41, 178 (1971)

THE SECONDARY CREEP BEHAVIOR OF URANIUM MONOCARBIDE IN COMPRESSION I: HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE

THE EFFECT OF TEMPERATURE ON THE SECONDARY CREEP RATE OF HYPOSTOICHIOMETRIC UC IS EXAMINED OVER THE RANGE 900 DEG C-1100 DEG C AT A STRESS OF 6000 PSI (41.4 MN/M**2) AND THE EFFECT OF STRESS OVER THE RANGE 4000-8000 PSI (27.6-55.2 MN/M**2) AT 950 DEG C. FROM THE CREEP BEHAVIOR AND METALLOGRAPHIC OBSERVATIONS IT IS CONCLUDED THAT THE CREEP MECHANISM IS CONTROLLED BY THE DIFFUSION OF CONSTITUTIONAL CARBON VACANCIES IN THE UC LATTICE. IT IS FOUND THAT CREEP OBEYS EQUATIONS OF THE FORM, $\dot{\epsilon} = A \text{ SUB } 1 \times 10$ AND $\dot{\epsilon} = A \text{ SUB } 2 \text{ EXP}(-Q_H/RT)$, WHERE Q_H , THE ACTIVATION ENTHALPY FOR CREEP HAS A VALUE OF 45 ± 3 KCAL PER MOLE WHICH IS LESS THAN THAT FOR THE DIFFUSION OF CARBON IN UC. A VALUE CALCULATED FOR THE CREEP DIFFUSION COEFFICIENT IS HOWEVER SIMILAR TO THAT FOR THE DIFFUSION OF CARBON.

ABSTRACT 378

KINGERY W D

CEA-R-3289 (1967)

MESURES DE DENSITE DECHANTILLONS DE BIOXYDE DURANIUM ET DE CARBURE DURANIUM IRRADIES A BASSE TEMPERATURE.

DENSITY MEASUREMENTS AT 21 DEG C AND AFTER ANNEALING FOR 10 HOURS AT 400 DEG C HAVE BEEN CARRIED OUT ON URANIUM DIOXIDE AND URANIUM CARBIDE SAMPLES PREVIOUSLY IRRADIATED AT LOW TEMPERATURE UP TO VALUES OF $0.86 \times 10^{+16}$ AND $0.83 \times 10^{+17}$ FISSIONS/CM**3. THE CHANGES IN THE DENSITY BEFORE AND AFTER IRRADIATION ARE COMPARED WITH MEASUREMENTS OF LATTICE PARAMETER CHANGE. IN THE CASE OF URANIUM DIOXIDE, THE AGREEMENT IS SATISFACTORY FOR AN EXPOSURE OF $0.86 \times 10^{+16}$ FISSIONS/CM**3. ON THE OTHER HAND FOR AN EXPOSURE OF $0.83 \times 10^{+17}$ FISSIONS/CM**3 THE DECREASE IN THE DENSITY IS GREATER THAN WHAT COULD HAVE BEEN EXPECTED FROM THE INCREASE IN LATTICE PARAMETER.

ABSTRACT 379

KINGERY W D

J NUCL MATER 26, 204 (1968)

MEASUREMENTS OF DENSITIES OF URANIUM DIOXIDE AND URANIUM CARBIDE IRRADIATED AT LOW TEMPERATURES

UO SUB 2 AND UC SAMPLES WERE IRRADIATED AT LIQUID NITROGEN TEMPERATURE AND THEN ANNEALED AT 21 OR 400 DEG C. DENSITY CHANGES DURING THESE ANNEALS WERE MEASURED TO A HIGH PRECISION AND WERE COMPARED WITH THE CORRESPONDING CHANGES IN LATTICE PARAMETER DETERMINED BY OTHERS. FOR UO SUB 2, AT A DOSE OF $0.86 \times 10^{+16}$ FISSIONS/CM**3, THE DENSITY CHANGES DETERMINED BY THE TWO METHODS WERE IN AGREEMENT, BUT AT $0.83 \times 10^{+17}$ FISSIONS/CM**3 THE DENSITY DECREASE MEASURED DIRECTLY EXCEEDS THAT CALCULATED FROM PARAMETER CHANGES. IT IS CONCLUDED THAT INTERSTITIALS PRODUCED BY FISSION DAMAGE RECOMBINE TO FORM DISLOCATION LOOPS.

ABSTRACT 380

KNIGHTS C F

J NUCL MATER 39, 224 (1971)

LEVITATION MELTING OF URANIUM MONOCARBIDE

URANIUM MONOCARBIDE CAN BE LEVITATION-MELTED IN A SIMPLE CYLINDRICAL COIL ASSOCIATED WITH A 450 KHZ FIXED FREQUENCY POWER UNIT. THE 3.6-3.7 G SAMPLE IS MELTED WITHIN 15 SEC AND HELD STABLY ABOVE THE MELTING POINT FOR NOT LESS THAN 4.5 MIN. THE VARIATION OF SAMPLE TEMPERATURE IS LESS THAN OR EQUAL TO ± 10 DEG C AND THE ABSOLUTE TEMPERATURE IS PROBABLY WITHIN THE RANGE 2520 ± 20 DEG C. THE BEHAVIOR IS REPRODUCIBLE AND THE SAMPLE IS NOT OBSCURED BY THE COIL.

ABSTRACT 381

KOLLIE T G

ORNL-P-148 (1964); NUCL MET, MET SOC AIME 10, 651 (1964)

A THERMAL COMPARATOR APPARATUS FOR THERMAL CONDUCTIVITY MEASUREMENTS FROM 50 TO 400 DEG C.

THE EXPERIMENTAL DETAILS, MATHEMATICAL MODELS, AND TYPICAL DATA FOR A RAPID COMPARATIVE METHOD FOR THERMAL CONDUCTIVITY MEASUREMENTS ARE PRESENTED. THE METHOD CONSISTS OF MEASURING THE TEMPERATURE CHANGE OF A SMALL SILVER SPHERE AFTER IT IS BROUGHT IN CONTACT WITH A SMALL DISK-SHAPED SPECIMEN WHICH WAS INITIALLY AT A HIGHER TEMPERATURE. THIS TEMPERATURE CHANGE WAS CALIBRATED IN THE RANGE OF 50 - 400 DEG C BY MAKING MEASUREMENTS ON SAMPLES OF KNOWN THERMAL CONDUCTIVITY. RESULTS AT 75 AND 300 DEG C ON URANIUM SULFIDE, THORIUM SULFIDE, URANIUM NITRIDE, AND URANIUM DIOXIDE ARE PRESENTED TO DEMONSTRATE THE USEFULNESS OF THE METHOD. THE ACCURACY OF THIS TECHNIQUE WAS SHOWN TO BE BETTER THAN $\pm 10\%$ WITH A REPRODUCIBILITY OF AT LEAST $\pm 2.5\%$. USING KNOWN TRANSPORT MECHANISMS FOR HEAT CONDUCTION IN SOLIDS AND THE TEMPERATURE DEPENDENCE OF THE ELECTRICAL CONDUCTIVITY A MEANS TO JUDICIOUSLY EXTRAPOLATE THERMAL CONDUCTIVITY DATA OBTAINED BETWEEN 50 AND 400 DEG C TO HIGHER TEMPERATURE IS PRESENTED.

ABSTRACT 382

KOSTIC E

NUKL ENERG 4, 6 (1967)

PHYSICO-CHEMICAL ASPECTS OF URANIUM NITRIDE PRODUCTION

THE USE OF UC AS A REACTOR FUEL ELEMENT PAVED THE WAY FOR THE USE OF OTHER NON-OXIDE MATERIALS AS NUCLEAR FUELS. THESE MATERIALS ENABLE HIGH BURNUPS AND HIGHER WORKING TEMPERATURES THAN METALLIC FUEL AND BETTER THERMAL CONDUCTIVITY AND GREATER DENSITY OF URANIUM THAN UO SUB 2. URANIUM MONONITRIDE HAS PROPERTIES BETTER THAN UC, SUCH AS BETTER COMPATIBILITY WITH METALS AND CORROSION RESISTANCE IN AIR. UN FUEL SHOWS BETTER THERMAL CONDUCTIVITY THAN UC AND UO SUB 2, GREATER RESISTANCE TO DEFORMATION AT HIGH TEMPERATURES, AND SUITABLE RESISTANCE TO IRRADIATION DURING BURNUP.

ABSTRACT 383

KRAKOWSKI R A

J NUCL MATER 32, 1208 (1969)

SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE

THE SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE HAS BEEN DETERMINED AS A FUNCTION OF TEMPERATURE IN THE RANGE 1338-1772 DEG K. A SIMPLE RADIOTracer TECHNIQUE HAS BEEN EMPLOYED WHICH MONITORS THE CHANGE IN SURFACE ACTIVITY AS A FUNCTION OF ANNEALING TIME. THE FOLLOWING EXPRESSION ADEQUATELY REPRESENTS THE DATA OVER THE ENTIRE RANGE OF TEMPERATURE STUDIED: $D = 0.1 \exp(-62,500/RT) \text{ CM}^2/\text{SEC}$

ABSTRACT 384

KRIKORIAN N H

J NUCL MATER 21, 236 (1967)

THE REACTION OF SOME NOBLE AND TRANSITION METALS WITH REFRACTORY CARBIDES

REACTION OF UC WITH AU, IR AND RH; AND REACTION OF UN WITH AU ARE DISCUSSED.

ABSTRACT 385

KRIKORIAN O H

UCRL-6785 (1962)

ESTIMATION OF HIGH-TEMPERATURE HEAT CAPACITIES OF CARBIDES

HIGH-TEMPERATURE HEAT CAPACITIES OF CARBIDES WERE COMPARED AND FOUND TO DEFINE A FAMILY OF CURVES. ON THE BASIS OF THE CURVES, AND FROM COMPARISONS OF S°_0 SUB 298 VALUES, AN EXPRESSION WAS DEVELOPED FOR THE ESTIMATION OF HEAT CAPACITIES OF CARBIDES. IN ORDER TO USE THE EXPRESSION, IT IS NECESSARY TO HAVE VALUES OF S°_0 SUB 298 FOR CARBIDES. A TABLE LISTING MEASURED AND ESTIMATED S°_0 SUB 298 VALUES IS INCLUDED.

ABSTRACT 386

KRIVY I

UJV-1832 (1967)

VAPORIZATION OF ACTINIDES AND THEIR BINARY COMPOUNDS. IV.

VAPORIZATION OF BINARY NEPTUNIUM AND PLUTONIUM COMPOUNDS

STUDIES WERE MADE ON THE VAPORIZATION OF SOME BINARY COMPOUNDS OF NEPTUNIUM AND PLUTONIUM. IT INVOLVES THE SURVEY AND THE CRITICAL TREATMENT OF AVAILABLE PAPERS IN THE FIELD UP TO 1ST JUNE 1966, WITH SPECIAL ATTENTION GIVEN TO THE COMPOUNDS OF INTEREST IN NUCLEAR REACTOR TECHNOLOGY, NAMELY PUD SUB 2 AND PUC SUB 2. FOR EACH TWO-COMPONENT SYSTEM DISCUSSED THERE IS A SEPARATE CHAPTER PRESENTING THESE FUNDAMENTAL DATA: THE LIST OF THE BINARY COMPOUNDS WITH THEIR CRYSTAL STRUCTURES, THE COMPOSITION OF THE VAPOR OVER THE CONDENSED PHASES (AT LEAST QUALITATIVELY) TOGETHER WITH THE DEPENDENCE ON THE EXPERIMENTAL CONDITIONS, AND LAST, THE RESULTS OF TENSIMETRIC EXPERIMENTS USUALLY GIVEN IN THE FORM $\log P = f(T)$. THE VALUES OF DISSOCIATION ENERGY FOR THE GASEOUS SPECIES OR EVENTUALLY THOSE OF STANDARD FREE ENERGY OF FORMATION FOR THE INDIVIDUAL CONDENSED PHASE @G SUB F $^{\circ}_0$ ARE PRESENTED PROVIDED THAT THEY ARE DERIVED ON THE BASIS OF TENSIMETRIC DATA.

ABSTRACT 387

KRUGER O L

ANL-7155 P105

PROPERTIES OF CARBIDES, SULFIDES AND PHOSPHIDES OF PU

REPORTED DATA ON THERMAL EXPANSION COEFFICIENT OF PUN AND PUC FROM 50 TO 1000 DEG C; AND ELECTRICAL RESISTIVITY OF PUC FROM ROOM TEMPERATURE TO 700 DEG C.

ABSTRACT 388

KRUGER O L

J AM CERAM SOC 46, 80 (1963)

PHASE STUDIES ON ARC-MELTED PLUTONIUM-CARBON ALLOYS NEAR THE MONOCARBIDE COMPOSITION

THE PHASE BOUNDARIES AND STRUCTURE OF PLUTONIUM MONOCARBIDE WERE STUDIED IN ARC-MELTED ALLOYS CONTAINING BETWEEN 42 AND 60 AT.% CARBON. METALLOGRAPHIC AND X-RAY DIFFRACTION TECHNIQUES WERE USED TO DETERMINE THE PHASES PRESENT IN AS-CAST AND HEAT-TREATED ALLOYS. THE PHASE BOUNDARIES OF CAST PUC WERE FOUND TO BE ABOUT 42.5 AT.% CARBON ON THE LOW-CARBON SIDE TO BETWEEN 48.5 AND 50 AT.% CARBON ON ITS HIGH-CARBON SIDE. AT 1000 DEG AND 400 DEG C THE LOW-CARBON PUC PHASE BOUNDARY SHIFTED TO HIGHER CARBON COMPOSITIONS OF ABOUT 45.5 AND 46 AT.% CARBON, RESPECTIVELY. A COMPARISON OF THE EXPERIMENTAL DENSITIES WITH THE THEORETICAL DENSITIES SHOWED THAT PUC WAS A DEFECT STRUCTURE WITH SOME OF ITS CARBON ATOM LATTICE SITES VACATED.

ABSTRACT 389

KRUGER O L

J CHEM PHYS 40, 3324 (1964)

HEAT CAPACITY OF PLUTONIUM MONOCARBIDE FROM 400 TO 1300K

THE HEAT CONTENT OF PUC ABOVE 298 DEG K WAS MEASURED WITH AN ISOTHERMAL DROP CALORIMETER. NO DISCONTINUITIES WERE OBSERVED IN THE HEAT-CONTENT-VS-TEMPERATURE CURVE, WHICH IS DESCRIBED BY THE EQUATION $HT-H_{SUB} 298 = -5035 + 13.08T + 5.718 \times 10^{-4} T^2 + 3.232 \times 10^{-5} T^3 - 1$. THE EQUATION FOR THE HEAT CAPACITY $CP = 13.08 + 11.44 \times 10^{-4} T - 3.232 \times 10^{-5} T^2$ WAS DERIVED FROM THE CALCULATED ENTHALPY EQUATION. VALUES OF THE CHANGE IN ENTHALPY, HEAT CAPACITY, AND ENTROPY INCREMENTS ARE GIVEN UP TO THE MELTING POINT OF PUC. CORRECTIONS OF THE ENTHALPY DATA FOR THE SELF-HEATING OF PLUTONIUM AND THE DEFECT STRUCTURE OF PUC ARE DESCRIBED.

ABSTRACT 390

KRUGER O L

J NUCL MATER 7, 142 (1962)

PREPARATION AND SOME PROPERTIES OF ARC-CAST PLUTONIUM MONOCARBIDE

PLUTONIUM-CARBON ALLOYS IN THE COMPOSITIONAL RANGE OF 42 TO 60 AT % CARBON WERE PREPARED BY ARC MELTING AND DROP CASTING. METALLOGRAPHY, X-RAY DIFFRACTION AND CHEMICAL ANALYSIS WERE USED TO EVALUATE THE ALLOYS. DENSITY, HARDNESS AND THERMAL EXPANSION WERE MEASURED. UNEXPECTED ABRUPT CHANGES IN THE RATE OF EXPANSION WHICH COULD NOT BE ATTRIBUTED TO A PHASE CHANGE WERE OBSERVED IN ALLOYS WITH MORE THAN 46 AT % CARBON. THIS EFFECT WHICH ACCOUNTED FOR INCREASES OF TWO TO FOUR TIMES THE NORMAL THERMAL EXPANSION COEFFICIENT WAS REMOVED ON THERMAL CYCLING.

ABSTRACT 391

KRUGER O L

J PHYS CHEM SOLIDS 28, 2321 (1967)

LATTICE CONSTANTS AND MELTING POINTS OF ACTINIDE-GROUP IVA-VIA COMPOUNDS WITH NaCl-TYPE STRUCTURES

COMPOUNDS OF THE ACTINIDES WITH GROUP V AND VI NONMETALS WERE PREPARED BY REACTION OF HIGH-PURITY METALS WITH THE APPROPRIATE GASES AND BY ARC-FUSION OF THE ELEMENTS. LATTICE CONSTANTS AND MELTING POINTS OF THE COMPOUNDS ARE REPORTED. THESE PROPERTIES WERE CORRELATED WITH THE ELECTRONIC CONFIGURATION OF THE ACTINIDES, AND THE POSITION OF THE NONMETAL COMPONENT IN THE PERIOD TABLE.

ABSTRACT 392

KRUGER O L

NUCL MET AIME 10,387 (1964)

CONSTITUTION AND PROPERTIES OF PLUTONIUM MONOCARBIDE

THE PREPARATION OF PLUTONIUM MONOCARBIDE BY ARC-MELTING AND POWDER METHODS IS DISCUSSED. DATA FROM PHASE STUDIES ON ARC-MELTED MATERIAL WERE USED TO CONSTRUCT A PARTIAL PHASE DIAGRAM SHOWING THE MOST PROBABLE PHASE BOUNDARIES OF PUC. THE FOLLOWING PROPERTIES ARE REVIEWED: DENSITY, HARDNESS, THERMAL EXPANSION, ELECTRICAL RESISTIVITY, THERMOELECTRIC POWER, VAPORIZATION, HEAT CAPACITY, THERMAL CONDUCTIVITY AND COMPATIBILITY.

ABSTRACT 393

KRUPKA M C

BULL AM CERAM SOC 48, 1133 (1969)

HIGH PRESSURE EFFECTS WITHIN THE URANIUM-CARBON SYSTEM

THE EFFECT OF HIGH PRESSURES ON COMPOUNDS WITHIN THE URANIUM-CARBON SYSTEM HAS BEEN STUDIED FROM AMBIENT TEMPERATURE TO APPROXIMATELY 1500 DEG C. RESISTANCE VS PRESSURE MEASUREMENTS AT AMBIENT TEMPERATURE HAVE BEEN MADE TO 50 KB. SINGLE AND DIPHASIC COMPOSITIONS RANGING FROM UC SUB 0.97 TO UC SUB 2.11 WERE STUDIED. A RAPID HIGH YIELD SYNTHESIS OF U SUB 2 C SUB 3 HAS BEEN ACCOMPLISHED UNDER CONDITIONS OF ELEVATED TEMPERATURE AND PRESSURE. AT 15 KB AND A CONSTANT REACTION TIME, A YIELD VS TEMPERATURE CURVE WAS ESTABLISHED FOR U SUB 2 C SUB 3. ACCELERATION OF THE REACTION RATE ABOVE THAT OBTAINED BY NORMAL ANNEALING TECHNIQUES WAS OBSERVED.

ABSTRACT 394

KUBOTA T

J NUCL SCI TECHNOL TOKYO 1, 93 (1964)

THERMAL CONDUCTIVITY OF UO SUB 2, UC, AND UC SUB 2

THERMAL CONDUCTIVITIES OF UC SUB 2, UC, AND UC SUB 2 WERE MEASURED. THERE WAS NO CLEAR EVIDENCE OF THE INCREASE OF THERMAL CONDUCTIVITY OF UO SUB 2 IN THE TEMPERATURE RANGE BETWEEN 1000 AND 1600 DEG C, ALTHOUGH THE EFFECT OF RADIATION TRANSFER MECHANISM WAS THOUGHT TO PLAY A ROLE FROM THE TENDENCY THAT THE DECREASE OF THERMAL CONDUCTIVITY DID CEASE AROUND 1200 DEG C. THERMAL CONDUCTIVITIES OF SINTERED UC AND UC SUB 2 PELLETS - BOTH 95% T.D. - WERE MEASURED BY AXIAL HEAT FLOW METHOD. THERMAL CONDUCTIVITY OF UC WAS AROUND 0.05 TO 0.04 CAL/S-CM-DEG C AT THE TEMPERATURE RANGE BETWEEN 100 AND 400 DEG C, WHILE MEASURED VALUES ON UC SUB 2 WERE AROUND

ABSTRACT 394 (CONT'D)

0.016 APPROX 0.014 IN THE TEMPERATURE RANGE BETWEEN 200 AND 400 DEG C.

ABSTRACT 395

KUL'VARSKAYA B S

AT ENERGIYA (USSR) 21, 368 (1966)

INVESTIGATION OF EVAPORATION VELOCITIES OF URANIUM AND ZIRCONIUM CARBIDE CATHODES AND THEIR SOLID SOLUTIONS

FOR INVESTIGATION OF THE EVAPORATION VELOCITY OF CARBIDE THERMOCATHODES, THE LANGMUIR METHOD WAS USED IN CONJUNCTION WITH THE BECKER METHOD. DATA WERE OBTAINED ON THE EVAPORATION RATES OF CATHODES OF ZrC, UC, AND THEIR SOLID SOLUTIONS. IT WAS ESTABLISHED THAT THE HIGHEST EVAPORATION RATE WAS POSSESSED BY UC AND THE LOWEST BY ZrC; THE SOLID SOLUTIONS OCCUPY AN INTERMEDIATE POSITION. IT WAS SHOWN THAT THE EVAPORATION RATES OF THE CARBIDE CATHODES DEPENDS ON THE CATHODE SUPPORT.

ABSTRACT 396

KUMMERER K

EURFNR-722 (1969)

CARBIDE FUELS FOR FAST BREEDER REACTORS

A COMPREHENSIVE VIEW OF THE PRESENT KNOWLEDGE AND EXPERIENCE ON THESE FUELS IS PRESENTED. SEVENTEEN CONTRIBUTIONS TO THE SEMINAR ARE COMPILED IN AN ELABORATED AND SUPPLEMENTED FORM. THEY ARE SELF-CONTAINED. THE MOST ESSENTIAL RESULTS OF THE DISCUSSIONS ARE ADDED TO EVERY SINGLE REPORT. BEGINNING WITH THE SIGNIFICANCE OF THESE FUELS FOR THE APPLICATION IN FAST BREEDERS AND THE CORRESPONDING POINTS OF VIEW IN TERMS OF REACTOR PHYSICS AND ECONOMICS, THE SERIES OF SUBJECTS COVER IMPORTANT PHYSICAL AND CHEMICAL PROPERTIES, THE IRRADIATION BEHAVIOR, AND THE FABRICATION AND RE-PROCESSING METHODS WITHIN THE FUEL CYCLE. A CONCLUSIVE EVALUATION OF THE PRESENT STATUS OF KNOWLEDGE IS MADE. IN THIS CONTEXT, THE MOST IMPORTANT GOALS OF FUTURE PRACTICAL DEVELOPMENT ARE ALSO CHARACTERIZED.

ABSTRACT 397

KURASAWA T

J NUCL MATER 43, 192 (1972)

TRANSFORMATION TO U SUB 2 C SUB 3 PHASE IN UC-UC SUB 2 AND UC SUB 2 PHASES

METALLOGRAPHIC STUDIES WERE CARRIED OUT ON THE U SUB 2 C SUB 3 TRANSFORMATION FROM URANIUM CARBIDES CHARACTERIZED BY THE PHASE OF THE IMMISCIBILITY REGION AND WIDMANSTATTEN STRUCTURE. THE FOLLOWING RESULTS WERE OBTAINED. THE U SUB 2 C SUB 3 PHASE GREW ALONG WIDMANSTATTEN UC SUB 2 CONGREGATING AT AN INITIAL STAGE. THE AMOUNT OF U SUB 2 C SUB 3 IN THE SPECIMENS HAVING WIDMANSTATTEN STRUCTURE WAS DETERMINED BY THE AMOUNT OF WIDMANSTATTEN UC SUB 2. THE SINTERED PELLET IN THE PHASE OF THE IMMISCIBILITY REGION EXHIBITED THE CONSUMPTION OF HERRINGBONE UC FOR U SUB 2 C SUB 3 TRANSFORMATION. DECOMPOSITION OF UC SUB 2 WITH EXCESS CARBON WAS FOUND TO BE ENHANCED, COMPARED WITH UC SUB 2 WITHOUT EXCESS CARBON. FROM THE METALLOGRAPHIC EXAMINATION AND X-RAY STUDY, THE U SUB 2 C SUB 3 PHASE WAS FOUND TO BE TRANSFORMED INWARD FROM THE OUTER SURFACE OF THE SPECIMENS. RATES OF U SUB 2 C SUB 3 TRANSFORMATION FOR THE ARC-MELTED AND SINTERED SPECIMENS (C/U APPROX =1.5) ARE EXPRESSED BY THE FOLLOWING EQUATIONS, RESPECTIVELY: $K=0.40\exp(-E_{SUB 2}/RT)\text{CM}^2/\text{SEC}$,

ABSTRACT 397 (CONT'D)

$K = 0.29 \exp(-E_{\text{SUB } 2} / RT) \text{ CM}^{**2} / \text{SEC}$, $E_{\text{SUB } 1} = 48.3 \pm 7.4 \text{ KCAL/MOLE}$, $E_{\text{SUB } 2} = 40.9 \pm 4.8 \text{ KCAL/MOLE}$. THESE PHENOMENA ARE ALSO CONSIDERED TO BE RELATED TO THE REMOVAL OF THE DISSOLVED OXYGEN FROM UC SUB 2 AND TO THE CARBON DIFFUSION PROCESS. MICROCRACKS AND WRINKLING OF WIDMANSTATTEN UC SUB 2 WERE OBSERVED, ACCOMPANIED BY VOLUME CONTRACTION DUE TO THE U SUB 2 C SUB 3 TRANSFORMATION.

ABSTRACT 398

LANGER S

MATERIALS AND FUELS FOR HIGH-TEMP NUCL ENERGY APPLICATIONS, P242 (1964)
PHYSICOCHEMICAL PROPERTIES OF CARBIDES FOR NUCLEAR APPLICATIONS

THE PHYSICOCHEMICAL PROPERTIES OF THE ACTINIDE AND REFRACTORY CARBIDES ARE REVIEWED, AND THE PHASE RELATIONS IN SYSTEMS COMPOSED OF MIXED ACTINIDE CARBIDES, ACTINIDE CARBIDES AND GRAPHITE, AND SYSTEMS OF THE ACTINIDE CARBIDES AND THE REFRACTORY CARBIDES ARE DISCUSSED. THE CONFLICTING AND ANOMALOUS DATA ARE DISCUSSED AND THE ABSENCE OF IMPORTANT DATA IS NOTED. THE BASIC PHYSICOCHEMICAL PROPERTIES OF THE CARBIDES WERE ANALYSED WITH RESPECT TO THEIR USE AS A REACTOR CORE MATERIAL. THE KNOWN PHASE EQUILIBRIA WERE ANALYSED TO PREDICT THE MELTING BEHAVIOR OF PREVIOUSLY PROPOSED REACTOR SYSTEMS, AND THE POTENTIAL OF VARIOUS COMBINATIONS OF THE ACTINIDE AND REFRACTORY CARBIDES FOR HIGH-POWERED BURNER OR POWER-REACTOR SYSTEMS WAS DISCUSSED.

ABSTRACT 399

LAPAT P E

IMD SPEC REP SER 13, 225 (1964); NUCL MET AIME 10, 225 (1964)
THERMODYNAMICS OF THE URANIUM-NITROGEN SYSTEM

A CONTINUOUS VACUUM BALANCE TECHNIQUE WAS USED TO MEASURE EQUILIBRIUM DECOMPOSITION PRESSURES OF U SUB 2 N SUB 3 FROM 600-1100 DEG C AND N/U RATIOS FROM 1.7 DOWN TO THE TWO-PHASE REGION UN + U SUB 2 N SUB 3. UN DATA WERE ALSO OBTAINED AT 1073 DEG C FOR SLIGHTLY HYPERSTOICHIOMETRIC COMPOSITIONS. SOME OF THE PHASE BOUNDARIES OF THE TWO NITRIDES WERE LOCATED. THE PARTIAL MOLAL HEATS AND ENTROPIES OF SOLUTION OF N SUB 2 IN SINGLE-PHASE "U SUB 2 N SUB 3" WERE CALCULATED AS A FUNCTION OF COMPOSITION. THE HEAT OF DECOMPOSITION OF "U SUB 2 N SUB 3" ACCORDING TO THE REACTION $x \text{ "U SUB 2 N SUB 3" } = y \text{ "UN" } + n \text{ "SUB 2" }$ WAS DETERMINED TO BE 57 KCAL/MOLE OF N SUB 2, WHICH IS IN EXCELLENT AGREEMENT WITH A PREVIOUSLY REPORTED VALUE OF 58 KCAL/MOLE OF N SUB 2.

ABSTRACT 400

LAPAT P E

UNC-5060 (1963)

THERMODYNAMICS OF THE URANIUM-NITROGEN SYSTEM

A CONTINUOUS VACUUM BALANCE TECHNIQUE WAS USED TO MEASURE EQUILIBRIUM DECOMPOSITION PRESSURES OF U SUB 2 N SUB 3 FROM 600-1100 DEG C AND N/U RATIOS FROM 1.7 DOWN TO THE TWO-PHASE REGION UN + U SUB 2 N SUB 3. DATA WERE ALSO OBTAINED ON UN AT 1073 DEG C AND SLIGHTLY HYPERSTOICHIOMETRIC COMPOSITIONS. SOME OF THE PHASE BOUNDARIES OF THE TWO NITRIDES WERE LOCATED.

ABSTRACT 401

LAPAT P E

UNC-5077 (1964)

THERMODYNAMICS OF THE URANIUM-NITROGEN SYSTEM

A CONTINUOUS VACUUM BALANCE TECHNIQUE HAS BEEN USED TO MEASURE EQUILIBRIUM DECOMPOSITION PRESSURES OF $U_{0.8}N_{0.2}$ FROM 600 TO 1100 DEG C AND N/U RATIOS FROM 1.7 DOWN TO THE TWO-PHASE REGION $UN + U_{0.8}N_{0.2}$. DATA WERE ALSO OBTAINED ON UN AT 1073 DEG C AND SLIGHTLY HYPERSTOICHIOMETRIC COMPOSITIONS. SOME OF THE PHASE BOUNDARIES OF THE TWO NITRIDES WERE LOCATED. THE PARTIAL MOLAL HEATS AND ENTROPIES OF SOLUTION OF $U_{0.8}N_{0.2}$ IN SINGLE-PHASE $U_{0.8}N_{0.2}$ WERE CALCULATED AS A FUNCTION OF COMPOSITION. THE HEAT OF DECOMPOSITION OF $U_{0.8}N_{0.2}$ ACCORDING TO THE REACTION $xU_{0.8}N_{0.2} = yUN + N_2$ WAS DETERMINED TO BE 57 KCAL/MOL OF N_2 , WHICH IS IN EXCELLENT AGREEMENT WITH A PREVIOUSLY REPORTED VALUE OF 58 KCAL/MOL OF N_2 . THE VACUUM BALANCE APPARATUS HAS BEEN MODIFIED TO OPERATE AT TEMPERATURES ABOVE 1100 DEG C.

ABSTRACT 402

LATIMER T W

ANL-7927 (1971)

COMPATIBILITY OF U-PU CARBIDE FUELS AND POTENTIAL LMFBR CLADDING MATERIALS

THE CONTACT COMPATIBILITY (IN THE ABSENCE OF SODIUM) BETWEEN (U,PU)C WITH EQUIVALENT CARBON CONTENTS OF 4.83, 5.25, AND 6.75 WT % AND VARIOUS IRON-, NICKEL-, AND VANADIUM-BASE ALLOYS WAS STUDIED AT 700-1100 DEG C FOR 168-4000 HR. AUSTENITIC IRON-BASE ALLOYS, CONTAINING 25 WT%, OR LESS NICKEL AND TESTED AT 800 DEG C FOR UP TO 4000 HR, SHOWED LITTLE OR NO EVIDENCE OF CARBON TRANSFER FROM STOICHIOMETRIC OR HYPERSTOICHIOMETRIC ($U_{0.8}Pu_{0.2}$)C THAT CONTAINED UP TO 20 VOL % ($U_{0.8}Pu_{0.2}$)C TO FORM THREE AUSTENITIC ALLOYS CONTAINING MORE THAN 30 WT%, NICKEL REACTED WITH STOICHIOMETRIC AND HYPERSTOICHIOMETRIC ($U_{0.8}Pu_{0.2}$)C TO FORM INTERMETALLIC COMPOUNDS AT FUEL-CLADDING INTERFACE AND PRECIPITATES IN THE CLADDING AT 700 AND 800 DEG C. VANADIUM BASE ALLOYS CONTAINING 15-20 WT% TITANIUM WERE CARBURIZED BY ($U_{0.8}Pu_{0.2}$)C AND REDUCED ($U_{0.8}Pu_{0.2}$)C TO ($U_{0.8}Pu_{0.2}$)C AT 800 DEG C. HOWEVER, ALLOYS CONTAINING 5 WT%, OR LESS TITANIUM OR OTHER RELATIVELY STRONG CARBIDE FORMERS WERE ONLY SLIGHTLY AFFECTED BY HYPERSTOICHIOMETRIC ($U_{0.8}Pu_{0.2}$)C AT 800 DEG C FOR UP TO 4000 HR.

ABSTRACT 403

LATIMER T W

NUCL MET MET SOC AIME 13, 322 (1968)

COMPATIBILITY OF (U,PU) CARBIDES WITH POTENTIAL JACKETING MATERIALS

OBSERVATIONS WERE MADE OF THE EXTENT AND TYPE OF REACTION OF SEVERAL IRON-, NICKEL-, AND VANADIUM-BASE ALLOYS IN CONTACT WITH URANIUM-PLUTONIUM CARBIDE COMPOSITIONS IN THE TEMPERATURE RANGE 700-1100 DEG C. REACTION ZONES WERE ANALYZED BY MEANS OF METALLOGRAPHY AND AN ELECTRON MICROSCOPE. BANDS IN WHICH FINE PRECIPITATES WERE FOUND TO A DEPTH OF APPROXIMATELY 25 MICRONS WERE OBSERVED IN SOME IRON-BASE ALLOYS AFTER CONTACT WITH ($U_{0.8}Pu_{0.2}$)C FOR 1000 HOURS AT 800 DEG C. REACTION OF ($U_{0.8}Pu_{0.2}$)C WITH NICKEL-BASE ALLOYS WAS CHARACTERIZED BY THE FORMATION OF ($U_{0.8}Pu_{0.2}$)C IN THE FUEL, AND THE FORMATION OF A LAYER, HAVING A RELATIVELY HIGH CHROMIUM AND CARBON CONTENT, IN THE JACKETING ALLOY. ADDITION OF IRON WAS SHOWN TO ELIMINATE FREE URANIUM AND PLUTONIUM FROM

ABSTRACT 403 (CONT'D)

HYPOSTOICHIOMETRIC (U,PU)C. (U,PU)FE SUB 2 WAS FOUND TO HAVE EXCELLENT COMPATIBILITY WITH STAINLESS STEEL AT 800 DEG C.

ABSTRACT 404

LATIMER T W

TRANS AM NUCL SOC 11, 511 (1968)

COMPATIBILITY OF VANADIUM ALLOYS WITH (U,PU) CARBIDES

THE VANADIUM ALLOYS ARE PROMISING CLADDING MATERIALS FOR (U,PU)C. HOWEVER THE AMOUNTS OF STRONG CARBIDE FORMERS IN THESE ALLOYS PLAY AN IMPORTANT ROLE IN DETERMINING THE OVERALL COMPATIBILITY OF THE ALLOYS WITH (U,PU)C.

ABSTRACT 405

LATIMER T W

TRANS AM NUCL SOC 12, 594 (1969)

COMPATIBILITY OF CARBIDE FUELS WITH POTENTIAL LMFBR CLADDINGS

IN SUMMARY, THE EXISTING EVIDENCE INDICATES THAT CARBON TRANSFER TO STAINLESS STEEL CLADDING FROM STOICHIOMETRIC (U,PU)C OR FROM HYPERSTOICHIOMETRIC (U,PU)C THAT CONTAINS DISCRETE PARTICLES OF (U,PU) SUB 2 C SUB 3 MAY NOT BE A LIMITING FACTOR IN HELIUM- OR SODIUM-BONDED SYSTEMS. PRELIMINARY INVESTIGATIONS OF THE EFFECT OF FISSION PRODUCTS AND OF IRRADIATION-ENHANCED CHEMICAL PROCESSES ON FUEL-CLADDING COMPATIBILITY INDICATE THAT CLADDING DAMAGE BY THESE PROCESSES IS SIGNIFICANTLY LESS THAN THAT FOUND WITH (U,PU)O SUB 2 FUEL.

ABSTRACT 406

LAUGIER J

COMPT REND ACAD SC PARIS C270, 1358 (1970)

STUDY OF THE EQUILIBRIUM DIAGRAM OF UC-UC SUB 2 BY HIGH TEMPERATURE X-RAY DIFFRACTION

BY X-RAY DIFFRACTION AT HIGH TEMPERATURE, IT IS SHOWN THAT THE EQUILIBRIUM DIAGRAM FOR UC-UC SUB 2 MUST BE MODIFIED. THE DECOMPOSITION OF U SUB 2 C SUB 3 IS EFFECTED ACCORDING TO THE REACTION @ 1790±30 DEG C, U SUB 2 C SUB 3 = UC SUB (1+X)+UC SUB (1+X**1) WHERE X=0.10 AND X**1=0.69. ONE OF THESE CUBIC SOLID SOLUTIONS, UC SUB 1+X**1 IS FORMED BY EUTECTOID REACTION AT 1700 DEG: U SUB 2 C SUB 3+UC SUB 2=UC SUB 1+X**1.

ABSTRACT 407

LAUGIER J

J NUCL MATER 28,215 (1968)

RELATIONS DE PHASES ENTRE LES DEUX VARIETES DU SESQUINITRURE D'URANIUM

THE CONDITIONS AND EQUILIBRIUM INVOLVED IN THE FORMATION OF HEXAGONAL U SUB 2 N SUB 3 ARE DESCRIBED.

ABSTRACT 408

LAUGIER J

J NUCL MATER 39, 245 (1971)

LE DIAGRAMME METASTABLE UC-UC SUB 2

HIGH TEMPERATURE X-RAY DIFFRACTION STUDIES WERE CARRIED OUT ON THE UC-UC SUB 2 SYSTEM. THE DIFFERENCES BETWEEN FORMERLY PUBLISHED RESULTS WERE SHOWN TO BE DUE TO THE EXISTENCE OF TWO DISTINCT PHASE DIAGRAMS, A STABLE AND A METASTABLE ONE. THE STABLE EQUILIBRIUM DIAGRAM DETERMINED BY BENZ WAS FOUND TO BE ESSENTIALLY CORRECT EXCEPT THAT CARBON STARTS DISSOLVING IN UC AT A TEMPERATURE AS LOW AS 1100 DEG C AND THAT THE UC SUB 2 DECOMPOSITION INTO U SUB 2 C SUB 3 AND CARBON TAKES PLACE AT ABOUT 1100 DEG C. THE METASTABLE DIAGRAM CAN BE DEDUCED FROM THE STABLE ONE BY SUPPRESSING THE U SUB 2 C SUB 3 PHASE, WHICH INDUCES A TWO-PHASE (UC+TETRAGONAL UC SUB 2) REGION OF METASTABILITY UP TO 1840 ± 30 DEG C. THE UC SUB 2 COMPOSITIONS ARE IN CLOSE CONNECTION WITH THE DECREASE OF LATTICE PARAMETER C THE VALUES OF WHICH ARE CORRECTED FOR THE THERMAL MOTION EFFECT. IN THE SINGLE-PHASE REGION THE C/U CONCENTRATION RATIO RANGES FROM 1.94 AT 750 DEG C TO 1.65 ON THE LEFT SIDE AND TO 1.905 ON THE RIGHT SIDE AT 1840 DEG C. THIS CHANGE IN CONCENTRATION EXPLAINS THE OCCURRENCE OF A UC PRECIPITATE IN THE URANIUM-CARBON ALLOYS WHICH CONTAIN FREE CARBON. THE METASTABILITY WAS SHOWN TO BE CAUSED BY A DRASTIC REDUCTION OF THE EXTENSIVE DIFFUSION OF CARBON

ABSTRACT 409

LEARY J A

(LA-DC-9059) (1967)

THERMAL CONDUCTIVITY OF URANIUM-PLUTONIUM CARBIDE FUELS

THE THERMAL CONDUCTIVITY OF URANIUM-PLUTONIUM CARBIDES WAS REVIEWED. IT WAS FOUND THAT THE THERMAL CONDUCTIVITY DATA FOR UC GENERALLY FALL WITHIN ±20% AT 200 TO 2000 DEG C. OVER THIS RANGE THE CONDUCTIVITY IS APPROXIMATELY CONSTANT AT 0.05 CAL/SEC. CM DEG C. REPLACEMENT OF URANIUM BY PLUTONIUM IN UC CAUSES A SIGNIFICANT DECREASE IN THERMAL CONDUCTIVITY AND DIFFUSIVITY AT 250 TO 1000 DEG C. MAXIMUM THERMAL CONDUCTIVITY IS OBSERVED IN THE NEAR-STOICHIOMETRIC COMPOSITION RANGE FOR UC AND U SUB 0.85 PU SUB 0.15 C. NICKEL SINTERING AIDS LOWER THE THERMAL CONDUCTIVITY AND DIFFUSIVITY OF UC AND (U,PU)C. APPARENTLY OXYGEN AND NITROGEN LOWERS THE THERMAL CONDUCTIVITY OF CARBIDES. AS FISSION PRODUCTS ARE GENERATED IN CARBIDES FUELS, IT IS UNLIKELY THAT THEY WILL IMPROVE THERMAL CONDUCTIVITY. IT SEEMS MORE PROBABLE THAT THE THERMAL CONDUCTIVITY WILL BE REDUCED. THERE DOES NOT APPEAR TO BE A SATISFACTORY METHOD FOR ADJUSTING THE EFFECTS OF POROSITY ON THERMAL CONDUCTIVITY OF CARBIDES. MORE EXPERIMENTAL WORK MUST BE DONE ON THE THERMAL CONDUCTIVITY OF FULLY CHARACTERIZED CARBIDES IN ORDER TO FULLY EXPLOIT THIS PROPERTY IN REACTOR APPLICATIONS. FURTHER WORK ON THERMAL CONDUCTIVITY SHOULD BE RELATED TO MEASUREMENT OF THE ELECTRICAL RESISTIVITY ON THE SAME MATERIALS.

ABSTRACT 410

LEARY J A

AM CERAM SOC SPEC PUBL 2, 38 (1969)

PRESENT STATUS OF THE URANIUM-PLUTONIUM-CARBON PHASE DIAGRAM

PHASE DIAGRAMS OF U-C, PU-C, AND U-PU-C SYSTEM ARE DISCUSSED.

ABSTRACT 411

LEARY J A

CARRIDES IN NUCL ENERGY, HARWELL C10 (1963)

THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF UC, (U,PU)C, AND PUC.

RODS OF UC, (U,PU)C SOLID SOLUTIONS, AND SINGLE PHASE PUC SUB 0.86 HAVE BEEN PREPARED BY CONVENTIONAL ARC MELTING AND CASTING TECHNIQUES. AFTER SOLUTION TREATMENT, THERMAL CONDUCTIVITIES WERE DETERMINED OVER THE TEMPERATURE RANGE OF 200 DEG -450 DEG C. THE RESULTS INDICATE IN THIS TEMPERATURE RANGE THE REPLACEMENT OF URANIUM BY PLUTONIUM IN THE SOLID SOLUTION SYSTEM RESULTED IN A DECREASE IN THERMAL CONDUCTIVITY. FOR EXAMPLE, AT 400 DEG C THE THERMAL CONDUCTIVITY OF UC WAS 0.0540, COMPARED TO 0.0498 AND 0.0420 CAL/S/CM**2/DEG C/CM FOR (U SUB 0.9 PU SUB 0.1)C AND (U SUB 0.8 PU SUB 0.2)C, RESPECTIVELY. THE THERMAL CONDUCTIVITY OF SINGLE PHASE PUC SUB 0.86 WAS 0.0310 CAL/S/CM**2/ DEG C/CM AT 400 DEG C. ALTHOUGH THE REPLACEMENT OF URANIUM BY PLUTONIUM IN THE CARBIDE LATTICE REDUCES THE THERMAL CONDUCTIVITY, THE TEMPERATURE COEFFICIENTS ARE POSITIVE AND INCREASE WITH INCREASING PLUTONIUM CONTENT, IN THIS TEMPERATURE RANGE. THE CONDUCTIVITY OF UC INCREASED LINEARLY FROM 0.0534 AT 300 DEG TO 0.054 AT 400 DEG C. OVER THE SAME TEMPERATURE INTERVAL, THE CONDUCTIVITY OF (U SUB 0.8 PU SUB 0.2)C INCREASED FROM 0.0400 TO 0.0420, WHILE THAT OF PUC SUB 0.86 INCREASED FROM 0.0271 TO 0.0310 CAL/S/CM**2/ DEG C/CM. THE ELECTRICAL RESISTIVITY OF UC, VARIOUS (U,PU)C SOLID COMPOSITIONS, AND PUC SUB 0.6 ALSO HAVE BEEN MEASURED. THE RESISTIVITY OF UC WAS 70 MICRO-OHM CM, COMPARED WITH 273 FOR THE DEFECT STRUCTURE PUC SUB 0.86 AT ROOM TEMPERATURE. REPLACEMENT OF 10 TO 20 PERCENT OF THE URANIUM BY PLUTONIUM RESULTED IN A 39 PERCENT INCREASE IN RESISTIVITY. MEASUREMENTS WERE MADE BY MEANS OF AN EDDY CURRENT METHOD THAT IS PARTICULARLY SUITABLE FOR SPECIMENS THAT CANNOT BE FABRICATED INTO RODS FOR MEASUREMENT BY CLASSICAL METHOD.

ABSTRACT 412

LEARY J A

LADC-10825

CERAMIC PLUTONIUM FUEL MATERIALS RESEARCH AT LOS ALAMOS SCIENTIFIC LABORATORY

DESCRIPTION OF LASL ADVANCED FUELS PROGRAM; SUMMARY OF IMPORTANT RESULTS TO DATE; MEAN LINEAR THERMAL EXPANSION OF PU SUB 2 C SUB 3 OVER THE TEMPERATURE RANGE 20 DEG-1600 DEG C WAS 15.6×10^{-6} /DEG C; MEAN LINEAR THERMAL EXPANSION OF PUC SUB 2 OVER THE RANGE 1750 TO 2000 DEG C WAS 21×10^{-6} /DEG C; NEUTRON DIFFRACTION STUDIES ON **240 PUC AND **240 PU SUB 2 C SUB 3 AT 20-100 DEG K; STRUCTURAL ANALYSIS OF PU SUB 2 C SUB 3 AND U SUB 2 C SUB 3; DIFFERENTIAL THERMAL ANALYSIS ON (U,PU) SUB 2, (U,PU)C, AND (U,PU)C SUB 2; THERMOCHEMICAL PROPERTIES OF PUCL SUB 3, PUN, PU SUB 2 C SUB 3, PUC, (U,PU)C, AND (U,PU)C SUB 2

ABSTRACT 413

LEARY J A

LADC-5924 (1963)

THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF UC, (U,PU)C AND PUC

THE THERMAL CONDUCTIVITIES AND ELECTRICAL RESISTIVITIES OF NUCLEAR CARRIDES HAVE BEEN DETERMINED AT ELEVATED TEMPERATURES. REPLACEMENT OF URANIUM BY PLUTONIUM IN THE CARBIDE LATTICE REDUCES THE THERMAL CONDUCTIVITY. HOWEVER, THE RATE OF INCREASE IN THERMAL CONDUCTIVITY WITH INCREASING TEMPERATURE IS GREATER FOR HIGHER PLUTONIUM CONTENTS. ON THE

ABSTRACT 413 (CONT'D)

BASIS OF ELECTRICAL RESISTIVITY. UC AND (U SUB 0.8 PU SUB 0.2)C ARE PRINCIPALLY METALLIC CONDUCTORS WHILE SINGLE PHASE PUC SUB 0.87 BEHAVES AS A SEMICONDUCTOR. THE LORENZ NUMBER FOR UC (3.30×10^{-13} C.G.S. UNITS) IS CONSTANT OVER THE TEMPERATURE RANGE 200-400 DEG C. FOR (U SUB 0.8 PU SUB 0.2)C, THE VALUE OF 3.92×10^{-13} ALSO REMAINS CONSTANT. HOWEVER, THERE IS CONSIDERABLE VARIATION IN THE LORENZ NUMBER OF PUC SUB 0.87 OVER THIS TEMPERATURE RANGE. IN ALL CASES, THE LORENZ NUMBER IS CONSIDERABLY LARGER THAN THAT CALCULATED THEORETICALLY FOR PURE ELECTRONIC CONDUCTION.

ABSTRACT 414

LEARY J A

LADC-8097 (1966)

PREPARATION AND PROPERTIES OF PLUTONIUM MONONITRIDE AND URANIUM MONONITRIDE-PLUTONIUM MONONITRIDE SOLID SOLUTIONS

METHODS FOR PREPARING SUBJECT NITRIDES AS POWDERS AND AS FINE DENSE PELLETS; REACTION OF PUN WITH PUD SUB 2; LATTICE DIMENSIONS OF SOLID SOLUTIONS OF PUN IN UN; DIFFERENTIAL THERMAL ANALYSIS OF NITRIDES TO MELTING; DECOMPOSITION PRESSURES OF ACTINIDE NITRIDES; GIBBS FREE ENERGY OF FORMATION OF PUN AT 700 DEG K WAS (-60 #1) KCAL/MOLE BY EMF MEASUREMENTS

ABSTRACT 415

LEARY J A

LADC-9913

PRESENT STATUS OF THE URANIUM-PLUTONIUM-CARBON PHASE DIAGRAM

PHASE DIAGRAMS AND STRUCTURE ANALYSIS FOR THE U-PU, THE U-C, AND THE PU-C SYSTEMS; PHASE RELATIONSHIPS IN THE U-PU-C SYSTEM OVER WIDE RANGE OF COMPOSITION AND TEMPERATURE; NO TERNARY COMPOUNDS

ABSTRACT 416

LEARY J A

LAMS-3023 (1963)

QUARTERLY STATUS REPORT ON SOLID PLUTONIUM FUELS PROGRAM FOR PERIOD JULY 1 THROUGH SEPTEMBER 30, 1963.

DEVELOPMENT AND PROPERTIES OF CERAMIC FUEL MATERIALS CONTAINING PLUTONIUM ARE SUMMARIZED. INFORMATION IS INCLUDED ON PREPARATION AND PROPERTIES OF PLUTONIUM OXIDES AND NITRIDES, PROPERTIES OF PLUTONIUM CARBIDE-URANIUM CARBIDE SYSTEMS, CRYSTAL STRUCTURE OF PU SUB 5 SI SUB 3, AND PHASE STUDIES OF PLUTONIUM-CARBON-OXYGEN SYSTEMS.

ABSTRACT 417

LEARY J A

LAMS-3054 (1964)

QUARTERLY STATUS REPORT ON SOLID PLUTONIUM FUELS PROGRAM FOR PERIOD
OCTOBER 1 THROUGH DECEMBER 31, 1963

A PELLET OF PUD SUB 2 WAS HELD FOR 3 H AT 1650 DEG C IN A VACUUM OF 10^{-5} TORR AND THEN QUENCHED AS RAPIDLY AS POSSIBLE BY CONTACTING WITH A CHILLED COPPER BLOCK. THE MICROSTRUCTURE OF THE POLISHED PELLET SHOWED ONLY THE A-PU SUB 2 α SUB 3 AND PUD SUB 2 NETWORK STRUCTURE, WITH NO PUD SUB 2 MATRIX. NITRIDE IS BEING PREPARED BY REACTION OF PU METAL AND N SUB 2, WITH AND WITHOUT THE USE OF H SUB 2. THERMAL CONDUCTIVITIES OF UC, PUC SUB 0.87, (U SUB 0.9 PU SUB 0.1)C, (U SUB 0.8 PU SUB 0.2)C, AND (U SUB 0.7 PU SUB 0.3)C AND ELECTRIC RESISTIVITIES OF (U SUB 0.8 PU SUB 0.2)C, PUC SUB 0.87, AND PUC SUB 1.0 WERE DETERMINED AND PLOTTED. THE THERMODYNAMIC PROPERTIES OF PU-FE ALLOYS AND PUF SUB 2 ARE BEING DETERMINED BY EMF MEASUREMENTS. STUDIES ARE BEING MADE OF THE PU-C-O SYSTEM IN ORDER TO DETERMINE THE PHASE DIAGRAM.

ABSTRACT 418

LEARY J A

NUCL MET MET SOC AIME 13, 309 (1968)

THERMAL CONDUCTIVITY OF URANIUM-PLUTONIUM CARBIDE FUELS

THE THERMAL CONDUCTIVITY AND THERMAL DIFFUSIVITY OF URANIUM MONOCARBIDE, PLUTONIUM MONOCARBIDE, AND URANIUM-PLUTONIUM MONOCARBIDE, SOLID SOLUTIONS ARE REVIEWED. EFFECTS OF SAMPLE POROSITY, STOICHIOMETRY, TEMPERATURE, IMPURITIES, AND SOLID SOLUTION FORMATION ARE DISCUSSED.

ABSTRACT 419

LEARY J A

PLUTONIUM 1965 P639 (1967)

REFRACTORY PLUTONIUM FUEL MATERIALS

THE PLUTONIUM CARBIDES PUC SUB 1-X, PU SUB 2 C SUB 3, (U,PU)C, AND (U,PU) SUB 2 C SUB 3 HAVE BEEN PREPARED AS SINGLE PHASE POWDERS AND AS DENSE BODIES SUITABLE FOR FUELS. SINTERING OF PUD SUB 2 IN INERT AND IN OXIDIZING ATMOSPHERES INDICATED THAT DENSE BODIES WERE PRODUCED IN EITHER CASE. HOWEVER, WHEN AN INERT ATMOSPHERE WAS USED, A B.C.C. FORM OF PU SUB 2 α SUB 3 WAS PRODUCED WHEN THE SINTERING TEMPERATURE WAS HIGH. STOICHIOMETRIC PUN POWDERS WERE PRODUCED BY REACTION OF PUH SUB 0.04 WITH N SUB 2. DENSIFICATION OF PELLETS PRESSED FROM PUN POWDERS WAS SLIGHT AT 1600 DEG AND 2000 DEG C. WHEN PUN WAS COSINTERED WITH PUD SUB 2 IN N SUB 2 THE PUD SUB 2 WAS REDUCED TO HEXAGONAL PU SUB 2 α SUB 3 WITH LIBERATION OF N SUB 2. COSINTERING OF UN AND PUN POWDERS AT 1900 DEG C IN N SUB 2 PRODUCED SOLID SOLUTIONS OF THE COMPOSITIONS (U SUB 0.80 PU SUB 0.20)N, (U SUB 0.50 PU SUB 0.50)N, AND (U SUB 0.3 PU SUB 0.7)N.

ABSTRACT 420

LEARY J A

PROC INTERN MTG ON FAST REACTOR FUEL AND FUEL ELEMENTS, KARLSRUHE,
P436 (1970)

SYNTHESIS, FABRICATION, AND BEHAVIOR OF SINGLE PHASE U-PU-CARBIDES FOR
FAST BREEDER REACTORS

PROCESSING OF POWDERS AND PELLETS OF VARIOUS DENSITIES AND ENRICHMENTS,

ABSTRACT 420 (CONT'D)

THERMAL REDISTRIBUTION OF PU IN MIXED TWO-PHASE CARBIDES, FABRICATION OF NA-BONDED PINS, IRRADIATION PROGRAM DESIGN, ELECTRON MICROPROBE STUDIES ON UNIRRADIATED FUEL.

ABSTRACT 421

LEARY J A

TRANS AM NUCL SOC 9, 37 (1966)

RECENT DEVELOPMENTS IN HIGH-TEMPERATURE PLUTONIUM COMPOUNDS

RECENT DEVELOPMENTS IN THE CHEMISTRY OF LESS COMMON PLUTONIUM COMPOUNDS THAT MIGHT BE SUITABLE AS NUCLEAR FUELS ARE REVIEWED. METHODS FOR SYNTHESIZING AND FABRICATING PU SUB 2 C SUB 3, (U, PU) SUB 2 C SUB 3, PUC SUB 2, (U,PU)C SUB 2, (TH,PU)C SUB 2, PUN, (U,PU)N, PU(C,N), PUS, AND PUP ARE REPORTED. THE PRESENT STATE OF KNOWLEDGE OF PROPERTIES OF THESE COMPOUNDS SUCH AS STRUCTURE, DENSITY, THERMAL EXPANSION, THERMAL CONDUCTIVITY, PHASE RELATIONSHIPS, THERMODYNAMIC PROPERTIES, COMPATIBILITY, AND IRRADIATION BEHAVIOR IS EVALUATED.

ABSTRACT 422

LEARY J A

TRANS AMER NUCL SOC 12, 577 (1969)

SYNTHESIS AND FABRICATION OF CARBIDE FUELS

SYNTHESIS AND FABRICATION OF SINGLE PHASE (U,PU)C FUEL FOR PROPERTIES AND IRRADIATION TESTING; REVIEW OF U.S. PROCESSES

ABSTRACT 423

LEARY J A

U S PATENT NO 3,279,898; (1966)

METHOD OF PREPARING PLUTONIUM MONONITRIDE

DESCRIBES METHOD OF PREPARING NONPYROPHORIC PLUTONIUM NITRIDE FROM PLUTONIUM METAL BY CONVERSION TO THE HYDRIDE AND REACTION WITH NITROGEN.

ABSTRACT 424

LEE H M

PROC BRIT CEPAM SOC 7, 141 (1967) AND J NUCL MATER 27, 275 (1968)

MEASUREMENTS OF SELF-DIFFUSION IN URANIUM CARBIDE AND THEIR APPLICATION TO RELATED ACTIVATED PROCESSES

THE SELF-DIFFUSION PARAMETERS FOR CARBON AND URANIUM IN STOICHIOMETRIC AND NONSTOICHIOMETRIC URANIUM CARBIDE WERE MEASURED BY MEANS OF $^{14}\text{SUB C}$ AND ^{235}U IN THE RANGE 1260 - 1800 DEG C BY STANDARD SECTIONING TECHNIQUE. FOR STOICHIOMETRIC UC THE DIFFUSION OF C IN THE TEMPERATURE RANGE 1266 - 1684 DEG C CAN BE REPRESENTED BY THE EQUATION $D = 1.75 \exp\{- (63,000 \div 1,000) / RT\}$. ALSO, THE DIFFUSION OF U IN THE TEMPERATURE RANGE 1505 - 1863 DEG C CAN BE REPRESENTED BY THE EQUATION $D = 8.47 \exp\{- (104,000 \div 7,000) / RT\}$. THESE RESULTS PERMIT COMPARISON WITH THE WORK OF OTHERS ON SINTERING, CREEP AND FISSION-GAS RELEASE. THE ACTIVATION ENERGY OF BULK DIFFUSION FOR U IS IN GOOD AGREEMENT WITH THAT OF THE SINTERING KINETICS OF MCLAREN, REGAN AND HEDGER FROM THE RESULTS OF NORREYS AND WHEELER, IT IS INDICATED THAT THE MECHANISM FOR CREEP IS MORE COMPLICATED

ABSTRACT 424 (CONT'D)
THAN THAT OF NABARRO AND HERRING.

ABSTRACT 425
LEITNAKER J M
HIGH TEMP SCI 48, 389 (1969)
THE LATTICE PARAMETER OF U(C,N) AS A FUNCTION OF COMPOSITION

THE UC-UN SOLID SOLUTION SHOWS SIGNIFICANT VARIATION FROM VEGARD'S LAW. THE SINGLE-PHASE REGION IS NARROW. THE EQUATION $N/N+C=1.00-12.6057(A \text{ SUB } 0-4.8892)+55.8264(A \text{ SUB } 0-4.8892)**2-3.38174*10**2(A \text{ SUB } 0-4.8892)**3-1.04432*10**4(A \text{ SUB } 0-4.8892)**4$, WHERE A SUB 0 IS IN ANGSTROMS, BEST EXPRESSES THE LATTICE PARAMETER-MOLE FRACTION RELATIONSHIP. TO OBTAIN THESE RESULTS, EQUILIBRIUM HAS BEEN APPROACHED FROM TWO DIRECTIONS, AND TWO SIDES OF THE SINGLE-PHASE SOLID SOLUTION REGION HAVE BEEN EXAMINED. OBTAINING TRUE EQUILIBRIUM BETWEEN UC AND N SUB 2 WAS VERY DIFFICULT EVEN AT TEMPERATURES AS HIGH AS 1900 DEG. THE LACK OF COMPLETE EQUILIBRIUM IS PROBABLY RESPONSIBLE FOR MUCH OF THE SCATTER OF LATTICE PARAMETER VERSUS COMPOSITION DATA FOR U(C,N) IN THE LITERATURE. CAREFUL CHEMICAL CHARACTERIZATION WAS CARRIED OUT ON THE SAMPLES.

ABSTRACT 426
LEITNAKER J M
J AM CERAM SOC 53, 479 (1970)
REACTION OF UC WITH N SUB 2 FROM 1475 TO 1700 DEG C

THE REACTION OF NITROGEN WITH ARC-MELTED UC WAS STUDIED FROM 1475 DEG TO 1700 DEG C AT AN N SUB 2 PRESSURE OF ABOUT 400 TORR. THE REACTION APPEARED TO PROCEED TOWARD EQUILIBRIUM IN DISTINCT STAGES: (1) UC AND N SUB 2 REACTED TO FORM UC SUB 2 AND UC SUB 0.8 N SUB 0.2; (2) UC SUB 2 REACTED WITH N SUB 2 TO PRODUCE MORE UC SUB 0.8 N SUB 0.2 AND FREE C; AND (3) THIS U(C,N) REACTED WITH N SUB 2 TO PRODUCE MORE FREE C AND THE EQUILIBRIUM PRODUCT, A HIGH-N U(C,N). THESE RESULTS ARE CONSISTENT WITH KNOWN THERMODYNAMIC AND PHASE BEHAVIOR IN THE U-C-N SYSTEM.

ABSTRACT 427
LEITNAKER J M
J CHEM ENG DATA 11, 392 (1966)
THERMODYNAMIC PROPERTIES OF URANIUM CARBIDES VIA THE U-C-O SYSTEM

EQUILIBRIUM DATA OF PIAZZA AND SINNOTT IN THE SYSTEMS UC SUB 2 -UC SUB 2 -C-CO AND UC SUB 2 -UC SUB 2 -UC -CO WERE RECALCULATED, USING BOTH SECOND- AND THIRD-LAW TREATMENTS. INTERNAL CONSISTENCY IS EXCELLENT FOR THE FIRST SYSTEM AND ACCEPTABLE FOR THE SECOND. THIRD-LAW TREATMENTS PREDICT THE HEATS OF FORMATION, $\Delta H \text{ SUB } 298$, FOR UC SUB 2, AND UC TO BE -20.5 AND -23.2 KCAL/MOLE, RESPECTIVELY, IN EXCELLENT AGREEMENT WITH COMBUSTION MEASUREMENTS. THE BEST VALUE OF $\Delta H \text{ SUB } 298 \text{ DEG UC SUB 2}$ IS -20.8, 0.7 KCAL/MOLE.

ABSTRACT 428

LEITNAKER J M

J CHEM PHYS 36, 1445 (1962)

DISSOCIATION PRESSURE OF URANIUM DICARBIDE

VAPOR TRANSPORT OF URANIUM FROM UC SUB 1.86 IN A GRAPHITE CRUCIBLE WAS MEASURED FROM 1930 TO 2365 DEG K BY THE KNUDSEN TECHNIQUE. IN ORDER TO TREAT THE DATA, UNUSUAL ASSUMPTIONS WERE MADE CONCERNING THE THERMAL PROPERTIES OF CARBIDES WHICH HYDROLYSE TO YIELD HYDROCARBONS. THE GASEOUS URANIUM SPECIES IS ASSUMED TO BE MONATOMIC. WITH THE AID OF THESE ASSUMPTIONS, THE DATA WERE TREATED BY THE THIRD-LAW AS WELL AS BY THE SECOND-LAW METHOD. AGREEMENT BETWEEN THE TWO IS CONSIDERED GOOD, AND THE ΔH SUB 298 OBTAINED FOR THE PROCESS $UC SUB 0.86(S) = U(G) + 1.86 C$ (GRAPHITE) IS 140.15 ± 1.82 KCAL/MOLE. REASONABLE ESTIMATIONS FOR REACTION ENTROPIES WITHIN THE SYSTEM LEAD TO AN UPPER LIMIT OF 0.5 KCAL/MOLE FOR ΔH SUB 298 FOR THE REACTION $UC(S) + 0.86 C$ (GRAPHITE) = $UC SUB 1.86(S)$, AND HENCE A VALUE OF 119.8 ± 2.8 KCAL/MOLE IS OBTAINED AS AN UPPER LIMIT FOR ΔH SUB 298 OF VAPORIZATION OF URANIUM.

ABSTRACT 429

LEITNAKER J M

J NUCL MATER 218, 175 (1967); ORNL-P-2185

THERMODYNAMIC PROPERTIES OF URANIUM CARBIDES

THERMODYNAMIC AND PHASE INFORMATION RELATIVE TO THE U-C SYSTEM WAS ANALYSED AND SHOWN TO BE CONSISTENT. THE ANOMALOUSLY HIGH HEAT CAPACITY OF UC SUB 2 WAS JUSTIFIED IN THE ANALYSIS. THERMAL FUNCTIONS WERE CALCULATED FOR UC AND UC SUB 2, USING A NON-2EPC S SUB 0 (0.60 EU) FOR THE DICARBIDE. FOR URANIUM ΔH SUB 298, VAP WAS CALCULATED TO BE 123.7 ± 1.3 KCAL/MOLE.

ABSTRACT 430

LEITNAKER J M

ORNL-3970 P93 (1966)

VAPORIZATION BEHAVIOR OF UN

STUDIED VAPORIZATION BEHAVIOR OF UN IN THE TEMPERATURE RANGE OF ABOUT 600 TO 1300 DEG C. FROM THE LITERATURE VALUES OF EQUILIBRIUM NITROGEN PRESSURES IN THE TEMPERATURE RANGE OF 1600 TO 2000 DEG C, HEAT OF FORMATION OF UN WAS CALCULATED AT ROOM TEMPERATURE USING CONSISTENT SET OF ASSUMPTIONS.

ABSTRACT 431

LEITNAKER J M

SYMP THERMO NUCL MATER , 317 (1967)

THE IDEALITY OF THE UC-UN SOLID SOLUTION

BOTH UN AND UC HAVE POTENTIAL AS NUCLEAR FUELS. A SOLID SOLUTION OF THE TWO MAY BE EVEN MORE ATTRACTIVE. THE WORK REPORTED WAS UNDERTAKEN TO PROVIDE BASIC THERMODYNAMIC DATA ON THESE SOLID SOLUTIONS. PRECISE X-RAY LATTICE PARAMETERS HAVE BEEN MEASURED AT ROOM TEMPERATURE FOR UC REACTED WITH NITROGEN BETWEEN 1500 AND 1900 DEG C AND FOR UN REACTED WITH GRAPHITE AT 1500 AND 1700 DEG C. THE DATA ARE USED TOGETHER WITH FREE ENERGY FUNCTIONS FROM THE LITERATURE TO CALCULATE ΔH SUB 298 FOR THE REACTION $UC(S) + 1/2 N SUB 2(G) = UN(S) + C(GRAPHITE)$ IN THESE CALCULATIONS WE ASSUMED THAT VEGARD'S LAW APPLIES. RESULTS INDICATE THAT THE SYSTEM IS

ABSTRACT 431 (CONT'D)

IDEAL FROM 0.3 TO 0.9 MOLE FRACTION UN AND THAT ΔH SUB 258 FOR THE REACTION GIVEN IS -47.19 ± 0.38 KCAL, WHERE THE ERROR QUOTED IS TWICE THE MAXIMUM DEVIATION. TWENTY ONE MEASUREMENTS AT 1500 DEG C ON UC REACTED WITH NITROGEN YIELD A ΔH DEG SUB 298 OF -46.58 ± 0.02 KCAL; THE CARBON RELEASED IN THE REACTION IS SHOWN TO BE IN A HIGHER ENERGY STATE THAN GRAPHITE.

ABSTRACT 432

LEITNAKER J M

TRANS AM NUCL SOC 12, 86 (1969)

POSSIBLE STABILIZATION OF NITRIDE FUELS BY OXYGEN

A MECHANISM IS AVAILABLE FOR DISPOSING OF EXCESS NITROGEN IN NITRIDE FUELS OTHER THAN BY REACTION WITH THE CLADDING MATERIAL. IN THE PRESENCE OF UO SUB 2 AND AS THE NITROGEN PRESSURE INCREASES, A PRESSURE IS REACHED WHERE OXYGEN-STABILIZED U SUB 2 N SUB 3 WILL BE FORMED. AT A GIVEN TEMPERATURE, THE NITROGEN PRESSURE IN THE UO SUB 2-UN-U SUB 2 N SUB 3 THREE-PHASE REGION WILL BE FIXED AND MUCH LOWER, ONLY ONE-TWENTIETH OF THAT IN THE OXYGEN-FREE TWO-PHASE UN-U SUB 2 N SUB 3 REGION. IT IS THIS BUFFERING OF THE NITROGEN PRESSURE THAT CAN PREVENT REACTION WITH THE CLADDING.

ABSTRACT 433

LEVINSON L S

CARBIDES IN NUCL ENERGY, HARWELL CBA (1963)

HIGH TEMPERATURE HEAT CONTENT OF URANIUM CARBIDES

THE HEAT CONTENTS OF THE URANIUM CARBIDES, UC SUB 1.01 AND UC SUB 1.93, WERE MEASURED USING A DROP CALORIMETER. THE UC SUB 1.01 HEAT CONTENT WAS MEASURED BETWEEN 1287 DEG AND 2481 DEG K AND THAT OF THE UC SUB 1.93 BETWEEN 1484 DEG AND 2851 DEG K. A GRAPHITE TUBE FURNACE WAS USED TO HEAT THE CARBIDES WHICH WERE IN GRAPHITE CONTAINERS. TO PREVENT CARBON PICKUP IN THE UC SUB 1.01 SAMPLE ITS CONTAINER WAS NBC COATED. THE CALORIMETER RECEIVER WAS AN ADIABATICALLY SHIELDED COPPER BLOCK. THE DATA WERE FITTED TO A POWER SERIES OF THE TYPE: $H \text{ SUB } T - H \text{ SUB } 310 = A + BT + CT^{**2}$, AND THE HEAT CAPACITY WAS COMPUTED. THE ERROR IN HEAT CONTENT MEASUREMENTS WAS APPROXIMATELY 2%, AND THE STANDARD DEVIATION OF THE DATA FITTING THE EQUATION WAS ABOUT 1/2%.

ABSTRACT 434

LEVINSON L S

J CHEM PHYS 38, 2105 (1963)

HEAT CONTENT OF URANIUM DICARBIDE FROM 1484 DEG TO 2581 DEG K

THE HEAT CONTENT AND SPECIFIC HEAT OF UC SUB 1.93 WAS MEASURED FROM 1484 TO 2581 DEG K USING A DROP CALORIMETER. THE HEAT OF TRANSFORMATION FROM TETRAGONAL TO CUBIC STRUCTURE AT 2043 DEG K WAS 11.0 CAL/G.

ABSTRACT 435

LIED R C

J AM CERAM SOC 45, 149 (1962)

PRELIMINARY STUDIES IN THE SYSTEM UC-PUC

(1) PLUTONIUM CARBIDE WAS PREPARED BY REACTING, UNDER VACUUM, A PELLETIZED MIXTURE OF PUO SUB 2 AND CARBON AT 1100 DEG C AND ABOVE. (2) PUC AND UC-PUC CYLINDERS WERE FABRICATED BY A METHOD COMMON TO CERAMIC TECHNOLOGY. (3) PROLONGED HEATING, UNDER VACUUM, AT VARIOUS TEMPERATURES CAUSED VAPORIZATION OF PLUTONIUM FROM PLUTONIUM CARBIDE AND LOSS OF PLUTONIUM AND CARBON FROM THE 80% URANIUM CARBIDE-20% PLUTONIUM CARBIDE SOLID SOLUTION. (4) WHEN A MIXTURE OF PUO SUB 2 AND CARBON CALCULATED TO BE THE CORRECT RATIO FOR STOICHIOMETRIC PUC WAS FIRED, UNDER VACUUM, TO 1300 DEG TO 1350 DEG C, A TWO-PHASE PRODUCT, MONOCARBIDE AND SESQUICARBIDE, WAS FORMED.

ABSTRACT 436

LINDEMERE T B

J AM CERAM SOC 52, 233 (1969)

KINETICS OF THE GRAPHITE-URANIUM DIOXIDE REACTION FROM 1400 TO 1756 DEG C.

THE REACTION OF MICROSPHERES OF UD SUB 2 WITH GRAPHITE WAS STUDIED FROM 1400 DEG TO 1756 DEG C. WHEN A SPHERICALLY SYMMETRICAL LAYER OF CARBIDE WAS PRODUCED AROUND THE UD SUB 2 CORE, ONLY UC SUB 2 WAS FORMED, AND THE DIFFUSION OF OXYGEN THROUGH THIS LAYER WAS RATE-CONTROLLING. THE ARRHENIUS RELATION FOR THIS SYSTEM IS $K \text{ SUB } P=21.0 \text{ EXP}(-90,000/RT) \text{ CM}^{**2}/\text{SEC}$ THE REACTION OF A GEOMETRICALLY NONSYMMETRICAL CONFIGURATION OF UD SUB 2 AND UC SUB 2 WAS ALSO STUDIED. COMPARISON OF THE REACTIONS IN THE SYMMETRICAL AND NONSYMMETRICAL SYSTEMS DEMONSTRATED THAT THE KINETIC BEHAVIOR OF THE TWO SYSTEMS IS QUITE DIFFERENT AND THAT THE CONVERSION IN THE NONSYMMETRICAL SYSTEM WAS 2 TO 5 TIMES FASTER. THE IMPORTANCE OF THESE OBSERVATIONS TO KINETIC RESULTS REPORTED IN THE LITERATURE FOR ANALOGOUS SYSTEMS IS DISCUSSED.

ABSTRACT 437

LINDEMERE T B

J AM CERAM SOC 53, 451 (1970)

KINETICS OF THE REACTION OF UC SUB 2 AND N SUB 2 FROM 1500 DEG C TO 1700 DEG C.

THE KINETICS OF THE REACTION OF UC SUB 2 SPHERES WITH NITROGEN WAS STUDIED FROM 1500 TO 1700 DEG C. A METALLOGRAPHIC METHOD WAS USED TO DETERMINE THE TIME-DEPENDENT CONVERSION OF UC SUB 2 TO U(C,N) AND FREE C. THE CONVERSION APPEARED TO BE CONTROLLED BY THE DIFFUSION OF SOLID CARBON. THESE SITES WERE THE SURFACE OF THE SPHERE AND PARTICLES OF FREE CARBON THAT EXISTED WITHIN THE ORIGINAL UC SUB 2. AN INCREASED DISTRIBUTION OF THESE INTERNAL SITES DECREASED THE DISTANCE FOR CARBON DIFFUSION AND RESULTED IN A INCREASED RATE OF REACTION. THE UC SUB 2 APPEARED TO UNDERGO A VERY RAPID INITIAL REACTION THAT RESULTED IN THE UPTAKE OF 1 TO 5 AT% NITROGEN IN THE UC SUB 2 AT THESE TEMPERATURES.

ABSTRACT 438

LINDEMER T B

NUCL APPL AND TECH 9, 711 (1970)

RATE CONTROLLING FACTORS IN THE CARBOTHERMIC SYNTHESIS OF ADVANCED FUELS

CONSIDERABLE EFFORT HAS BEEN EXPENDED TO SYNTHESIZE THE CARBIDES, NITRIDES AND CARBONITRIDES, OF URANIUM, PLUTONIUM, AND THEIR SOLID SOLUTIONS BY THE CARBOTHERMIC REDUCTION OF OXIDE-CARBON MIXTURES. EXPERIMENTAL RESULTS REPORTED IN THE LITERATURE FOR THE U-C-O-N SYSTEM INDICATE THAT ONE OF TWO LIMITING MECHANISMS CONTROLS THE RATE OF THE CONVERSION REACTION: THESE MECHANISMS ARE SOLID-STATE DIFFUSION WITHIN THE INDIVIDUAL REACTANT-PRODUCT PARTICLES, AND REMOVAL OF CO FROM THE ENTIRE REACTING SYSTEM. THIS REPORTED INFORMATION IS USED TO ANALYZE THE USE OF A FLUIDIZED BED FOR CARBOTHERMIC CONVERSION IN THE VICINITY OF 1500 DEG C IN THE U-C-O-N SYSTEM AND TO APPROXIMATE THE RATE OF CONVERSION IN THE U-PU-C-O-N SYSTEM.

ABSTRACT 439

LINDNER R

J NUCL MATER 23, 222 (1967)

SELF-DIFFUSION OF URANIUM IN URANIUM MONOCARBIDE

SELF-DIFFUSION OF U IN MONOCRYSTALLINE AND CAST MATERIAL OF UC OF SLIGHTLY HYPOSTOICHIOMETRIC AND HYPERSTOICHIOMETRIC COMPOSITIONS HAS BEEN MEASURED IN THE TEMPERATURE RANGE 800 TO 2100 DEG C, USING THE TECHNIQUE OF ALPHA ENERGY DEGRADATION. NEARLY IDENTICAL ACTIVATION ENERGIES OF ABOUT 30 KCAL/MOLE WERE FOUND FOR BOTH MATERIALS AT TEMPERATURES UP TO 1600 DEG C FOR THE 4.68% - AND 1400 DEG C FOR THE 4.83% MATERIAL RESPECTIVELY. AT HIGHER TEMPERATURES HOWEVER, DIFFERENT VALUES OF THE ACTIVATION ENERGY WERE OBSERVED: 70 ± 5 KCAL FOR THE HYPOSTOICHIOMETRIC AND 90 ± 6 KCAL FOR THE HYPERSTOICHIOMETRIC UC.

ABSTRACT 440

LITTON F B

LA-3799 (1968)

THE PROPERTIES AND IRRADIATION BEHAVIOR OF CARBIDE FUELS: A LITERATURE SURVEY

NO MAJOR DEFICIENCIES FOR FAST REACTOR APPLICATIONS WERE FOUND IN THE REPORTED PROPERTIES OF CARBIDE FUELS. IT APPEARS PROBABLE THAT CONTAINER COMPATIBILITY PROBLEMS CAN BE REDUCED BY USING CARBIDE COMPOSITIONS THAT ARE STRICTLY STOICHIOMETRIC, OR BUFFERED. FREE METAL IN CARBON-DEFICIENT FUEL REACTS WITH IRON- OR NICKEL- BASE CONTAINERS TO FORM LOW-MELTING ALLOYS. IN SODIUM-BONDED CONFIGURATIONS, CARBON IN EXCESS OF STOICHIOMETRIC MONOCARBIDE IS TRANSFERRED TO CLADDING MATERIALS THAT CONTAIN ELEMENTS FORMING CARBIDES MORE STABLE THAN THE FUEL CARBIDE. NO INFORMATION WAS FOUND ON HEAT TRANSFER OR SODIUM STABILITY IN SODIUM-BONDED FUEL ELEMENTS. IRRADIATION DATA INDICATE THAT FUEL SWELLING DEPENDS ON THE CARBON CONTENT, OPERATION TEMPERATURE, AND BURNUP. FUEL SWELLING IS A LINEAR FUNCTION OF TEMPERATURE TO 1800 DEG F, AFTER WHICH IT IS AN EXPONENTIAL FUNCTION. FISSION GAS RELEASE IS RELATED TO THE INTEGRITY OF THE FUEL STRUCTURE, THE OPERATION TEMPERATURE, AND BURNUP. THE RETENTION OF FISSION GAS APPEARS TO BE SATISFACTORY IN MIXED FUELS UP TO ABOUT 50,000 MWD/T BURNUP. STRONG CONTAINERS THAT ARE STABLE TO RADIATION EFFECTS WILL BE REQUIRED FOR BURNUPS APPROACHING 100,000 MWD/T. METALLURGICAL ADVANCES ARE ANTICIPATED FROM CURRENT CARBIDE DEVELOPMENT PROGRAMS; IT IS RECOMMENDED THAT THEIR ECONOMIC SIGNIFICANCE BE EVALUATED

ABSTRACT 440 (CONT'D)

IN COMPARISON TO THE TOTAL PROCESSING CYCLE VISUALIZED FOR OTHER COMPETITIVE FUEL SYSTEMS. NO CLEAR-CUT ANALYSIS APPEARS IN THE LITERATURE.

ABSTRACT 441

LITTON F B

TMS PAPER NO A71-89 (1971)

STABILITY OF SODIUM-BONDED ACTINIDE CARBIDES IN TYPE 316 STAINLESS STEEL CONTAINERS

THE REACTION OF NA-BONDED ACTINIDE CARBIDES WITH TYPE 316 STAINLESS STEEL WAS INVESTIGATED AT TEMP FROM 450-750 DEG C FOR TIME PERIODS TO 8000 H. CARBON WAS NOT TRANSPORTED FROM SINGLE-PHASE, H-REDUCED URANIUM-PLUTONIUM CARBIDE BUT WAS TRANSPORTED FROM HYPERSTOICHIOMETRIC ACTINIDE CARBIDES TO 316 STAINLESS STEEL CONTAINERS. ESTIMATES OF THE CHEMICAL ACTIVITY OF C IN THE ACTINIDE CARBIDES AND IN THE CARBIDE FORMED IN THE CONTAINER MATERIAL WERE IN AGREEMENT WITH THE EXPERIMENTAL RESULTS. THIS AGREEMENT SUGGESTS THAT ESTIMATES OF THE CHEMICAL ACTIVITIES OF THE COMPONENTS SHOULD BE PRIME CRITERIA FOR THE SELECTION OF MATERIALS FOR USE IN SYSTEMS IN WHICH CARBIDES ARE PRESENT. THE O PHASE WAS OBSERVED IN UNCARBURIZED 316 STAINLESS STEEL CONTAINERS HEATED TO 550 DEG C AND HIGHER TEMP. THE FORMATION OF THE O PHASE AND THE ENRICHMENT OF THE MATRIX PHASE WITH NI CAUSED A PU-NI INTERMETALLIC COMPOUND TO FORM BETWEEN THE SINGLE-PHASE URANIUM-PLUTONIUM CARBIDE AND THE 316 STAINLESS STEEL CONTAINER AFTER 8000 H AT 750 DEG C.

ABSTRACT 442

LIVEY D T

AERE-M/R-1746 (1955)

WETTING PROPERTIES OF SOLID OXIDES AND CARBIDES BY LIQUID METALS

EXPERIMENTS HAVE BEEN CARRIED OUT ON THE WETTING PROPERTIES OF SOLID OXIDES AND CARBIDES BY LIQUID METALS AND AN ESTIMATION HAS BEEN MADE OF THE SURFACE ENERGY OF UO_2 AND OF THE REFRACTORY MONOCARBIDES. THE RESULTS INDICATE THAT, IN THE ABSENCE OF CHEMICAL REACTION, OXIDE SURFACES ARE ONLY WETTED BY METALS OF LOW ATOMIC NUMBER. THE SUGGESTION IS MADE THAT THIS IS DUE TO AN ATTRACTION EXISTING BETWEEN THE POSITIVE NUCLEUS OF THE METAL AND THE NEGATIVELY CHARGED ANIONS OF THE OXIDE SURFACE. CONVERSELY NONWETTING BY METALS OF HIGHER ATOMIC NUMBER IS DUE TO REPULSION BETWEEN THE NEGATIVE SURFACE AND THE ELECTRON CLOUD OF THE METAL. CARBIDES ARE MORE READILY WETTED BY LIQUID METALS BECAUSE OF THE DIFFERENT NATURE OF THE CARBIDE SURFACE, THIS BEING DOMINATED BY THE METAL ATOMS AND NOT AS IN OXIDES, BY NEGATIVE ANIONS. CARBIDES OF HIGH SURFACE ENERGY HAVE THEN A LOW INTERFACIAL TENSION WITH LIQUID METALS AND HENCE GOOD WETTING PROPERTIES. FOR THE APPLICATION OF LIQUID METALS TO NUCLEAR REACTORS IN WHICH REFRACTORY URANIUM COMPOUNDS ARE SUSPENDED IN THE LIQUID METAL, WETTING IS ESSENTIAL. URANIUM OXIDE (UO_2) AND URANIUM CARBIDE ARE READILY WETTED BY LIQUID SODIUM AT 400 DEG C. BISMUTH, OF SPECIAL IMPORTANCE BECAUSE OF ITS LOW CAPTURE CROSS SECTION, IS NON-WETTING TO OXIDE AND CARBIDE. THE ADDITION OF 0.3% NICKEL LOWERS THE WETTING TEMPERATURE IN THE BI-UC SYSTEM IN VACUO FROM 700 TO 580 DEG C. COATING OF THE CARBIDE PARTICLES WITH SILVER ALSO PROMOTES WETTING BY BISMUTH.

ABSTRACT 443

LIVEY D T

ATOM ENERGY REV 4, 53 (1966)

II: PHASE DIAGRAMS

PHASE DIAGRAM OF PU-C SYSTEM IS DISCUSSED.

ABSTRACT 444

LONSDALE H K

GA-3015 (1962)

VAPORIZATION OF THE DICARBIDES OF U, TH, AND PA

THE MEASUREMENTS OF THE VAPOR PRESSURE OF URANIUM OVER URANIUM DICARBIDE WERE CARRIED OUT OVER A TEMPERATURE RANGE OF 2000 TO 2900 DEG K. THE VAPOR PRESSURE MAY BE REPRESENTED OVER THE ENTIRE RANGE BY THE EQUATION: $\log P_{\text{SUB U}} (\text{ATM}) = -28400/T + 4.76$ THIS RESULTS IN A 2ND LAW HEAT OF VAPORIZATION OF APPROX 130 KCAL/MOLE WHICH LEADS TO A VALUE OF 25 KCAL/MOLE FOR THE HEAT OF FORMATION. ASSUMING A VALUE OF -3 CAL/MOLE, DEG FOR $\Delta C_{\text{SUB P}}$, THE HEAT OF FORMATION AT ROOM TEMPERATURE IS 19 KCAL/MOLE.

ABSTRACT 445

LONSDALE H K

THERMO NUCL MATER, P601 (1962)

VAPORIZATION OF THE CARBIDES OF URANIUM, THORIUM, AND PROTACTINIUM

VAPOR PRESSURE MEASUREMENTS WERE MADE ON THE CARBIDES OF URANIUM, THORIUM, AND PROTACTINIUM IN THE PRESENCE OF AN EXCESS OF CARBON USING THE KNUDSEN EFFUSION TECHNIQUE. MEASUREMENTS OF VAPOR PRESSURE OF URANIUM OVER URANIUM DICARBIDE OVER A TEMPERATURE RANGE OF 2000 TO 2900 DEG K AND A URANIUM VAPOR PRESSURE RANGE OF 3×10^{-10} TO 1×10^{-5} ATM. OVER THE ENTIRE RANGE THE VAPOR PRESSURE MAY BE REPRESENTED BY THE EQUATION $\log P (\text{ATM}) = -29500/T + 5.26 + 0.30$. THIS RESULTS IN A SECOND-LAW HEAT OF VAPORIZATION OF APPROXIMATELY 135 KCAL/MOLE AND A HEAT OF FORMATION OF URANIUM DICARBIDE OF APPROXIMATELY 30 KCAL/MOLE. THERE IS EVIDENCE OF POSITIVE CURVATURE IN THE VAPOR PRESSURE PLOT ABOVE THE URANIUM DICARBIDE-CARBON EUTECTIC TEMPERATURE (CA 2700 DEG K). THORIUM DICARBIDE WAS STUDIED OVER APPROXIMATELY THE SAME RANGE OF VAPOR PRESSURES. A PRELIMINARY ANALYSIS OF THE RESULTS INDICATES THAT THE PRESSURE MAY BE REPRESENTED BY THE EQUATION $\log P (\text{ATM}) = -33400/T + 5.77$. FROM A SECOND-LAW TREATMENT OF THE DATA, IT APPEARS THAT THE HEAT OF FORMATION OF $\text{ThC}_{\text{SUB 2}}$ IS LESS THAN THAT OF $\text{UC}_{\text{SUB 2}}$. RESULTS FOR THE PROTACTINIUM SYSTEM YIELD A SECOND-LAW HEAT OF VAPORIZATION SIMILAR TO THAT OF $\text{ThC}_{\text{SUB 2}}$. THE PA PRESSURE OVER THE CARBIDE, CALCULATED ASSUMING IDEAL BEHAVIOR, IS LESS THAN THAT OF TH INDICATING EITHER (1) A FAIRLY LARGE NEGATIVE DEVIATION FROM IDEAL SOLID SOLUTION BEHAVIOR IN THE DILUTE $\text{PAC}_{\text{SUB 2}}$ - $\text{ThC}_{\text{SUB 2}}$ SYSTEM OR (2) THAT THE VAPOR PRESSURE OF $\text{PAC}_{\text{SUB 2}}$ IS LESS THAN THAT OF $\text{ThC}_{\text{SUB 2}}$.

ABSTRACT 446

LORENZELLI N

ANL-TRANS-920 (1972)

VARIATION OF THE CARBON ACTIVITY AS A FUNCTION OF THE BURN UP IN A CARBIDE FUEL

TWO IMPORTANT CONCLUSIONS CAN BE DRAWN FROM THIS STUDY: THE FISSION OF A CARBIDE-TYPE FUEL (UC OR (U,PU)C) CONSUMES CARBON AS LONG AS A HIGHER CARBIDE IS PRESENT ($M \text{ SUB } 2 \text{ C SUB } 3$). THE DISSOLUTION OF SOLUBLE FISSION PRODUCTS (ZR, NB, MO, LA, CE, ND, Y) IN THE UC MATRIX DOES NOT SIGNIFICANTLY MODIFY ITS THERMODYNAMIC STABILITY (ACTIVITY OF CARBON AND FREE ENERGY OF FORMATION). IT WILL BE NOTED THAT THESE TWO RESULTS ARE EXACTLY THE OPPOSITE OF WHAT IS OBSERVED IN IRRADIATED OXIDES.

ABSTRACT 447

LORENZELLI N

J LESS- COMMON METALS 26, 71 (1972)

ETUDE DES SYSTEMES TERNAIRES U-C TERRES RARES (CE, ND, LA)

LATTICE PARAMETER MEASUREMENTS OF URANIUM MONOCARBIDE CONTAINING VARIOUS AMOUNTS OF EACH OF THE RARE ELEMENTS: CERIUM, NEODYMIUM AND LANTHANUM, HAVE BEEN PERFORMED AND USED FOR AN ACCURATE DETERMINATION OF THEIR SOLUBILITY LIMITS IN VARIOUS PHASE FIELDS. IN THE CASE OF CERIUM, THE LIMITS OBTAINED ARE LESS THAN THOSE REPORTED IN THE LITERATURE. THE FOLLOWING PHASE DIAGRAMS U-CE-C, U-ND-C, U-LA-C HAVE BEEN CAREFULLY INVESTIGATED BY THIS METHOD; SOME THERMODYNAMIC DATA CONCERNING CERIUM CARBIDES HAVE THUS BEEN DERIVED.

ABSTRACT 448

LORENZELLI N

J NUCL MATER 44, 57 (1972)

THERMODYNAMIC STUDY OF A UC FUEL DESIGNED TO SIMULATE A BURN-UP OF 100,000 MWD/TBY MEASUREMENT OF VAPORIZATION

USING A VAPORIZATION METHOD AND ALSO MASS-SPECTROMETRIC ANALYSIS, WE DETERMINED THE CHEMICAL ACTIVITIES OF THE VARIOUS CONSTITUENTS (CARBON, URANIUM AND FISSION PRODUCTS) OF A UC FUEL DESIGNED TO SIMULATE A BURN-UP OF 100,000 MWD/T. ACCORDING TO THE C/U RATE, WE OBSERVED VERY SUBSTANTIAL VARIATIONS IN THE ACTIVITIES OF CARBON, URANIUM AND ESPECIALLY OF THE RARE EARTH METALS, WHICH WE RELATED TO THE CHEMICAL STATE OF EACH OF THESE CONSTITUENTS IN THE FUEL. FINALLY, WE NOTED THAT THE SOLUTION OF "FISSION PRODUCTS" IN UC DID NOT DETECTABLY AFFECT THE THERMODYNAMIC STABILITY OF THAT PHASE.

ABSTRACT 449

LORENZELLI R

J INORG NUCL CHEM 33, 3297 (1971)

HEAT OF COMBUSTION OF ACTINIDE CARBIDES (THC, PUC, PU SUB 2 C SUB 3)

HEATS OF COMBUSTION OF THE CARBIDES OF ACTINIDES THC, PUC, PU SUB 2 C SUB 3 HAVE BEEN MEASURED BY MEANS OF A CALORIMETRIC BOMB. THE FOLLOWING ENTHALPIES OF FORMATION HAVE BEEN DERIVED FROM THESE MEASUREMENTS: THC SUB 1.00 : $\Delta H \text{ SUB F } **298 = (-30.2 \pm 2.5) \text{ KCAL/MOLE}$, PUC SUB 0.91 : $\Delta H \text{ SUB F } **298 = (-12.0 \pm 2.0) \text{ KCAL/MOLE}$, PUC SUB 1.50 : $\Delta H \text{ SUB F } **298 = (-24.4 \pm 2.7) \text{ KCAL/MOLE}$.

ABSTRACT 450

LORENZELLI R

PLUTONIUM 1970, P818

INVESTIGATION OF CARBIDE TYPE COMPOUNDS PHASE DIAGRAMS AND PROPERTIES

IN ORDER TO IMPROVE THE PROPERTIES OF THE CARBIDES (U,PU)C, A STUDY OF THE CARBIDE TYPE COMPOUNDS (CARBIDES, NITRIDES, CARBONITRIDES AND OXYCARBIDES) HAS BEEN UNDERTAKEN. THESE COMPOUNDS, IN WHICH NITROGEN OR OXYGEN ATOMS ARE SUBSTITUTED FOR CARBON ATOMS, HAVE BEEN OBTAINED BY NATURAL SINTERING, IN VACUUM, AT TEMPERATURES RANGING FROM 1400 TO 1750 DEG C. THE FOLLOWING PHASE DIAGRAMS: (U,PU)C, (U,PU)N, (U,PU)C,N, (U,PU)C,O, (U,PU)N,O, HAVE BEEN INVESTIGATED FOR A PU/U+PU RATIO BETWEEN 15 AND 25 AT %. THE PHASE LIMITS IN THE MIXED (U,PU) SYSTEMS ARE VERY CLOSE TO THOSE OF THE EQUIVALENT URANIUM SYSTEMS. THE PSEUDO TERNARY PHASE DIAGRAM MC-MN-MO HAS BEEN STUDIED, WITH ITS DIRECT IMPLICATION ON THE CHOICE OF A FAST REACTOR FUEL. SOME PROPERTIES, LIKE COMPATIBILITY WITH CLADDING, THERMAL CONDUCTIVITY AND ELASTIC CONSTANTS, HAVE BEEN INVESTIGATED. WITH A SODIUM BOND, IT HAS BEEN SHOWN THAT CARBURIZING OF A STAINLESS STEEL (316 L) CLADDING REMAINS LOW IN ALL CASES AFTER A 4000 HOURS ANNEAL AT 700 DEG C. IN THE CASE OF CARBONITRIDES, ANOMALIES IN THERMAL CONDUCTIBILITY AND YOUNG'S MODULUS HAVE BEEN ASCRIBED TO THE NONIDEALITY OF THE SOLID SOLUTION (U,PU)C,N ON ITS NITROGEN RICH SIDE.

ABSTRACT 451

MACDONALD R D

AECL-2571

SAP CLAD URANIUM CARBIDE FUEL ELEMENTS

FROM X-721 TEST, CONCLUSIONS ARE DRAWN REGARDING FUEL SWELLING, GAS RELEASE, MOBILITY OF URANIUM AND COMPATIBILITY BETWEEN THE SAP SHEATHING AND CARBIDE PELLETS.

ABSTRACT 452

MACLEOD A C

J INORG NUCL CHEM 31, 715 (1969)

HIGH-TEMPERATURE THERMODYNAMIC PROPERTIES OF URANIUM DICARBIDE

THE ENTHALPY OF URANIUM DICARBIDE HAS BEEN MEASURED FROM 400 TO 1520 DEG K IN AN ADIABATIC DROP CALORIMETER. THE DATA ARE REPRESENTED BY THE EQUATION ($H_{SUB} T - H_{SUB} 299.15$) = $17.24 T + 1.3714 \times 10^{-3} T^{*2} + 3.1605 \times 10^{-5} T^{*3} - 6322$ WITH A MEAN DEVIATION OF 0.38 PER CENT. MOLAR THERMODYNAMIC PROPERTIES HAVE BEEN CALCULATED FROM 100 TO 1800 DEG K AND ARE COMPARED WITH PUBLISHED EXPERIMENTAL VALUES. BY CALCULATION FROM EXISTING FREE ENERGY DATA AND THE PRESENT ENTHALPY VALUES, THE HEAT OF FORMATION OF URANIUM DICARBIDE FROM THE SOLID ELEMENTS AT 298 DEG K IS FOUND TO BE -21.0 ± 0.2 KCAL/MOLE.

ABSTRACT 453

MACLEOD A C

PROC BRIT CER SOC 8 , 15 (1967)

HIGH-TEMPERATURE ADIABATIC DROP CALORIMETER: THE ENTHALPIES OF AL SUB 2 O SUB 3, UC SUB 2 AND US BETWEEN 330-1700 DEG K

THE CONSTRUCTION AND OPERATION OF AN ADIABATIC DROP CALORIMETER FOR ENTHALPY MEASUREMENTS UP TO 1800 DEG K IS DESCRIBED. ENTHALPY DATA DETERMINED FOR A SAMPLE OF 2-AL SUB 2 O SUB 3 PROVIDED BY THE NATIONAL BUREAU OF STANDARDS AGREED WITH THE VALUES CALCULATED FROM THE NBS "CORRECTED" EQUATION WITH A MEAN DEVIATION OF LESS THAN 0.1%. THE HEAT CAPACITIES OF UC SUB 2 AND US WERE DERIVED FROM ENTHALPY MEASUREMENTS MADE OVER THE TEMPERATURE RANGE 200 DEG TO 1500 DEG K.

ABSTRACT 454

MAGNIER P

CARBIDES IN NUCL ENERGY, HARWELL A2 (1963)

THE SOLUBILITY OF URANIUM IN URANIUM MONOCARBIDE

URANIUM-CARBON ALLOYS CAN EXIST AS A SINGLE PHASE UC (UC IS USED TO REPRESENT HYPOSTOICHIOMETRIC ALLOYS WITHIN THE SINGLE PHASE UC FIELD) FOR CARBON CONTENTS BETWEEN 4.8 AND 5 AT. %. THE VARIATION OF THE LATTICE PARAMETERS OF THESE ALLOYS AS A FUNCTION OF COMPOSITION HAS BEEN DETERMINED AND USED TO EVALUATE, AS A FUNCTION OF TEMPERATURE, THE COMPOSITION OF UC IN THERMODYNAMIC EQUILIBRIUM WITH METALLIC URANIUM OR WITH UC SUB 2. IT HAS BEEN SHOWN THAT MAXIMUM SOLUBILITY OF URANIUM TAKES PLACE AT 1700 DEG ± 30 DEG C, THE COMPOSITION OF UC IN EQUILIBRIUM WITH METALLIC U BEING UC SUB 0.96. THE EFFECT OF THESE OBSERVATIONS ON THE NATURE OF THE U-C PHASE DIAGRAM IS DISCUSSED.

ABSTRACT 455

MAGNIER P

CEA-R-2852 (1966)

INFLUENCE OF OXYGEN, NITROGEN , AND CARBON ON THE LATTICE PARAMETER OF URANIUM MONOCARBIDE

RESULTS OF STUDIES ON THE EFFECTS OF O AND N ON THE LATTICE PARAMETER OF U(C,O,N) SOLID SOLUTIONS AROUND UC COMPOSITION ARE DISCUSSED. THE DATA LEAD TO A DETERMINATION OF THE SOLUBILITY OF O IN UC:U(C SUB 1-X O SUB X) SOLID SOLUTIONS EXIST IF X IS SMALLER THAN 0.37. THE EFFECTS OF C ON THE LATTICE PARAMETER OF U-UC SOLID SOLUTIONS AROUND UC WAS ALSO INVESTIGATED. RESULTS OF THE STUDY ARE USED AS A BASIS FOR DETERMINING THE SOLUBILITY OF U IN UC AT THE DIFFERENT TEMPERATURES AND THEIR EFFECTS ON THE U-C DIAGRAM ARE ANALYZED.

ABSTRACT 456

MAGNIER P

PROC BRIT CERAM SOC 7, 141 (1967)

HIGH-TEMPERATURE COMPRESSIVE CREEP AND HOT EXTRUSION OF URANIUM-CARBON ALLOYS

THE AUTHORS HAVE STUDIED THE HIGH-TEMPERATURE CREEP OF URANIUM-CARBON ALLOYS AROUND THE UC COMPOSITION. THE BEHAVIOR OF THESE ALLOYS IS STRONGLY DEPENDENT ON THEIR TOTAL CARBON CONTENT. THE DATA OBTAINED SHOW THAT THESE ALLOYS CAN UNDERGO VERY IMPORTANT PLASTIC DEFORMATION AND DIE-FORMING WITH THEM AT ABOUT 2200 - 2300 DEG C IS POSSIBLE. X-RAY

ABSTRACT 456 (CONT'D)

INVESTIGATION OF EXTRUDED RODS SHOWS A PREFERENTIAL TEXTURE: UC(100) PARALLEL TO THE EXTRUSION DIRECTION. THIS DIE-FORMING CAN BE EXTENDED TO UC SUB 2, THC SUB 2 AND (TH,U)C SUB 2 ALLOYS.

ABSTRACT 457

MAIYA P S

J NUCL MATER 34, 111 (1970)

DIFFUSION IN URANIUM CARBIDE BY THE MASS TRANSFER METHOD

ANALYSIS OF GRAIN BOUNDARY GROOVING EXPERIMENTS ON UC GAVE $D_{SUB V} = (0.18 \pm 0.19) \times 10^{-3} \exp(-(62,000 \pm 4000)/RT)$ AND $D_{SUB S} = (4.9 \pm 7.3) \exp(-(70000 \pm 4000)/RT)$ WHERE $D_{SUB V}$ IS VOLUME DIFFUSION AND $D_{SUB S}$ IS SURFACE DIFFUSION.

ABSTRACT 458

MAKINO Y

J NUCL MATER 49, 225 (1973)

SELF-DIFFUSION OF C IN HYPERSTOICHIOMETRIC UC

THE SELF-DIFFUSION OF C IN HYPERSTOICHIOMETRIC UC WAS MEASURED IN THE SINGLE-PHASE REGION OF UC, USING A RADIOACTIVE TRACER AND SECTIONING TECHNIQUE. THE DIFFUSION EQUATIONS AS A FUNCTION OF TEMPERATURE ARE: (I) FOR UC SUB 1.38, $D = 0.10 \times \exp(-(53.5 \pm 10.6)/RT)$ CM**2/SEC FOR THE TEMPERATURE RANGE 2100 TO 2230 DEG C; (II) FOR UC SUB 1.52, $D = 0.11 \exp(-(54.6 \pm 4.6)/RT)$ CM**2/SEC FOR THE TEMPERATURE RANGE 1950 TO 2150 DEG C. THE DEPENDENCE OF THE DIFFUSION COEFFICIENTS AND THE ACTIVATION ENERGY IS DESCRIBED AS FOLLOWS, (I) WHEN X (C/U MOLAR RATIO) APPROX SMALLER OR= 1.11, THE DIFFUSION COEFFICIENTS INCREASE WITH X, WHILE THE ACTIVATION ENERGY DECREASES, (II) WHEN X APPROX GREATER OR= 1.11, THE DIFFUSION COEFFICIENTS NO LONGER INCREASE WITH X BUT REMAIN CONSTANT, AS DOES THE ACTIVATION ENERGY, I.E., E IS ABOUT 54 KCAL/MOLE. THE MECHANISM FOR C DIFFUSION IN HYPERSTOICHIOMETRIC UC IS CONSIDERED TO BE AN INTERSTITIAL OR INTERSTITIALCY.

ABSTRACT 459

MAKINO Y

J NUCL SCI TECHNOL TOKYO 9, 569 (1972)

SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE

THE DIFFUSION OF C IN UC HAS BEEN MEASURED USING RADIOACTIVE TRACER AND SECTIONING TECHNIQUE. SELF-DIFFUSION COEFFICIENTS OF C IN UC ARE DESCRIBED WELL BY THE EQUATION $D = 4.7 \times 10^{-2} \exp(-(54.7 \pm 2.8)/RT)$ CM**2/SEC OVER THE TEMPERATURE RANGE OF 1,400 TO 2,000 DEG C.

ABSTRACT 460

MALLETT M W

J ELECTROCHEM SOC 99, 197 (1952)

THE URANIUM-CARBON SYSTEM

AN INVESTIGATION OF THE URANIUM-CARBON SYSTEM HAS BEEN MADE AND A CONSTITUTIONAL DIAGRAM DRAWN ON THE BASIS OF MELTING POINT, X-RAY, AND METALLOGRAPHIC DATA. THREE CARBIDES OF URANIUM HAVE BEEN DETECTED AND IDENTIFIED: UC, U SUB 2 C SUB 3, AND UC SUB 2. NO COMPOUNDS HAVE BEEN FOUND CONTAINING A CARBON CONTENT HIGHER THAN THAT OF UC SUB 2. UC AND UC SUB 2 ARE COMPLETELY SOLUBLE IN EACH OTHER AT ELEVATED TEMPERATURES, FORMING A SOLID SOLUTION. THE SOLID SOLUTION PHASE CANNOT BE RETAINED ON COOLING TO ROOM TEMPERATURE IN ALLOYS CONTAINING BETWEEN ABOUT 5.0 TO 9.0 WEIGHT PER CENT CARBON. A WIDMANSTATTEN TYPE OF PRECIPITATION TAKES PLACE ON COOLING, LEAVING EITHER UC PRECIPITATED IN A UC SUB 2 MATRIX OR VICE VERSA, DEPENDING ON THE CARBON CONTENT OF THE ALLOY. IN ALLOYS CONTAINING ABOVE ABOUT 9.0 WEIGHT PER CENT TOTAL CARBON, UC CAN QUITE EFFECTIVELY BE RETAINED IN SOLID SOLUTION BY QUENCHING FROM TEMPERATURES ABOVE ABOUT 1800 DEG C.

ABSTRACT 461

MARCON J P

CEA-CONF-1588 (1970)

THERMODYNAMIC PROPERTIES OF PU-CARBIDES

VARIOUS EXPERIMENTAL METHODS HAVE BEEN INVESTIGATED TO GATHER MORE ACCURATE DATA ON FREE ENERGIES OF FORMATION OF PLUTONIUM CARBIDES NAMELY: - VAPOR PRESSURE MEASUREMENTS. THE PRESENT RESULTS, TOGETHER WITH THOSE OF THE LITERATURE, HAVE BEEN INTERPRETED WITH REFERENCE TO THE KNOWN DATA RELATIVE TO THE PU-C DIAGRAM; THE UTMOST IMPORTANCE OF OXYGEN, ALWAYS PRESENT AS AN IMPURITY, HAS BEEN EMPHASIZED. - CARBON MONOXIDE PRESSURE MEASUREMENTS AT EQUILIBRIUM ABOVE THE DOMAIN PU SUB 2 O SUB 3 -PU SUB 2 C SUB 3 -C. THE DETERMINATION OF THE PRESSURE OF CO AS A FUNCTION OF TEMPERATURE, YIELDED THE FREE ENERGY OF FORMATION OF PU SUB 2 C SUB 3. THIS METHOD IS VERY ACCURATE, BUT IS LIMITED TO ONE COMPOUND ONLY, FOR WHICH WE HAVE FOUND BETWEEN 1400 AND 2000 DEG C: ΔG SUB F (PUC SUB 1.5) = - 25.870 - 1.57 T. - CALORIMETRY WHICH REQUIRES TWO DETERMINATIONS: - THE HEAT OF FORMATION AT ROOM TEMPERATURE, WHICH WE HAVE MEASURED FOR PUC SUB 0.9 (ΔH SUB F, 298 = - 12 KCAL) AND PUC SUB 1.5 (ΔH SUB F, 298 = - 24.4 KCAL). - THE VARIATION OF SPECIFIC HEAT WITH TEMPERATURE.

ABSTRACT 462

MARCON J P

J INORG NUCL CHEM 32, 2581 (1970)

VAPORIZATION OF PU-CARBIDES

WE HAVE MEASURED THE VAPOR PRESSURE OF THE DIFFERENT PLUTONIUM CARBIDES BY THE KNUDSEN EFFUSION METHOD. WE HAVE ESPECIALLY STUDIED THE DOMAINS PUC+PU SUB 2 C SUB 3, PU SUB 2 C SUB 3 +C, PUC SUB 2+C AND PU SUB 2 C SUB 3+PUC SUB 2. WE HAVE EVIDENCED THE RELATION BETWEEN THE PU-C DIAGRAM AND THE VAPORIZATION CURVES ON THE ONE HAND AND THE VERY LARGE INFLUENCE OF OXYGEN IN VAPORIZATION PHENOMENA ON THE OTHER HAND. THE FOLLOWING ENERGIES OF FORMATION WERE OBTAINED: ΔH SUB 298 (PUC SUB 0.9) = -10.5 KCAL, ΔH SUB 298 (PUC SUB 1.5) = -15.9 KCAL. THEY ARE COMPARED WITH THE RESULTS OBTAINED BY OTHER THERMODYNAMIC MEASUREMENTS (CALORIMETRY F.E.M. METHODS, DETERMINATION OF EQUILIBRIUM PRESSURES IN PU-C-O SYSTEM).

ABSTRACT 463

MARCON J P

J INORG NUCL CHEM 32, 463 (1970)

VAPORIZATION OF PLUTONIUM MONONITRIDE

THE KNUDSEN METHOD WAS EMPLOYED TO MEASURE THE VAPOR PRESSURE OF PLUTONIUM MONONITRIDE. IT WAS CONFIRMED THAT THE DISSOCIATION OF PuN IS GIVEN BY THE FOLLOWING REACTION: $\text{PuN(s)} = \text{Pu(l)} + 1/2 \text{N}_2\text{(g)}$. THE ENTHALPY OF FORMATION AT 298 DEG K ($\Delta H = -72.8 \text{ KCAL}$) OBTAINED FROM THIS STUDY AGREED VERY WELL WITH THE OTHER THERMODYNAMIC MEASUREMENTS FOR THIS COMPOUND.

ABSTRACT 464

MARCON J P

STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES ABOVE 2000K,

P381

PHASE CHANGES REVEALED BY VAPORIZATION MEASUREMENTS ON PLUTONIUM CARBIDES AND OXIDES

FROM INTERNATIONAL COLLOQUIUM ON THE STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES ABOVE 2000K; ODEILLO, FRANCE (27 SEP 1971). IN A BINARY SYSTEM, IT IS POSSIBLE TO CONSTRUCT A $P = F(T)$ DIAGRAM WITH EACH TWO-PHASE DOMAIN BEING REPRESENTED BY A CURVE. UNDER SUCH CONDITIONS THE TRIPLE POINTS OF THE COMPOSITION-TEMPERATURE DIAGRAM ARE ALSO TRIPLE POINTS ON THE VAPOR PRESSURE-TEMPERATURE DIAGRAM. IN THIS WAY IT WAS POSSIBLE TO STUDY THE SOLID-PHASE DECOMPOSITION $2\text{PuC SUB 2} = \text{Pu SUB 2 C SUB 3} + \text{C}$; THE PERITECTIC MELTING OF PuC SUB 3 INTO LIQUID AND PuC SUB 2 ; THE PERITECTIC MELTING OF PuC SUB 2 INTO LIQUID AND CARBON; THE SOLID-PHASE DECOMPOSITION OF THE BCC OXIDE PuO SUB 1.56 INTO HEXAGONAL Pu SUB 2 O SUB 3 AND FCC PuO SUB 1.60 PHASES.

ABSTRACT 465

MARDON P G

PLUTONIUM 1970, P842

ON THE URANIUM-PLUTONIUM-CARBON PHASE DIAGRAM PART II

THE FREEZING OF THE ALLOYS AND CALCULATION OF SOME EQUILIBRIUM

THE EXPERIMENTALLY DETERMINED LIQUIDUS VALUES FOR THE TERNARY, TOGETHER WITH THE PUBLISHED DATA FOR THE U-C AND PU-C BINARIES HAVE BEEN EMPLOYED TO POSTULATE SEVERAL POSSIBLE ISOTHERMS INDICATING THE MOST LIKELY FREEZING BEHAVIOR FOR THE TERNARY ALLOYS WITH CARBON CONTENTS GREATER THAN 40 AT.%. THE EQUILIBRIA IN THE UC SUB 2-PUC SUB 2 REGION ARE DISCUSSED, AND THE TEMPERATURE OF THE DECOMPOSITION OF THE DICARBIDE TO SESQUICARBIDE AND CARBON AS A FUNCTION OF PU CONCENTRATION HAVE BEEN CALCULATED. A REGULAR SOLUTION MODEL WITH A SMALL INTERACTION PARAMETER MUST BE EMPLOYED TO DESCRIBE EITHER THE DICARBIDE OR SESQUICARBIDE SOLID SOLUTIONS IN ORDER TO OBTAIN A FIT TO THE EXPERIMENTAL DATA. THE TRANSFORMATIONS FROM THE TETRAGONAL TO CUBIC DICARBIDES IS ALSO CONSIDERED. THE EQUILIBRIA IN THE TWO PHASE REGIONS, METAL + MONOCARBIDE AND MONOCARBIDE + SESQUICARBIDE ARE CALCULATED. THE CALCULATIONS PREDICT THAT THE PU CONCENTRATION IS ALWAYS GREATER IN THE METAL THAN IN THE MONOCARBIDE, AND THE GREATER IN THE SESQUICARBIDE THAN IN THE MONOCARBIDE. THESE PREDICTIONS HAVE BEEN CONFIRMED BY EXPERIMENT. THE SIGNIFICANCE OF THESE EQUILIBRIA TO THE PU AND U PRESSURES ABOVE THE SYSTEMS TOGETHER WITH THE VARIATIONS OF CARBON POTENTIAL IN THESE REGIONS IS DISCUSSED AND ILLUSTRATED BY CALCULATION.

ABSTRACT 466

MARTIN J F

PROC BRIT CERAM SOC 8, 1 (1967)

TECHNIQUES FOR THE MEASUREMENT OF ENTROPY AND THEIR APPLICATION TO SOME URANIUM COMPOUNDS, UC, UC SUB 1.91, AND U SUB 2 C SUB 3

EQUIPMENT FOR THE MEASUREMENT OF HEAT CAPACITIES AND HEATS OF TRANSITION IN THE TEMPERATURE RANGE 10 DEG -450 DEG K IS DESCRIBED. A SPECIAL FEATURE OF THE APPARATUS IS THE USE OF AUTOMATIC DEVICES FOR RECORDING THE EXPERIMENTAL DATA ON PUNCHED TAPE WHICH IS THEN PROCESSED BY COMPUTER. RESULTS OF MEASUREMENTS ON URANIUM CARBIDES (UC, UC SUB 1.91, AND U SUB 2 C SUB 3) AND URANIUM NITRIDES (UN SUB 1.01, UN SUB 1.59, UN SUB 1.73) ARE SUMMARIZED.

ABSTRACT 467

MARTIN J M

J NUCL MATER 34, 81 (1970)

LES DIAGRAMMES DE PHASES U-UN-UO SUR 2 ET UO SUR 2-UN-N SUR 2

EARLIER RESULTS HAVE BEEN COMPLEMENTED AND GATHERED TO ESTABLISH THE PHASE DIAGRAM OF THE SYSTEM UO SUB 2-UN-N SUB 2 AT ONE ATMOSPHERE. A THEORETICAL PERSPECTIVE VIEW OF THE DIAGRAM IS PROPOSED. EXPERIMENTS PERFORMED IN ARGON ALLOW THE DETERMINATION OF THE LIMITING COMPOSITIONS OF THE DIOXIDE AND OF THE MONONITRIDE SIMULTANECUSLY IN EQUILIRRIUM WITH LIQUID URANIUM. THE MAIN PROPERTIES OF THE U-UN-UO SUB 2 PHASE DIAGRAM HAVE BEEN SPECIFIED.

ABSTRACT 468

MARTIN R L

BMI-1731 (1965)

RADIATION STABILITY OF UN

THE IRRADIATION CHARACTERISTICS OF UN FABRICATED BY VARIOUS TECHNIQUES AND CLAD WITH TYPE 316L STAINLESS STEEL WERE STUDIED AT SURFACE TEMPERATURES UP TO ABOUT 750 DEG C AND FISSION BURNUPS TO 6.3 AT. % (2.2×10^{21} FISSIONS PER CM² 3) OF THE URANIUM. DIAMETRAL SWELLING OF CLAD SPECIMENS VARIED FROM 1.3 TO 4 PER CENT. NO CLEAR-CUT RELATIONSHIPS BETWEEN SWELLING CHARACTERISTICS AND FABRICATION TECHNIQUE WERE OBSERVED. FRACTIONAL FISSION-GAS RELEASES RANGED UP TO 26 PER CENT. HYDROGEN RESULTING FROM $^{14}\text{N}(n,p)^{14}\text{C}$ REACTION WAS ALMOST TOTALLY RELEASED FROM THE UN BUT SIGNIFICANT FRACTIONS WERE RETAINED WITHIN SOUNDLY CLAD SPECIMENS. ABOUT HALF OF THE STAINLESS STEEL CLADDINGS EXHIBITED VERY SMALL CRACKS OF UNKNOWN ORIGIN.

ABSTRACT 469

MATZKE H J

J APPL PHYS (1973)

URANIUM SELF-DIFFUSION IN STOICHIOMETRIC URANIUM MONOCARBIDE

SELF-DIFFUSION MEASUREMENTS WITH U-233 AS THE TRACER HAVE BEEN PERFORMED WITH STOICHIOMETRIC ARC-CAST UC OVER A TEMPERATURE RANGE OF 1480 DEG C TO THE MELTING POINT AND WITH ZONE-REFINED UC SINGLE CRYSTALS IN THE TEMPERATURE RANGE OF 1500 TO 2150 DEG C. ALPHA-SPECTROSCOPY AND THE METHOD OF β -ENERGY DEGRADATION WERE USED TO DETERMINE THE DIFFUSION PROFILES. CONVENTIONAL SECTIONING TECHNIQUES WERE EMPLOYED AT HIGH TEMPERATURES. THE RESULTS OBTAINED FROM ARC-CAST UC YIELDED A CURVED ARRHENIUS

ABSTRACT 469 (CONT'D)

PLOT. COMPUTER PROGRAMS WERE DEVELOPED TO FIT THE SUM OF TWO EXPONENTIALS TO THE EXPERIMENTAL DATA BY MINIMIZING THE STANDARD DEVIATION σ WHILE VARYING ONE OR TWO OF THE PARAMETERS $D_{SUB 0,1}$; $D_{SUB 0,2}$; $\sigma H_{SUB 1}$; $\sigma H_{SUB 2}$ IN STEPS AND ADJUSTING THE REMAINING PARAMETERS. THE RESULTING EQUATION WAS $D^{*}U_{SUB UC} = 6.9 \exp(-141,000/RT) + 3.6 \cdot 10^{*5} \exp(-84,500/RT) \text{ CM}^{*2}/\text{SEC}$. THE SINGLE CRYSTALS SHOWED ONLY A SINGLE PROCESS DESCRIBED BY $D^{*}U_{SUB UC} = 11.7 \cdot \exp(-141900/RT) \text{ CM}^{*2}/\text{SEC}$. THE INFLUENCE OF IMPURITIES AT LOW TEMPERATURES (2100 DEG C) IS THE MOST PROBABLE CAUSE OF THE CURVATURE IN THE ARRHENIUS PLOT MEASURED FOR THE ARC-CAST UC. IT IS ARGUED THAT MANY OF THE PREVIOUSLY PUBLISHED VALUES FOR D WERE TOO HIGH SINCE THEY WERE AFFECTED EITHER BY POOR EXPERIMENTAL TECHNIQUES OR BY HIGH IMPURITY CONCENTRATIONS.

ABSTRACT 470

MATZKE H J

SOLID STATE COMMUN 12,401 (1973)

SELF-DIFFUSION OF URANIUM IN URANIUM DICARBIDE UC SUB 2

THE SELF-DIFFUSION OF URANIUM IN URANIUM DICARBIDE, UC SUB 2, WAS MEASURED BETWEEN 1670 AND 2500 DEG K USING THE α -ENERGY DEGRADATION METHOD WITH THE THIN LAYER CONDITION AND ^{233}U AS TRACER. THE ACTIVATION ENTHALPY WAS $5.7 \pm 0.2 \text{ EV}$. A DISCONTINUITY WAS INDICATED AT ABOUT 2050 DEG K, THE TRANSITION TEMPERATURE OF α -UC SUB 2 TO β -UC SUB 2.

ABSTRACT 471

MATZKE H J

THERMODYNAMICS OF NUCL FUELS, VIENNA (1974)

URANIUM SELF-DIFFUSION IN UC: EFFECTS OF DEVIATIONS FROM STOICHIOMETRY, OF REACTOR IRRADIATION AND OF IMPURITIES

SUMMARIZES RESULTS OF UC DIFFUSION STUDY. SELF DIFFUSION IN UC FROM 1400 DEG TO MELTING POINT. SINGLE CRYSTALS: $C/U = 1.00 \pm 0.02$, $D^{*}U_{SUB UC} = 11.7 \cdot \exp(-141900 \pm 7600/RT) \text{ CM}^{*2}/\text{SEC}$ POLYCRYSTALS: $C/U = 1.00 \pm 0.01$, $D^{*}U_{SUB UC} = 6.9 \cdot \exp(-141000 \pm 10000/RT) + 3.6 \cdot 10^{*5} \exp(-84500 \pm 5000/RT) \text{ CM}^{*2}/\text{SEC}$ DEVIATIONS AT LOWER TEMPERATURE (<1800 DEG C) ARE BLAMED ON IMPURITY EFFECTS. EFFECTS OF C/U ON σ AND $\log D$ ARE ALSO SHOWN.

ABSTRACT 472

MCCOLM I J

J INORG NUCL CHEM 34, 3809 (1972)

THE CUBIC-TETRAGONAL TRANSFORMATION IN METAL DICARBIDES-1: THE URANIUM - LANTHANUM AND URANIUM - CERIUM DICARBIDE SYSTEMS

THE COMPOSITION DEPENDENCE OF THE CUBIC TETRAGONAL PHASE TRANSFORMATION FOR SOLID SOLUTIONS OF UC SUB 2 WITH LAC SUB 2 AND WITH CEC SUB 2 IS REPORTED. THE EXISTENCE OF CUBIC PHASES DOWN TO ROOM TEMPERATURE IS SHOWN FOR TERNARY CARBIDES WITHIN THE COMPOSITION LIMITS $La_{SUB 0.10}U_{SUB 0.90}C_{SUB 2}$ - $La_{SUB 0.85}U_{SUB 0.15}C_{SUB 2}$ AND $Ce_{SUB 0.16}U_{SUB 0.84}C_{SUB 2}$ - $Ce_{SUB 0.81}U_{SUB 0.19}C_{SUB 2}$. A DISORDERED DOMAIN MODEL IS DESCRIBED TO ACCOUNT FOR THE FAILURE OF A TETRAGONAL PHASE TO NUCLEATE ON COOLING FROM THE MELT. THE VARIATIONS OF LATTICE PARAMETER WITH COMPOSITION FOR THE CUBIC SOLID SOLUTIONS ARE GIVEN. THE APPEARANCE OF UC FROM THE CUBIC SOLID SOLUTIONS ON ANNEALING SHOWS THAT UC PRECIPITATION

ABSTRACT 472 (CONT'D)

OCCURS ABOVE THE B = A TRANSITION. TERNARY F.C.C. SOLID SOLUTIONS CONTAINING C SUB 2 UNITS HAVE BEEN SHOWN NOT TO OCCUR WHEN THE OVERALL CARBON/TOTAL METAL RATIO FALLS BELOW 2:1. IN SUCH PREPARATIONS THE PHASES IN THE MELT ARE UC AND THE LANTHANIDE CARBIDE EXPECTED FROM THE MELT STOICHIOMETRY. THE LIMITING SOLUBILITIES OF CE IN UC AND OF U IN CE SUB 2 C SUB 3 ARE 4.5% AND 5.5 ATOM % TOTAL METAL RESPECTIVELY.

ABSTRACT 473

MCGRATH F E

NMI-5025 P39 (1965)

METALLOGRAPHY OF CERAMIC FUEL AND REFRACTORY METAL COMPATIBILITY COUPLES, TECHNICAL PAPERS OF THE 18TH METALLOGRAPHIC GROUP MEETING

TENTATIVE CONCLUSIONS MAY BE DRAWN ON THE BASIS OF METALLOGRAPHIC EXAMINATION OF COMPATIBILITY COUPLES HEATED FOR 100 HOURS. THEY ARE: (1) IN CESIUM VAPOR TUNGSTEN, TUNGSTEN-BASE ALLOYS AND TZM PERFORM WELL AT 3400 F. (2) IN LITHIUM AT TEMPERATURES UP TO 2500 F TUNGSTEN, TUNGSTEN-BASE ALLOYS AND TZM ARE COMPATIBLE. (3) TUNGSTEN AND TUNGSTEN-BASE ALLOYS EXHIBIT LIMITED COMPATIBILITY WITH HYPERSTOICHIOMETRIC UC. EXCESS CARBON MIGRATES TO THE CORE CLADDING INTERFACE TO FORM A REACTION ZONE. HOWEVER, WHEN THIS EXCESS CARBON IS DEPLETED THE REACTION APPEARS TO STOP. TUNGSTEN AND TUNGSTEN-BASE ALLOYS APPEAR TO BE COMPATIBLE WITH UN AT 3100 F AND UC SUB 2 AT 3400 F. (4) THE TANTALUM-BASE ALLOYS REACT WITH UC AT 2500 F TO FORM A ZONE, CONTAINING TA SUB 2 C AND TAC. THE DEPLETION OF CARBON FROM THE UC GIVING RISE TO FREE URANIUM. AT 2800 F UN AND TA-12W REACT TO FORM LIQUID URANIUM, BUT THIS ALLOY DOES NOT REACT WITH UD SUB 2 AT 3100 F. (5) THE MOLYBDENUM-BASE ALLOY, TZM, DOES NOT REACT WITH UC AND UN AT 3100 F OR UD SUB 2 AT 3400 F. (6) THE NIOBIUM-BASE ALLOY, B-66, REACTS WITH UC AND UN AT 2500 F, BUT DOES NOT REACT WITH UD SUB 2 AT THE SAME TEMPERATURE.

ABSTRACT 474

MCIVER E J

AERE-R-4983 (1966)

GALVANIC CELL FOR MEASURING THE URANIUM ACTIVITY IN CARBIDES AT HIGH TEMPERATURE

A HIGH-TEMPERATURE GALVANIC CELL WITH A FUSED SALT ELECTROLYTE WAS DEVELOPED AND USED FOR MEASURING THE U ACTIVITY IN URANIUM CARBIDES. THE FREE ENERGY OF FORMATION OF UC HAS BEEN FOUND TO BE $\Delta G \text{ SUB UC} = -20300 - 1.6 T$ CALORIES AND OF UC SUB 2 TO BE $\Delta G \text{ SUB UC2} = -24200 + 0.9 T$ CALORIES. THE DISSOLUTION OF O SUB 2 IN UC SUB 2 WAS FOUND TO LOWER ITS FREE ENERGY OF FORMATION BY AS MUCH AS 5.4 KCAL AT 1000 DEG K.

ABSTRACT 475

MCNEILLY C E

BNWL-435 P4 6 (1967)

PU-O-N PHASE EQUILIBRIA

AS PART OF CONTINUING STUDY TO DETERMINE SOLUBILITY LIMITS OF OXYGEN IN PUN AND UN-PUN SOLID SOLUTION, PUN SAMPLES WERE SYNTHESIZED IN NITROGEN ATMOSPHERES CONTAINING 30, 100 AND 300 PPM OXYGEN. THE AMOUNT OF DISSOLVED OXYGEN WILL THEN BE RELATED TO THE OBSERVED LATTICE PARAMETER

ABSTRACT 475 (CONT'D)
FOR THE PU(N,O) PHASE IN EACH SAMPLE.

ABSTRACT 476
MEERSON G A
ATOMN ENERG 9, 387 (1960)
URANIUM MONOCARBIDE

UC POWDER WAS PREPARED FROM UC SUB 2 AND U (INITIATION OF THE REACTION AT 1300 DEG) AT 1800 DEG ; THE CONTENT OF FREE C WAS < 0.1%. UC IS CUBIC, WITH A 4.9512 ± 0.0003 KX; AND THE DENSITY IS 12.97 ± 0.09 . THE RATE OF OXIDATION OF UC POWDER WAS STUDIED IN AIR. THE DEPENDENCE OF THE DENSITY ON THE PRESURE, TEMPERATURE, AND THE TIME OF TREATMENT WAS DETERMINED WITH RESPECT TO THERMAL COMPRESSION. MAXIMUM VALUES WERE OBTAINED AT 1800-1850 DEG . THE POROSITY WAS 5%. UPON SINTERING UC FOR 2 H AT 2200 DEG , THE POROSITY REACHED 10%. THE INTRODUCTION OF 9.5 - 31.8 WT. % U REDUCED THE POROSITY. UPON SINTERING THE UC + 31.8 WT. % U AT 1700 DEG , POROSITY WAS REDUCED TO < 5%. THE MICROTOUGHNESS FOR THE UC PHASE WAS 923 # 56 AND THAT OF THE U INTERMEDIATE LAYER 376 # 24 KG/CM. THE THERMAL CONDUCTIVITIES OF THE SINTERED SAMPLES WERE DETERMINED AT 100 - 700 DEG FOR UC AND FOR THE UC + 20 WT. % U. THE MEAN COEFFICIENT OF LINEAR EXPANSION FOR THESE SAMPLES AT 20 - 600 DEG WAS 8.9 AND 12.4, RESPECTIVELY. SINTERED UC BROKE DOWN AFTER 500 CYCLES OF THERMAL TREATMENT AT 200 - 1000 DEG . UC + 20 WT. % U DID NOT BREAK DOWN AFTER 1000 CYCLES, NEITHER DID ITS PROPERTIES CHANGE AS A RESULT OF THIS TREATMENT.

ABSTRACT 477
MEERSON G A
J NUCL ENERGY PT A AND B 16, 485 (1962)
URANIUM MONOCARBIDE

URANIUM MONOCARBIDE IS OF INTEREST AS A POSSIBLE NUCLEAR FUEL AND AS A MATERIAL FOR NUCLEAR THERMOELECTRIC CONVERSION. TO DEFINE MORE ACCURATELY THE INFLUENCE OF THE CONDITIONS OF FABRICATION OF URANIUM MONOCARBIDE ON ITS CONSTITUTION, EXPERIMENTS ARE UNDERTAKEN, BY MEANS OF WHICH THE OPTIMUM CONDITIONS FOR OBTAINING STOICHIOMETRIC UC ARE DEFINED. INVESTIGATION OF THE CONDITIONS OF SINTERING AND HOT PRESSING OF UC POWDER AND ALSO CONDITIONS FOR SINTERING ALLOYS OF UC + U RESULTS IN A METHOD OF PREPARING SPECIMENS WITH A POROSITY OF ABOUT 5 PER CENT. THE SPECIFIC GRAVITY OF UC POWDER DETERMINED WITH A PICHNOMETER IS 12.97 ± 0.09 G/CM³ , AND THE MICRO HARDNESS IS 923 ± 56 KG/MM². THE THERMAL CONDUCTIVITY OF UC IN THE RANGE 100 TO 700 DEG C IS FOUND TO BE FROM 0.028 TO 0.04 CAL/CM/S/ DEG C; THE MEAN THERMAL COEFFICIENT OF LINEAR EXPANSION IN THE INTERVAL 20 TO 1500 DEG C IS 11.6 ± 10^{-6} . SPECIMENS OF UC THERMALLY CYCLED IN THE RANGE 200 TO 1000 DEG C WITHSTOOD 500 CYCLES WITHOUT DISINTEGRATION. SPECIMENS OF UC + U WITHSTAND MORE THAN 1000 CYCLES.

ABSTRACT 478

MENDEA-PENALOSA R

J AM CERAM SOC 47, 416 (1964)

THERMAL EXPANSION OF URANIUM SESQUICARBIDE

THE THERMAL EXPANSION OF STOICHIOMETRIC $U_{0.8}C_{1.2}$ WAS DETERMINED TO ITS DECOMPOSITION TEMPERATURE AND THE EFFECTS OF THE DECOMPOSITION TO UC AND $UC_{0.8}$ WERE OBSERVED. THE MEAN THERMAL EXPANSION COEFFICIENT INCREASED SMOOTHLY TO 1700 DEG C AND THEN INCREASED RAPIDLY. THIS WAS MOST PRONOUNCED AT ABOUT 1780 DEG C, AT WHICH TEMPERATURE A MARKED INCREASE IN SPECIMEN LENGTH WAS OBSERVED WITHOUT A CORRESPONDING INCREASE IN TEMPERATURE. THIS EXPANSION WAS THOUGHT TO BE CAUSED BY THE ONSET OF THE DECOMPOSITION REACTION $U_{0.8}C_{1.2} = UC + UC_{0.8}$, WHICH BEGINS AT ABOUT THIS TEMPERATURE.

ABSTRACT 479

MENDEZ-PENALOSA R

ATOMICS INTERNATIONAL REP (1963)

THERMAL EXPANSION OF URANIUM MONOCARBIDE

THE INFLUENCE OF THE CARBON CONTENT ON THE THERMAL EXPANSION OF ARC-CAST UC NEAR THE STOICHIOMETRIC COMPOSITION WAS EXAMINED. EXPANSION MEASUREMENTS WERE MADE ON SAMPLES WHICH VARIED FROM 4.35 TO 5.24 WT. % CARBON, OVER A TEMPERATURE RANGE THAT, FOR THE HIGHER CARBON CONTENT SAMPLES, EXTENDED TO ABOUT 2000 DEG C. THE INFLUENCE OF FREE URANIUM IN THE HYPOSTOICHIOMETRIC RANGE WAS OBSERVED. THE THERMAL EXPANSION OF ALL THE SAMPLES WAS SIMILAR, UP TO 600 DEG C. AT 700 AND 780 DEG C. A DIFFERENCE IN THE EXPANSION BEHAVIOR WAS OBSERVED BETWEEN HYPOSTOICHIOMETRIC AND HYPERSTOICHIOMETRIC SAMPLES. THESE CHANGES CAN BE RELATED TO THE α -TO- β , AND β -TO- γ TRANSFORMATION OF FREE URANIUM. THE EXPANSION OF HYPOSTOICHIOMETRIC UC INCREASES RAPIDLY ABOVE 850 DEG C. THIS SHARP INCREASE, OBSERVED ON SINTERED UC WITH 4.4 WT. % CARBON BY OTHER AUTHORS, IS PRESUMABLY CAUSED BY FREE URANIUM, AND MAY BE CAUSED BY THE LARGER THERMAL EXPANSION COEFFICIENT OF γ -URANIUM AND THE RELEASE OF FORCES ACCUMULATED IN THE GRAIN BOUNDARIES OF UC NEAR THE MELTING POINT OF URANIUM.

ABSTRACT 480

MENDEZ-PENALOSA R

J AM CERAM SOC 47, 101 (1964)

THERMAL EXPANSION OF URANIUM MONOCARBIDE

LINEAR THERMAL EXPANSION DATA ARE REPORTED FOR U-UC MIXTURES CONTAINING 4.35-5.05 WT. % C. FOR MIXTURES CONTAINING 4.8% C (STOICHIOMETRIC UC); THE LINEAR THERMAL EXPANSION INCREASED RAPIDLY >850 DEG AND THE SPECIMENS WERE PERMANENTLY DEFORMED 0.2 - 0.4% WHEN HEATED TO 1100 DEG.

ABSTRACT 481

MIKAELOFF H

CEA-R-3223 (1967)

IRRADIATION BEHAVIOUR OF MIXED U-PU-CARBIDES NITRIDES AND CARBO-NITRIDES,

IN THE FRAMEWORK OF THE RESEARCH PROGRAM ON FAST REACTOR FUELS TWO IRRADIATION EXPERIMENTS WERE CARRIED OUT ON MIXED URANIUM-PLUTONIUM CARBIDES, NITRIDES AND CARBONITRIDES. IN THE FIRST EXPERIMENT CARRIED OUT WITH THERMAL NEUTRONS, THE FUEL CONSISTED OF SINTERED PELLETS SHEATHED IN

ABSTRACT 481 (CONT'D)

A STAINLESS STEEL CAN WITH A SMALL GAP FILLED WITH HE. THERE WERE THREE PUC-UC SAMPLES AND THE MAXIMUM LINEAR POWER WAS 715 W/CM. AFTER A BURNUP SLIGHTLY LOWER THAN 20,000 MWD/T, A SWELLING OF THE FUEL THAT HAD RUPTURED THE CANS WAS OBSERVED. IN THE SECOND EXPERIMENT CARRIED OUT IN THE BR-2 REACTOR WITH EPITHERMAL NEUTRONS, THE SAMPLES CONSISTED OF SINTERED PELLETS SODIUM BONDED IN A STAINLESS STEEL TUBE. THERE WERE THREE SAMPLES CONTAINING DIFFERENT FUELS AND THE LINEAR POWER VARIED BETWEEN 1130 AND 1820 W/CM. POST-IRRADIATION EXAMINATION AFTER A MAXIMAL BURNUP OF 1550 MWD/T SHOWED THAT THE BEHAVIOR OF THE THREE FUEL ELEMENTS WAS SATISFACTORY.

ABSTRACT 482

MILET C A

CEA-R-3656

A CONTRIBUTION TO THE STUDY OF U-TI AND U-PU-TI CARBIDES

AFTER HAVING DISCUSSED THE REASONS TO USE (U,PU) CARBIDES AS FAST REACTOR FUEL, WE EXAMINE THE INFLUENCE OF THE ADDITION OF TITANIUM TO THESE CARBIDES. A PRELIMINARY STUDY HAS BEEN DONE ON THE SYSTEM OF U-C-TI AND SOME PROPERTIES HAVE BEEN MEASURED SUCH AS: DENSITY, THERMAL EXPANSION, ELECTRICAL RESISTIVITY, ATMOSPHERIC CORROSION AND COMPATIBILITY WITH STAINLESS STEEL. THE SYSTEMS U-PU-C-TI (PU/U+PU EQUAL TO 15 PER CENT) AND U-C-TI HAVE BEEN FOUND TO BE VERY SIMILAR. THERE EXISTS A TWO PHASES REGION (U,PU)C+TIC, AN EUTECTIC BETWEEN (U,PU)C AND TIC FOR APPROXIMATELY 15 AT %. THE SOLUBILITIES OF U+PU IN TIC AND OF TI IN (U,PU)C IS LESS THAN 1 % AT. THE ADDITION OF TITANIUM DOES NOT MARKEDLY CHANGE THERMAL EXPANSION COEFFICIENTS OF (U,PU)C. HOWEVER THE RESISTANCE TO ATMOSPHERIC CORROSION AND COMPATIBILITY WITH STAINLESS STEEL IS IMPROVED. THERMAL CONDUCTIVITY, CALCULATED FROM ELECTRICAL RESISTIVITY, HAS INCREASED. ON THE OTHER SIDE, THE DENSITY OF FISSILE MATERIAL IS LOWERED. THE COMBINATION OF (U,PU)C+TIC SEEMS TO BE THE MOST PROMISING ALLOY FOR APPLICATION AS NUCLEAR FUEL.

ABSTRACT 483

MONTGOMERY M

GU-5286 (1972)

POST-IRRADIATION EXAMINATIONS OF HIGH DENSITY URANIUM-PLUTONIUM CARBIDE FUEL RODS IN EBR-II TO 65,000 MWD/T BURN UP

THE POST-IRRADIATION EXAMINATION OF NINE HELIUM-BONDED, MIXED CARBIDE FUEL RODS IRRADIATED IN THE EBR-II WAS MADE AT LOS ALAMOS SCIENTIFIC LABORATORY. THE FUEL WAS IN THE FORM OF HIGH-DENSITY (97% OF THEORETICAL), SOLID-SOLUTION URANIUM-PLUTONIUM CARBIDE PELLETS, WITH A STRUCTURE OF $MC + 10 \text{ V/O M SUB } 2 \text{ C SUB } 3 \text{ (M = U SUB } 0.8 \text{ PU SUB } 0.2)$. THE FUEL WAS PREPARED BY THE CARBOTHERMIC REDUCTION OF THE DIOXIDES OF URANIUM AND PLUTONIUM FOLLOWED BY COLD PRESSING AND SINTERING OF PELLETS. THE CLADDING WAS SOLUTION ANNEALED TYPE 316 STAINLESS STEEL AND INCOLOY-800 ALLOY. TWO RODS (UNC 89 AND UNC 90) CONTAINED FOUR SEGMENTS EACH, WHILE THE REMAINDER WERE FULL LENGTH PROTOTYPIC RODS, ALL DESIGNED TO TEST AND EVALUATE THE EFFECTS OF ANNULAR FUEL-CLAD GAP AND CLADDING STRENGTH. VISUAL EXAMINATION OF THE RODS SHOWED THAT THREE OUT OF FOUR RODS CLAD IN INCOLOY-800, INCLUDING THE MULTISPECIMEN ROD, WERE IN EXCELLENT CONDITION AFTER IRRADIATION, WHILE ALL TYPE 316 STAINLESS STEEL CLAD RODS HAD SEVERE CIRCUMFERENTIAL AND/OR LONGITUDINAL CRACKS.

ABSTRACT 483 (CONT'D)

INCOLLOY-800 PERFORMED BETTER THAN TYPE 316 STAINLESS STEEL IN EVERY RESPECT.

ABSTRACT 484

MOORE J P

J AM CERAM SOC 53 (1970)

THERMAL CONDUCTIVITY, ELECTRICAL RESISTIVITY, AND SEEBECK COEFFICIENT OF URANIUM MONONITRIDE

MEASUREMENTS ARE REPORTED FOR THE THERMAL CONDUCTIVITY, INVERTED γ (80 DEG TO 400 DEG K), ELECTRICAL RESISTIVITY, ρ (4.2 DEG TO 400 DEG K), AND ABSOLUTE SEEBECK COEFFICIENT, Q (6 DEG TO 400 DEG K), OF PRESSED AND SINTERED URANIUM MONONITRIDE. THE MEASUREMENTS BETWEEN 77 DEG AND 400 DEG K WERE MADE USING AN ABSOLUTE LONGITUDINAL HEAT FLOW APPARATUS. THESE DATA AND LITERATURE VALUES FOR THE THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY AT HIGHER TEMPERATURES WERE USED TO SEPARATE THE ELECTRONIC AND LATTICE PORTIONS OF THE THERMAL CONDUCTIVITY. THE RESULTS INDICATE THAT THE LATTICE CONDUCTIVITY PEAKS IN THE RANGE 250 DEG TO 300 DEG K AND THAT THE HIGH-TEMPERATURE LIMIT OF THE LORENZ FUNCTION MAY BE GREATER THAN THE SOMMERFELD VALUE OF $2.443 \times 10^{-8} (V^{**2} - DEG K^{**2})$. THE ELECTRICAL RESISTIVITY AND THE ABSOLUTE SEEBECK COEFFICIENT EXHIBIT SHARP SLOPE CHANGES NEAR THE NEEL TEMPERATURE, $T_{SUB N}$ (=50 DEG TO 60 DEG K). THE SEEBECK COEFFICIENT HAS A MINIMUM AT 34 DEG K AND THEN RISES TO A LOCAL MAXIMUM AT 10 DEG K. THIS LOW-TEMPERATURE PEAK IS PROBABLY DUE TO MAGNON DRAG. THE TEMPERATURE DEPENDENCE OF THE ELECTRICAL RESISTIVITY IS DOMINATED BY THE MAGNETIC CONTRIBUTION WHICH INCREASES AS $T^{**2.38 \pm 0.08}$ BETWEEN 10 DEG AND 52 DEG K. THE MAGNETIC CONTRIBUTION IS CONSTANT AT HIGH TEMPERATURES WITH AN ESTIMATED VALUE OF 142 (MICRO OHM-CM)

ABSTRACT 485

MOREAU C

COMPT REND 256, 5366 (1963)

KINETICS OF THE REACTION OF PURE OXYGEN WITH URANIUM MONONITRIDE

LA REACTION DE L'OXYGENE SUR LE MONONITRURE D'URANIUM UN ENTRE 350 ET 480 DEG C ET SOUS UNE PRESSION DE 100 MM DE MERCURE CONDUIT A UN OXYDE DE FORMULE INTERMEDIAIRE ENTRE $U_{SUB 3} O_{SUB 8}$ ET $UO_{SUB 3}$. ELLE OBEIT A UNE CINETIQUE LINEAIRE AVEC UNE ENERGIE D'ACTIVATION DE 24.5 KCAL/MOLE.

ABSTRACT 486

MORGAN C S

ORNL- 4370, 30-4

PHYSICAL CERAMICS STUDIES

COMPRESSIVE DEFORMATION STUDIES OF POLYCRYSTALLINE UN AND $UO_{SUB 2}$ ARE BEING CONDUCTED.

ABSTRACT 487

MOSER J B

ANL-7299 P130

THERMAL CONDUCTIVITY AND HEAT CAPACITY OF ACTINIDE COMPOUNDS

REPORTED MOLAR THERMODYNAMIC PROPERTIES OF UC SUCH AS SPECIFIC HEAT, ENTHALPY AND ENTROPY FROM 400 TO 1000 DEG K, ALSO MEASURED THERMAL CONDUCTIVITY AND THERMAL DIFFUSIVITY OF UC FROM ROOM TEMPERATURE TO 600 DEG C. VALUE OF ELECTRICAL CONDUCTIVITY OF UC AT 600 DEG C IS GIVEN.

ABSTRACT 488

MOSER J B

J APPL PHYS 38, 3215 (1967)

THERMAL CONDUCTIVITY AND HEAT CAPACITY OF THE MONOCARBIDE, MONOPHOSPHIDE, AND MONOSULFIDE OF URANIUM

THE HEAT-TRANSPORT PROPERTIES AND HEAT CAPACITY OF UC, UP, AND US WERE DETERMINED BETWEEN ROOM TEMPERATURE AND 600 DEG C. THESE PROPERTIES WERE MEASURED BY A TRANSIENT TECHNIQUE WITH A LASER AS A HEAT PULSE SOURCE. AT ROOM TEMPERATURE THE THERMAL CONDUCTIVITY OF THE THREE COMPOUNDS CORRECTED TO THEORETICAL DENSITY WAS FOUND TO BE 0.057, 0.033, AND 0.021 CAL/SEC-CM-DEG C FOR UC, UP, AND US, RESPECTIVELY. AT 600 DEG C THE VALUE FOR UC DECREASED TO 0.041 CAL/SEC-CM-DEG C. THE THERMAL CONDUCTIVITY OF UP REMAINED EQUAL TO ITS ROOM-TEMPERATURE VALUE AND THAT OF US INCREASED TO 0.029 CAL/SEC-CM-DEG C. THE ROOM-TEMPERATURE HEAT CAPACITY VALUES FOR THE THREE COMPOUNDS INVESTIGATED WERE ALL SLIGHTLY ABOVE 12 CAL/MOLE-DEG K. AT 600 DEG C THE HEAT CAPACITY OF UC INCREASED TO 15.2 CAL/MOLE-DEG K WHEREAS NO APPRECIABLE CHANGES WERE FOUND FOR UP AND US AT THIS TEMPERATURE. THE EXPERIMENTAL HEAT-CAPACITY VALUES WERE USED TO FORMULATE EXPRESSIONS OF THE TYPE $C_{SUB} P = A + BT + CT^{** - 2}$, AND ENTHALPIES AND ENTROPIES OF THE COMPOUNDS WERE CALCULATED FROM 400 TO 1000 DEG K. THE ELECTRONIC CONTRIBUTIONS TO THE THERMAL CONDUCTIVITIES OF THE THREE COMPOUNDS WERE CALCULATED BY MEANS OF THE WIEDEMANN-FRANZ LAW WITH THE LORENZ CONSTANT FOR METALLIC CONDUCTORS. A VALUE OF 0.02 CAL /SEC-CM-DEG C FOR THE LATTICE CONDUCTIVITY ALONE WAS OBTAINED. THIS VALUE IS CLOSE TO THE 0.01 TO 0.02 CAL/SEC-CM-DEG C OBTAINED BY USING THE WIEDEMANN-FRANZ LAW ON UP AND US. THE THERMAL CONDUCTIVITY OF UC ABOVE 300 DEG C CAN BE ASCRIBED TO ELECTRONS IF THE TRADITIONAL LORENZ CONSTANT IS USED. HOWEVER, COMPARISON OF THE THERMAL AND ELECTRICAL CONDUCTIVITY FOR THE THREE COMPOUNDS INDICATES THAT THE LORENZ NUMBER WHEN APPLIED TO UC SHOULD BE LOWER, POSSIBLY BECAUSE OF THE PRESENCE OF OPTICAL SCATTERING. IT WAS FOUND THAT THE LATTICE RESISTANCE TO THE FLOW OF HEAT IN THIS GROUP OF COMPOUNDS IS ESSENTIALLY TEMPERATURE INDEPENDENT AND THAT CALCULATIONS BASED ON THE CLASSIC MODELS DO NOT GIVE GOOD AGREEMENT WITH MEASURED VALUES.

ABSTRACT 489

MOSER J B

J NUCL MATER 17, 153 (1965)

HEAT PULSE MEASUREMENTS OF URANIUM COMPOUNDS

THERMAL DIFFUSIVITIES AND HEAT CAPACITIES OF URANIUM MONOCARBIDE, URANIUM MONOSULPHIDE, AND URANIUM MONOPHOSPHIDE WERE MEASURED AT ROOM TEMPERATURE BY A PULSE METHOD. THE FRONT SURFACE OF A THIN SMALL PLATE WAS HEATED WITH A PULSE OF THERMAL ENERGY AND THE RESULTANT REAR SURFACE TEMPERATURE RISE WAS DETECTED BY A THERMOCOUPLE. FROM AN ANALYSIS OF THE RATE AND EXTENT OF THIS RISE, THE THERMAL DIFFUSION COEFFICIENT AND HEAT CAPACITY

ABSTRACT 489 (CONT'D)

WERE OBTAINED. THE THERMAL CONDUCTIVITY WAS THEN CALCULATED FROM THE PRODUCT OF THE DENSITY, THERMAL DIFFUSIVITY AND SPECIFIC HEAT. THE THERMAL CONDUCTIVITIES OF URANIUM MONOCARBIDE AND URANIUM MONOPHOSPHIDE CORRECTED TO THEORETICAL DENSITY WERE 0.055 AND 0.025 CAL/CM-SEC-DEG C RESPECTIVELY. URANIUM MONOSULPHIDE WITH A DENSITY OF 96.4% OF THEORETICAL HAD A THERMAL CONDUCTIVITY OF 0.019 CAL/CM-SEC-DEG C. EFFECTS OF POROSITY ON THIS TYPE OF MEASUREMENT ARE CONSIDERED. THE DATA ARE COMPARED WITH HEAT CAPACITY AND THERMAL CONDUCTIVITY VALUES OBTAINED BY OTHER INVESTIGATORS.

ABSTRACT 490

MOSER J B

PROC BRIT CERAMIC SOC 10,129 (1968)

ELECTRICAL AND THERMAL PROPERTIES OF SOME ACTINIDE COMPOUNDS

THE ELECTRICAL PROPERTIES OF COMPOUNDS FORMED BETWEEN URANIUM AND PLUTONIUM AND SOME GROUP (IV)A-(VI)A ELEMENTS ARE COMPARED AND DISCUSSED. EMPHASIS IS ON CUBIC COMPOUNDS OF HIGH MELTING POINTS, SUCH AS THE MONO-CARBIDES, -NITRIDES, -PHOSPHIDES, AND -SULFIDES, DUE TO THEIR IMPORTANCE IN NUCLEAR TECHNOLOGY. PROPERTIES CONSIDERED INCLUDE ELECTRICAL AND THERMAL CONDUCTIVITY, AND THE SEEBECK COEFFICIENT. FIGURES OF MERIT OF THESE NUCLEAR CERAMICS ARE EVALUATED AND DISCUSSED.

ABSTRACT 491

MOSER J B

THERMAL CONDUCTIVITY, P461 (1968)

THERMAL DIFFUSIVITY OF ACTINIDE COMPOUNDS

THE THERMAL DIFFUSIVITY OF THE CARBIDES OF URANIUM AND PLUTONIUM WAS MEASURED FROM 500 TO 1500 DEG C BY MEANS OF THE NSRDL FLASH TECHNIQUE. A RUBY LASER WAS USED AS THE PULSING SOURCE WHILE THE DISK-SHAPED SPECIMENS WERE HEATED IN A HIGH VACUUM RESISTANCE FURNACE. THE REAR SURFACE TEMPERATURE OF THE SPECIMEN WAS MONITORED BY AN OPTICAL DETECTOR WHICH CONTAINED A DUAL LEAD SULFIDE PHOTOCONDUCTOR IN A TEMPERATURE COMPENSATING CIRCUIT. THE VARIATIONS IN THERMAL DIFFUSIVITY AS A FUNCTION OF EFFECTIVE CARBON CONTENT AND URANIUM-PLUTONIUM RATIO ARE DISCUSSED AND COMPARED WITH RESULTS OF OTHER INVESTIGATORS.

ABSTRACT 492

MOUCHNINO M

CEA-R-3353 (OCT, 1967)

REACTION OF URANIUM AND PLUTONIUM CARBIDES WITH AUSTENITIC STEELS

THE REACTION OF URANIUM AND PLUTONIUM CARBIDES WITH AUSTENITIC STEELS HAS BEEN STUDIED BETWEEN 650 AND 1050 DEG C USING UC/STEEL, AND (UP)UC/STEEL DIFFUSION COUPLES. THE STEELS ARE OF THE TYPE CN 18.10 WITH OR WITHOUT ADDITION OF MOLYBDENUM. THE CARBIDES USED ARE HYPER-STOICHIOMETRIC. TESTS WERE ALSO CARRIED OUT WITH UCTI, UCNO, UPUCTI, AND UPUCTNO. UP TO 800 DEG C NO MARKED DIFFUSION OF CARBON INTO STAINLESS STEEL IS OBSERVED. BETWEEN 800 AND 900 DEG C THE CARBON PRODUCED BY THE DECOMPOSITION OF THE HIGHER CARBIDES DIFFUSES INTO THE STEEL. ABOVE 900 DEG C, DECOMPOSITION OF THE MONOCARBIDE OCCURS ACCORDING TO A REACTION WHICH CAN BE WRITTEN AS:

ABSTRACT 492 (CONT'D)

(U,PUC) + (FE, NI, CR) = (U,PU) FE SUB 2 + CR SUB 23 C SUB 6. ABOVE 950 DEG C THE BEHAVIOR OF UPUCMO AND THAT OF THE TITANIUM (CN 18.12) AND NICKEL (NC 38.18) STEELS IS OBSERVED TO BE VERY SATISFACTORY.

ABSTRACT 493

MUKAIRO T
NIPPON GENSHIRYOKU GAKKAISHI 5, 601 (1963)
THERMOCHEMICAL PROPERTIES OF URANIUM CARBIDES

MEASUREMENTS WERE MADE OF SPECIFIC HEATS ON UC AND UC SUB 2 ABOVE ROOM TEMPERATURE, AND THE ASSESSMENT OF EXPERIMENTAL THERMOCHEMICAL DATA BECAME POSSIBLE WITH SOME ACCURACY. THE SPECIFIC HEAT FUNCTIONS FOR UC AND UC SUB 2 WERE DERIVED AS A FUNCTION OF TEMPERATURE, FROM WHICH THE HEATS OF FORMATION, FREE ENERGIES OF FORMATION, AND ENTROPIES OF FORMATION OF THESE CARBIDES WERE ALSO CALCULATED AS A FUNCTION OF TEMPERATURE, RESPECTIVELY. IT WAS FOUND THAT MEASUREMENTS AT HIGH TEMPERATURES BY SEVERAL AUTHORS WERE FAIRLY ACCURATE WITH SOME SCATTERING OF DATA.

ABSTRACT 494

MUKAIRO T
THERMO NUCL MATER, P645 (1962)
THE MEASUREMENT OF THE SPECIFIC HEAT OF URANIUM CARBIDES ABOVE ROOM TEMPERATURE

PURE URANIUM MONOCARBIDE AND DICARBIDE WERE PREPARED BY SOLID PHASE REACTION FROM URANIUM HYDRIDE AND CARBON. THE SPECIFIC HEATS OF THESE SAMPLES WERE MEASURED ABOVE THE ROOM TEMPERATURE AND ARE GIVEN AS FUNCTION OF TEMPERATURE.

ABSTRACT 495

MULFORD R N R
J NUCL MATER 17, 324 (1965)
THE PLUTONIUM-CARBON-OXYGEN SYSTEM

A PORTION OF THE PU-C-O CONDENSED TERNARY PHASE DIAGRAM HAS BEEN EXAMINED. A SINGLE-PHASE FIELD CONTAINING A PU(C,O) PHASE WAS FOUND. LATTICE PARAMETER DATA AND THE COMPOSITION RANGE FOR THE PU(C,O) PHASE ARE DESCRIBED. ADJOINING THE PU(C,O) SINGLE-PHASE FIELD, THREE TWO-PHASE FIELDS CONTAINING PU+PU(C,O), PU SUB 2 O SUB 3+PU(C,O) AND PU SUB 2 C SUB 3 +PU(C,O) WERE FOUND. A THREE-PHASE FIELD CONTAINING PU+PU SUB 2 O SUB 3 + PU(C,O) WAS ALSO DELINEATED.

ABSTRACT 496

MULFORD R N R

PLUTONIUM 1960, P301

THE PLUTONIUM-CARBON SYSTEM.

A PHASE DIAGRAM FOR THE PLUTONIUM-CARBON SYSTEM HAS BEEN CONSTRUCTED FROM X-RAY, METALLOGRAPHIC, AND THERMAL EVIDENCE. AT LEAST FOUR CARBIDE PHASES HAVE BEEN SHOWN TO EXIST. IN ADDITION TO THE COMPOUNDS PUC AND PU SUB 2 C SUB 3 WHICH HAVE BEEN PREVIOUSLY REPORTED, A PHASE, DESIGNATED L, CONTAINING SLIGHTLY LESS CARBON THAN PUC HAS BEEN FOUND. THE L-PHASE DECOMPOSES TO PUC AND E-PU UPON HEATING AT 575 DEG C. A HIGHER CARBIDE, PROBABLY PUC SUB 2, HAS BEEN FOUND. THIS HIGHER CARBIDE APPEARS TO BE UNSTABLE WITH RESPECT TO PU SUB 2 C SUB 3 AND CARBON AT TEMPERATURES BELOW ABOUT 1750 DEG C. PUC AND PU SUB 2 C SUB 3 MELT PERITECTICALLY AT 1654 DEG AND 2050 DEG C, RESPECTIVELY. PUC APPEARS TO EXIST AS A PHASE DEFICIENT IN CARBON AND NOT AS THE STOICHIOMETRIC COMPOUND. PU SUB 2 C SUB 3 EXISTS AS THE STOICHIOMETRIC COMPOUND. THE EUTECTIC COMPOSITION BETWEEN PU AND PUC IS VERY CLOSE TO PURE PLUTONIUM; SO CLOSE THAT A EUTECTIC STRUCTURE HAS NOT BEEN OBSERVED IN PHOTOMICROGRAPHS. THERMAL DATA SHOW THE EUTECTIC TEMPERATURE TO BE ABOUT 630 DEG C, WHEREAS PURE PLUTONIUM MELTS AT 639 DEG C. THE PRESENCE OF CARBON DOES NOT AFFECT THE SOLID TRANSITION TEMPERATURES OF PLUTONIUM, SUGGESTING THAT THE SOLUBILITY OF CARBON IN SOLID PLUTONIUM IS VERY SMALL.

ABSTRACT 497

MULFORD R N R

THERMO NUCL MATER P517 (1962)

THE VOLATILITY OF PLUTONIUM CARBIDE

THE VAPOR PRESSURE OVER PUC SUB 2 IN EQUILIBRIUM WITH GRAPHITE HAS BEEN MEASURED BY THE KNUDSEN EFFUSION METHOD IN THE RANGE 2000 TO 2400 DEG K. ASSUMING THAT THE GASEOUS SPECIES OVER THIS SYSTEM IS MONATOMIC PLUTONIUM, THE TEMPERATURE-PRESSURE RELATIONSHIP IS OBTAINED: $\log \text{SUB } 10 \text{ P (ATM)} = -179020/T + 2.779$. THIS GIVES $\Delta H \text{ DEG SUB } 298 = 95100 \text{ CAL/MOLE}$ AS A SECOND-LAW HEAT FOR THE VAPORIZATION PROCESS. EXPERIMENTAL EVIDENCE IS PRESENTED TO SHOW THAT PLUTONIUM CARBIDES VAPORIZE TO GIVE MONATOMIC PLUTONIUM AS THE GASEOUS SPECIES.

ABSTRACT 498

MUSTACCHI C

EUR-337 (1963)

DEVELOPMENT OF METHODS FOR THE DETERMINATION OF THE HIGH TEMPERATURE THERMAL DIFFUSIVITY OF UC

A MODULATED ELECTRON GUN WAS USED TO DETERMINE THE THERMAL DIFFUSIVITY OF URANIUM CARBIDE IN THE RANGE 1000 TO 2000 DEG C. BOTH SINE WAVE AND PULSE TECHNIQUES WERE APPLIED TO THIN WAFER-SHAPED SAMPLES OF CARBIDE. THE TEMPERATURE OF THE HIND FACE WAS DETECTED BY MEANS OF A PHOTOCELL-OSCILLOSCOPE ARRANGEMENT. ARC-CAST CARBIDE YIELDED A VALUE $0.049 \pm 0.004 \text{ CM}^2 \text{ SEC}^{-1}$ FOR THERMAL DIFFUSIVITY IN THE RANGE IN QUESTION. VALUES FOR EMISSIVITY AND ELECTRICAL AND THERMAL CONDUCTIVITY WERE MEASURED OR DERIVED FOR URANIUM CARBIDE.

ABSTRACT 499

NAOUMIDIS A

PROC BRIT CERAM SOC 8, 193 (1967)

THERMODYNAMIC DATA OF UN SUB X ($X = 1.5 - 1.75$)

THE NITRIDING OF CUBIC U SUB 2 N SUB 3 (FCC SUB 2 O SUB 3 STRUCTURE) LEADS TO PRODUCTS WHICH CAN BE CONSIDERED AS SOLID SOLUTIONS OF CUBIC U SUB 2 N SUB 3 AND THE HYPOTHETICAL UN SUB 2 (FLUORITE STRUCTURE). MAXIMUM NITROGEN CONTENT AT ATMOSPHERIC PRESSURE CORRESPONDS TO UN SUB 1.75, AND AT HIGH PRESSURES TO UN SUB 1.81. EQUILIBRIUM PRESSURES HAVE BEEN MEASURED AT DIFFERENT TEMPERATURES, AND THERMODYNAMIC DATA FOR COMPOSITIONS BETWEEN UN SUB 1.5 AND UN SUB 1.75 ARE PRESENTED.

ABSTRACT 500

NAOUMIDIS A

SYMP THERMO NUCL MATER P287, (1967)

STABILITY OF UC-UN SOLID SOLUTIONS IN THE PRESENCE OF FREE CARBON

FOR UTILIZATION AS A NUCLEAR FUEL, UC-UN SOLID SOLUTIONS SHOW SOME ADVANTAGES OVER THE SINGLE COMPONENTS UC AND UN. THE STABILITY OF THESE SOLID SOLUTIONS TOWARDS FREE CARBON IS OF INTEREST BOTH FOR THE PREPARATION PROCESS AND THE FORMING OF THE MATERIAL, E. G. BY HOT-PRESSING IN A GRAPHITE DIE. DUE TO THE FORMATION OF SOLID SOLUTIONS, THE NITROGEN EQUILIBRIUM PRESSURE CANNOT BE CALCULATED FROM THE FREE ENERGY OF THE REACTION $UC + 1/2 N_2 = UN + C$. IN THE WORK PRESENTED THE NITROGEN EQUILIBRIUM PRESSURE OVER MIXTURES OF UC-UN SOLID SOLUTIONS AND FREE CARBON WAS MEASURED AS A FUNCTION OF TEMPERATURE AND COMPOSITION OF THE SOLID SOLUTIONS. THE TEMPERATURE RANGE WAS 1350-1800 DEG C, THE PRESSURE RANGE 5×10^{-2} TO 10^3 TORR. FROM THESE MEASUREMENTS THE PARTIAL MOLAR VALUES WERE CALCULATED FOR NITROGEN DISSOLUTION IN SOLID SOLUTIONS OF VARIOUS COMPOSITIONS. THE PHASES WERE IDENTIFIED BY X-RAY AND METALLOGRAPHIC EXAMINATION AND THE COMPOSITION OF THE SOLID SOLUTIONS WAS DETERMINED BY CHEMICAL ANALYSIS FOR NITROGEN, CARBON AND OXYGEN. THE PRACTICAL APPLICATION OF THE DATA OBTAINED WITH REGARD TO PREPARATION PROCESSES AND HOT-PRESSING IS DISCUSSED. THE PRINCIPLES OF A NEW METHOD OF OXYGEN ANALYSIS, WHICH IS BASED ON THE TRANSFORMATION OF CARBIDES INTO CARBONITRIDES, BY REACTION WITH NITROGEN WITH THE SIMULTANEOUS FORMATION OF FREE CARBON IS BRIEFLY OUTLINED.

ABSTRACT 501

NARAIN M G

J NUCL MATER 49, 329 (1974)

FREE ENERGY OF FORMATION OF UMO₂ SUB 2 AND PHASE BEHAVIOR IN THE U-MO-C SYSTEM.

AN INVESTIGATION HAS BEEN MADE OF THE FREE ENERGY OF FORMATION OF UMO₂ SUB 2 AND OF THE COMPOSITION RANGE OF THIS COMPOUND. ALSO LISTED IS THE RELATION BETWEEN FREE ENERGY OF FORMATION OF UC AND TEMPERATURE.

ABSTRACT 502

NASU S

J NUCL SCI TECHNOL TOKYO 5, 318 (1968)

THERMAL DIFFUSIVITY OF UN FROM 20 TO 1000 DEG C BY LASER PULSE METHOD.

SOME RESULTS OBTAINED FOR THE THERMAL DIFFUSIVITY AND HEAT CAPACITY OF URANIUM MONONITRIDE, TOGETHER WITH CALCULATED THERMAL CONDUCTIVITY VALUES BASED ON THE MEASURED DATA ARE REPORTED IN GRAPHIC FORM. THE THERMAL DIFFUSIVITY INCREASED SLIGHTLY FROM ROOM TEMPERATURE TO 1,000 DEG C. THE THERMAL CONDUCTIVITIES OBTAINED FROM THE PRODUCT OF DIFFUSIVITY, HEAT CAPACITY, AND DENSITY ARE COMPARED WITH PREVIOUSLY PUBLISHED VALUES.

ABSTRACT 503

NASU S

JAERI-MEMO 3541 (1969)

THERMAL CONDUCTIVITIES OF URANIUM MONOCARBIDE, MONONITRIDE AND CARBONITRIDES

THERMAL DIFFUSIVITIES OF UC, UN AND U(C,N) WERE MEASURED BY LASER PULSE METHOD IN THE TEMPERATURE RANGE OF ROOM TEMPERATURE TO 1000 DEG C. FROM THESE RESULTS AND THE ESTIMATION OF SPECIFIC HEATS WE OBTAINED THE TEMPERATURE DEPENDENCE OF THERMAL CONDUCTIVITIES OF THE SPECIMENS. TEMPERATURE DEPENDENCE OF THERMAL CONDUCTIVITY OF U(C,N) OF SMALL C CONTENT WAS SIMILAR TO UN AND THAT OF SMALL N CONTENT WAS SIMILAR TO UC. MINIMUM VALUE OF THERMAL CONDUCTIVITY WAS FOUND TO BE IN THE CONCENTRATION RATIO C/(C+N) OF ABOUT 0.4.

ABSTRACT 504

NEIMARK L A

ANL-7120 P314 (1965)

MIXED CARBIDE FUELS FOR FAST REACTORS,

THE PRESENT DIFFICULTY IN MAKING LARGE QUANTITIES OF STOICHIOMETRIC (U,Pu)C LEAVES SLIGHTLY HYPERSTOICHIOMETRIC CARBIDE AS THE FAVORED COMPOSITION FOR FUELS WITH TODAY'S TECHNOLOGY. TECHNIQUES HAVE BEEN DEMONSTRATED FOR PRODUCING HIGH-QUALITY PRESSED-AND-SINTERED PELLETS AND VIBRATORILY COMPACTED FUEL COLUMNS. ALTHOUGH COMPATIBILITY TESTS HAVE SHOWN STAINLESS STEEL TO BE AN ACCEPTABLE JACKET MATERIAL FROM THIS STANDPOINT, THERE IS STILL A NEED FOR MAKING NONSTOICHIOMETRIC FUEL MORE COMPATIBLE WITH THE JACKET AND FOR FINDING STRONGER JACKET MATERIALS. THE PROMISING IRRADIATION RESULTS ON VIBRATORILY COMPACTED CARBIDE INDICATE THAT THIS SYSTEM IS WORTHY OF CONSIDERATION FOR FUTURE REACTORS.

ABSTRACT 505

NELSON S G

CONF-40-2 (1962)

THE STABILITY OF MOLTEN URANIUM AND REFRACTORY CARBIDES IN HIGH VACUUM

AN ELECTRON BEAM TECHNIQUE IS DESCRIBED FOR THE STUDY OF THE THERMODYNAMIC PROPERTIES OF MATERIALS AT EXTREMELY HIGH TEMPERATURES. THIS TECHNIQUE, A MODIFICATION OF THE LANGMUIR METHOD, WAS THEN USED TO MEASURE THE EVAPORATION RATES AND VAPOR PRESSURES OF MOLTEN CARBIDES OF URANIUM, TUNGSTEN, NIOBIUM, ZIRCONIUM, TANTALUM, VANADIUM, AND TITANIUM. THE EVAPORATING SPECIES FROM EACH OF THESE CARBIDES WERE IDENTIFIED BY CHEMICAL ANALYSIS AND BY METALLOGRAPHIC EXAMINATION.

ABSTRACT 506

NEWKIRK H W

HW-59468 (1959)

THE MELTING POINTS OF URANIUM DIOXIDE, URANIUM MONOCARBIDE, AND URANIUM MONONITRIDE

THE MELTING POINTS OF URANIUM DIOXIDE, URANIUM MONOCARBIDE, AND URANIUM MONONITRIDE ARE 2500 ± 50 DEG C, 2280 ± 50 DEG C, AND 2480 ± 50 DEG C, RESPECTIVELY. THE MELTING POINT OF URANIUM DIOXIDE WAS OBSERVED TO BE INDEPENDENT OF THREE METHODS OF FABRICATION AND OF THE INITIAL O/U RATIO IN THE RANGE 1.95 TO 2.36. THE MELTING POINTS AGREE WITH THE MOST RELIABLE PUBLISHED VALUES.

ABSTRACT 507

NICHOLS J L

CARBIDES IN NUCL ENERGY, HARWELL A17 (1963)

AN INVESTIGATION OF THE U-Fe-C AND Pu-Fe-C TERNARY PHASE DIAGRAMS WITH SOME OBSERVATIONS OF THE U-Pu-Fe-C QUATERNARY

THE WORK WAS UNDERTAKEN AS BACKGROUND TO: A) THE COMPATIBILITY STUDIES BETWEEN THE CARBIDES AND STEEL CANNING MATERIALS. B) THE METAL BONDED URANIUM-PLUTONIUM CARBIDE CERMETS. THE BASIC FEATURES OF THE U-Fe-C TERNARY DIAGRAM HAVE BEEN PREVIOUSLY INVESTIGATED AND DRAWN UP BY WORKERS AT SHEFFIELD UNIVERSITY, BUT ALTHOUGH PRESENT WORK CONFIRMED THESE THE EUTECTIC TEMPERATURES WERE SLIGHTLY DIFFERENT. THE EFFECT, ON THE PHASE DIAGRAM, OF REPLACING 15 AND 30% OF THE URANIUM BY PLUTONIUM WAS EXAMINED BUT IN GENERAL LITTLE CHANGE RESULTED, THE TEMPERATURES INVOLVED USUALLY BEING SLIGHTLY LOWER. WHEN STAINLESS STEEL WAS SUBSTITUTED FOR IRON THE CHANGES OCCURRING WERE CONSIDERABLY GREATER, AND LIQUID APPEARED AT A TEMPERATURE OVER 100 DEG C LOWER THAN IN THE SIMPLE TERNARY. THE Pu-Fe-C TERNARY WAS FOUND TO BE QUITE DIFFERENT FROM THE U-Fe-C DIAGRAM DUE TO THE LOWER STABILITY OF PUC COMPARED WITH UC AND TO THE EXISTENCE OF A SECOND TERNARY COMPOUND. THE LATTER HAS A BODY CENTRED CUBIC STRUCTURE WITH A LATTICE PARAMETER OF $10.10 \text{ \AA}$ AND OCCURS AT APPROXIMATELY 42 AT.% CARBON 33 AT. % IRON AND 25 AT. % PLUTONIUM.

ABSTRACT 508

NICKEL H

J NUCL MATER 28, 93 (1968)

UBER DIE BILDUNG DES U SUB 2 C SUB 3

FROM THE RESULTS DESCRIBED, IT IS CONCLUDED THAT BY HEATING MELTED ALLOYS OF UC-UC SUB 2 AT A TEMPERATURE OF 1350 DEG C. THE SESQUICARBIDE MAY BE FORMED EITHER BY THE SYNTHETIC REACTION (A) $UC + UC \text{ SUB } 2 = U \text{ SUB } 2 C \text{ SUB } 3$ OR BY THE DECOMPOSITION REACTION (B) $2 UC \text{ SUB } 2 = U \text{ SUB } 2 C \text{ SUB } 3 + C$. HOWEVER THE TWO REACTIONS OCCUR AT DIFFERENT SPEEDS. WHILE AT A TEMPERATURE OF 1350 DEG C THE REACTION (A) PROCEEDS IN A FEW HOURS (<3H), THE URANIUM DICARBIDE DECOMPOSES AN ORDER OF MAGNITUDE MORE SLOWLY. THE UC ONLY REACTED WITH THE UC SUB 2-MATRIX AFTER U SUB 2 C SUB 3 NUCLEI HAD FORMED AT CRACKS. THEREFORE THE HEATING OF PURE UC SUB 2 ALLOYS DOES NOT LEAD DIRECTLY TO SESQUICARBIDE BUT IN CONTRARY TAKES PLACE FOLLOWING THIS REACTION (C) $UC \text{ SUB } 2 = UC + C$ THEREFORE WE MUST CONCLUDE THAT TO PERMIT THE REACTION (A), THERE MUST BE TENSIONS BETWEEN THE UC AND UC SUB 2 PHASES. THESE TENSIONS LIE IN THE MICRO-RANGE AND ARE THE RESULT OF VARIABLE MUTUAL ORIENTATIONS OF GRAINS OF THE TWO PHASES. A CHANGE IN ORIENTATION MAY BE PRODUCED BY BLOW OR DEFORMATION OF THE CRYSTAL. RESEARCHES IN ORDER TO OBSERVE DIRECTLY THE FORMATION OF U SUB 2 C SUB 3

ABSTRACT 508 (CONT'D)

HAVE SHOWN THAT THE LAYER OF OXIDE APPROX = 5 μ M) WHICH IS FORMED AT THE SURFACE OF THE SAMPLE DURING HEATING, ALWAYS PREVENTED THE REACTION TO FORM SESQUICARBIDE.

ABSTRACT 509

NIGHTINGALE R E

BNWL-842 (1968)

FAST REACTOR NITRIDES RESEARCH

THE OBJECTIVE WAS TO DETERMINE THE EFFECT OF COMPOSITION, PARTICULARLY CARBON AND OXYGEN IMPURITIES, ON THE MELTING BEHAVIOR OF UN-PUN FUEL.

ABSTRACT 510

NIKOL'SKII S S

TEPLOFIZIKA VYSOKIKH TEMPERATUR, 7, 1087 (1969)

HIGH-TEMPERATURE THERMODYNAMICS OF URANIUM CARBIDES:

CALCULATION OF URANIUM AND CARBON ACTIVITIES ON THE BASIS OF STORMS DATA

STORMS' DATA ARE USED TO DERIVE EQUATIONS LINKING THE URANIUM VAPOR PRESSURE, THE CARBON ACTIVITY, AND THE TEMPERATURE AND COMPOSITION OF UC SUB Y SOLUTION (CUBIC LATTICE). THESE EQUATIONS ARE IN GOOD AGREEMENT WITH THE EXPERIMENTAL PLOTS OF LOG PU VERSUS TEMPERATURE AND COMPOSITION. BESIDES LOG A SUB C ALSO THE FREE ENERGY OF THE REACTION $XU(R) + (1-X)C$ (GRAPHITE) = $U SUB X C SUB 1-X$ SOLID IS CALCULATED WITH $C/U=0.90, 0.95, \dots, 1.90$ AND $T=1600, 1700, \dots, 2800$ DEG K; THE ZONES OF METASTABLE AND UNSTABLE STATES ARE DETERMINED IN CONNECTION WITH THE DISINTEGRATION OF THE SOLID SOLUTION INTO UC AND UC SUB 2; THE CARBON ACTIVITY IS CALCULATED FOR EQUILIBRIUM BETWEEN THE CARBIDE AND LIQUID URANIUM; THE VAPOR COMPOSITION AND THE EVAPORATION RATES OF THE COMPONENTS ARE ALSO CALCULATED AND THE CONDITIONS FOR CONGRUENT EVAPORATION ARE CONSIDERED.

ABSTRACT 511

NIKOL'SKII S S

TEPLOFIZIKA VYSOKIKH TEMPERATUR, 7, 873 (1969)

HIGH-TEMPERATURE THERMODYNAMICS OF URANIUM CARBIDES

THE ARTICLE PROPOSED EQUATIONS WITH FOUR PARAMETERS TO DESCRIBE THE ACTIVITIES OF URANIUM AND CARBON AS A FUNCTION OF THE COMPOSITION OF A CUBIC SOLID SOLUTION OF UC SUB Y. FORMALLY, THESE EQUATIONS CORRESPOND TO AN IDEAL SOLUTION CONSISTING OF U, UC, AND UC SUB 2, BETWEEN WHICH THERE TAKES PLACE THE REACTION $UC SUB 2 + U = 2UC$.

ABSTRACT 512

NISHIO G

J NUCL MATER 47, 87 (1973)

KINETICS OF CARBON TRANSFER GOVERNING COMPATIBILITY BETWEEN URANIUM CARBIDE AND STAINLESS STEEL BONDED WITH SODIUM

THE PURPOSE OF THE PRESENT STUDY WAS UNDERTAKEN TO PROVIDE INFORMATION ON THE KINETICS OF CARBON TRANSFER GOVERNING THE DEGREE OF COMPATIBILITY BETWEEN CARBIDE FUEL AND AUSTENITIC STAINLESS STEEL, BY COMPARING THE EXPERIMENTAL DATA WITH CALCULATED RESULTS. HYPERSTOICHIOMETRIC URANIUM

ABSTRACT 512 (CONT'D)

CARBIDE CONTAINING ^{14}C (6.0 WT%) AND STAINLESS STEEL (AISI 304) SPECIMENS WERE ENCLOSED IN A NICKEL CAPSULE TOGETHER WITH SODIUM, AND THEN HEATED TO 750 DEG C ACCORDING TO THE PRE-DETERMINED SCHEDULE. WITH RESPECT TO THE DEGREE OF CARBURIZATION OF THE STAINLESS STEEL USING THE RADIOACTIVE CARBIDE, THE ACTIVITY IN THE STEEL DECREASED EXPONENTIALLY WITH DEPTH AND INCREASED WITH HEATING TIME. THE KINETICS OF CARBON TRANSFER WAS WELL INTERPRETED BY ASSUMING THAT CARBON ATOMS LEACHED OUT INTO SODIUM FROM UC SUB 2 PLATELETS IN THE CARBIDE AND THEN DIFFUSED INTO THE STAINLESS STEEL ALONG ITS GRAIN BOUNDARY.

ABSTRACT 513

NORMAN J H

J PHYS CHEM 68, 3802 (1964)

MASS SPECTROMETRY-KNUDSEN CELL STUDIES OF THE VAPORIZATION OF URANIUM DICARBIDE

THE PRESENCE OF UC SUB 2 (G) WAS FOUND TO BE IMPORTANT IN THE VAPORIZATION OF URANIUM DICARBIDE. IN THE PRESENCE OF EXCESS CARBON, THE VAPORIZATION OF URANIUM DICARBIDE AS UC SUB 2 (G) CAN BE REPRESENTED BY A HEAT OF VAPORIZATION OF 185 KCAL/MOLE AND AN ENTROPY OF 38.3 CAL/ DEG K MOLE IN THE TEMPERATURE RANGE FROM 2350 - 2700 DEG K. GOOD THERMODYNAMIC AGREEMENT BETWEEN THIS WORK AND PREVIOUS STUDIES OF VAPORIZATION OF URANIUM DICARBIDE TO $\text{U}(\text{G}) + 2\text{C}(\text{S})$ WAS OBTAINED. THE VALUES OBTAINED IN THIS STUDY WERE $\Delta H = 127.3$ KCAL/MOLE AND $\Delta S = 18.6$ CAL/ DEG K MOLE IN THE TEMPERATURE RANGE FROM 2150-2700 DEG K.

ABSTRACT 514

NORREYS J J

CARBIDES IN NUCL ENERGY 1, 435 (1964)

THE COMPRESSIVE-CREEP OF URANIUM MONOCARBIDE

A SIMPLE DIRECT-CURRENT HEATED CONSTANT-LOAD COMPRESSIVE-CREEP MACHINE IS DESCRIBED. TESTS WERE MADE ON SAMPLES OF URANIUM MONOCARBIDE OF DIFFERENT STOICHIOMETRY AND PURITY IN THE TEMPERATURE RANGE 1000 TO 1500 DEG C UNDER STRESSES OF UP TO 6000 PSI. THE APPARENT ACTIVATION ENERGY FOR CREEP OF SLIGHTLY HYPERSTOICHIOMETRIC MONOCARBIDE (4.9 WT% C) HAS BEEN DETERMINED AS 49 ± 8 KCAL/MOLE OVER THE TEMPERATURE RANGE 1200 TO 1400 DEG C. THIS FIGURE IS CLOSE TO THE ACTIVATION ENERGIES FOR SELF-DIFFUSION OF URANIUM AND CARBON IN URANIUM MONOCARBIDE. SMALL AMOUNTS OF FREE URANIUM MARKEDLY INCREASE CREEP RATES. SMALL ADDITIONS OF TUNGSTEN HAVE BEEN SHOWN TO IMPROVE CONSIDERABLY THE CREEP RESISTANCE OF HYPERSTOICHIOMETRIC ALLOYS.

ABSTRACT 515

NOWOTNY H

ATOMIC ENERGY REVIEW 4, SPECIAL ISSUE 1, 73 (1966)

COMPOUNDS WITH NON-METALS

VALUES FOR DENSITY, UNIT CELL DIMENSIONS, AND LINEAR EXPANSION COEFFICIENT ARE TABULATED FOR PUC, PU SUB 2 C SUB 3 AND PUN. LATTICE PARAMETERS FOR PUC, PUN, (U,PU)-C AND (U,PU)-N ARE ALSO GIVEN AS A FUNCTION OF COMPOSITION AND FOR PUN AS A FUNCTION OF TEMPERATURE TOO. DENSITY OF PU-C ALLOYS IS SHOWN AS A FUNCTION OF COMPOSITION.

ABSTRACT 516

NUTT A W

6TH US/JAPAN CERAM FUELS INFORMATION EXCHANGE, SEATTLE, S-12 (1970)
ELASTIC CONSTANTS OF (U SUB 0.8 PU SUB 0.2)C

ROOM TEMPERATURE LONGITUDINAL AND TRANSVERSE SOUND VELOCITIES OF POLYCRYSTALLINE SINGLE PHASE (U SUB 0.8 PU SUB 0.2)C HAVE BEEN MEASURED BY EMPLOYING A CONVENTIONAL ULTRASONIC PULSE-ECFD TECHNIQUE. FROM THE EXPERIMENTAL DATA, VALUES WERE CALCULATED FOR YOUNG'S MODULUS, SHEAR MODULUS, BULK MODULUS, AND POISSON'S RATIO. EQUATIONS ARE GIVEN CORRELATING WITH VOLUME FRACTION POROSITY. ABOVE ELASTIC CONSTANTS WERE ALSO COMPARED WITH SIMILAR VALUES OF UC OBTAINED FROM LITERATURE.

ABSTRACT 517

O'HARE P A G

THERMO NUCL MATER P265 (1967)

THE THERMOCHEMISTRY OF SOME URANIUM COMPOUNDS

THE THERMOCHEMISTRY OF SOME URANIUM COMPOUNDS. THE STANDARD ENTHALPIES OF FORMATION, ΔH SUB F, 298.15 (KCAL/MOL), OF UN SUB 0.992 (-75.2#1.3), US SUB 1.011 (-73.2#3.6), UN SUB 0.965 (-71.5#1.1), UN SUB 1.510 (-90.1#1.7), AND UN SUB 1.690 (-94.1#1.7), WERE MEASURED BY FLUORINE REACTION CALORIMETRY. THE RESULTS FOR URANIUM PHOSPHIDE AND URANIUM SULPHIDE, WHEN COMBINED WITH DATA FROM RECENT HIGH-TEMPERATURE STUDIES, CAN BE USED TO ARRIVE AT VALUES FOR THE HEAT OF SUBLIMATION OF URANIUM.

ABSTRACT 518

OBLINGER C J

NLCO-965 (1965)

THE URANIUM-CARBON PHASE DIAGRAM: THE MELTING POINTS OF URANIUM WITH VARIOUS CARBON LEVELS

HIGH-PURITY URANIUM WAS HEATED TO THE LIQUID STATE IN BERYLLIUM OXIDE OR URANIUM OXIDE LINERS INSIDE TUNGSTEN KNUDSEN CELLS. A URANIUM MELTING POINT OF 1133 DEG C WAS DETERMINED BY OPTICAL PYROMETRY. COMMERCIAL PURE URANIUM SAMPLES CONTAINING 187, 615, AND 857 PPM CARBON SHOWED A MELTING POINT OF APPROXIMATELY 1137 DEG C. METALLOGRAPHIC EXAMINATIONS INDICATED A PERITECTIC POINT AT APPROXIMATELY 55 PPM CARBON CONTENT.

ABSTRACT 519

GETTING F L

CHEM REV 67 , 261 (1967)

THE CHEMICAL THERMODYNAMIC PROPERTIES OF PLUTONIUM COMPOUNDS

A REVIEW OF THE PUBLISHED THERMOCHEMICAL DATA SUCH AS SPECIFIC HEAT, ENTROPY, ENTHALPY, HEAT OF FORMATION, FREE ENERGY OF FORMATION, AND EQUILIBRIUM CONSTANT OF FORMATION REACTION (FROM THE ELEMENTS) IS GIVEN FOR PUC SUB 0.67 , PUC SUB 0.85 , PU SUB 2 C SUB 3, PUC SUB 2 , AND PUN. THE TEMPERATURE RANGE VARIES FROM 298 - 850 DEG K TO 298 - 2843 DEG K FOR DIFFERENT COMPOUNDS.

ABSTRACT 520

GETTING F L

J CHEM THERMO 4, 199 (1972)

THE CHEMICAL THERMODYNAMIC PROPERTIES OF NUCLEAR MATERIALS : I UN

THE HIGH TEMPERATURE ENTHALPY H DEG (T) - H DEG (298.15K) OF URANIUM MONONITRIDE HAS BEEN DETERMINED FROM 298 TO 1700 K BY A COPPER-BLOCK DROP CALORIMETER OF THE ISOPERIBOL TYPE. THE EXPERIMENTAL RESULTS MAY BE EXPRESSED BY THE EQUATION: $H_{\text{SUB T}} - H_{\text{SUB 298.15K}} \text{ CAL/MOLE} = 11.681T + 1.3291 \cdot 10^{-3}(T)^{**2} + 9.812 \cdot 10^{-4}(1/T)^{-3.930} \cdot 10^{**3}$. THE HEAT CAPACITY OF URANIUM MONONITRIDE IS EXPRESSED AS $C_{\text{SUB P}} \text{ CAL/DEG K, MOLE} = 11.681 + 2.6582 \cdot 10^{-3}T - 9.812 \cdot 10^{-4}(1/T)^{**2}$. IN THE TEMPERATURE RANGE GIVEN ABOVE COMBINATION OF THESE RESULTS WITH THE HEAT CAPACITY AND ENTROPY AT 298 K AVAILABLE FROM THE LITERATURE HAS MADE IT POSSIBLE TO CONSTRUCT A TABLE OF THERMODYNAMIC FUNCTIONS FOR URANIUM MONONITRIDE. AN EVALUATION OF THE ENTHALPIES OF VAPORIZATION OF URANIUM MONONITRIDE ALSO FOUND IN THE LITERATURE COMBINED WITH THE PRESENT ENTHALPIES INDICATES THAT THE ENTHALPY OF FORMATION AT 298.15K OF URANIUM MONONITRIDE IS -170.6 ± 1.0 KCAL/MOLE AND THE ENTHALPY OF VAPORIZATION OF URANIUM METAL IS 1128 ± 2 KCAL/MOLE.

ABSTRACT 521

GETTING F L

J NUCL MATER 45, 271 (1972/73)

THE CHEMICAL THERMODYNAMIC PROPERTIES OF NUCLEAR MATERIALS:

II HIGH TEMPERATURE ENTHALPY OF THE URANIUM CARBIDES

THE HIGH TEMPERATURE ENTHALPY OF URANIUM MONOCARBIDE, URANIUM SESQUICARBIDE AND URANIUM DICARBIDE HAS BEEN DETERMINED BY A COPPER BLOCK DROP CALORIMETER OF THE ISOPERIBOL TYPE. THE EXPERIMENTAL DATA OVER THE TEMPERATURE RANGE TO 1700 K RELATIVE TO 298 K FOR THE MONOCARBIDE AND SESQUICARBIDE, AND 1500 K RELATIVE TO 298 K FOR THE DICARBIDE. THESE RESULTS COMBINED WITH THE HEAT CAPACITY AND ENTROPY OF THE RESPECTIVE CARBIDE AT 298 K AVAILABLE FROM THE LITERATURE MADE IT POSSIBLE TO CONSTRUCT TABLES OF THERMODYNAMIC FUNCTIONS FOR THE URANIUM CARBIDES. THE UNUSUAL BEHAVIOR OF THE HEAT CAPACITY OF URANIUM SESQUICARBIDE, AND TO SOME EXTENT URANIUM MONOCARBIDE, IS CORRELATED TO A VACANCY FORMATION OF 19.5 KCAL/MOL FOR URANIUM SESQUICARBIDE AND 23.4 KCAL/MOL FOR URANIUM MONOCARBIDE, RESPECTIVELY.

ABSTRACT 522

OGARD A E

J INORG NUCL CHEM 24, 29 (1962)

THE PREPARATION OF URANIUM MONOCARBIDE - PLUTONIUM MONOCARBIDE SOLID SOLUTIONS, $\text{Pu}_{\text{SUB 2}}\text{C}_{\text{SUB 3}}$ AND PUC.

HYPOSTOICHIOMETRIC URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SOLID SOLUTIONS WITH NO IMPURITIES DETECTABLE BY X-RAY DIFFRACTION OR METALLOGRAPHIC EXAMINATION HAVE BEEN PREPARED SIMPLY BY SINTERING AT 1450-1850 DEG C MIXTURES OF URANIUM DIOXIDE, PLUTONIUM DIOXIDE AND GRAPHITE. PELLETS WITH DENSITIES UP TO 12.85 G/CM^{**3} (94.5 PER CENT OF THEORETICAL DENSITY) WERE ACHIEVED BY A SECOND SINTERING OF PRESSED PELLETS OF THE REACTION PRODUCT. BY A SIMILAR PROCEDURE SINGLE-PHASE STOICHIOMETRIC PLUTONIUM SESQUICARBIDE HAS BEEN PREPARED WITH PELLET DENSITIES UP TO 12.6 G/CM^{**3} (99 PER CENT OF THEORETICAL DENSITY). HOWEVER, HYPOSTOICHIOMETRIC PLUTONIUM MONOCARBIDE PREPARED IN THE SAME MANNER ALWAYS CONTAINED PLUTONIUM SESQUICARBIDE AS THE ONLY IMPURITY. ARC

ABSTRACT 522 (CONT'D)

MELTING OF THE SINTERED URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SOLID SOLUTIONS AND PLUTONIUM SESQUICARBIDE YIELDED COMPARABLY PURE MATERIALS OF NEAR THEORETICAL DENSITY. ARC MELTING OF THE SINTERED PLUTONIUM MONOCARBIDE ELIMINATED THE PLUTONIUM SESQUICARBIDE IMPURITY RESULTING IN A SINGLE-PHASE HYPOSTOICHIOMETRIC PLUTONIUM MONOCARBIDE.

ABSTRACT 523

OGARD A E

J NUCL MATER 15,43 (1965)

THE THERMAL EXPANSION OF PUC AND UC-PUC SOLID SOLUTION

THERMAL EXPANSION CHARACTERISTICS FOR ARC-MELTED PLUTONIUM-CARBON SYSTEM CONTAINING 41.1, 43.2, 44.9, 45.4, AND 45.8 AT.% CARBON AND FOR U SUB 0.87 PU SUB 0.13C WERE DETERMINED BETWEEN ROOM TEMPERATURE AND 900 DEG C. THE AVERAGE COEFFICIENTS OF LINEAR THERMAL EXPANSION FOR A SINGLE PHASE ALLOY CONTAINING 45.8 AT.% CARBON AND FOR SINGLE PHASE U SUB 0.87 PU SUB 0.13C ARE PRESENTED AS WELL AS RESULTS PERTAINING TO THE PLUTONIUM-CARBON PHASE DIAGRAM. A MECHANISM IS SUGGESTED TO EXPLAIN THE CONTRACTION OBSERVED IN THE DILATOMETRIC CURVES FOR THE ALLOYS, WHICH CONTAINED 43.2, 44.9, AND 45.4 AT.% CARBON.

ABSTRACT 524

OGARD A E

LA-2768 (1962)

THE THERMAL EXPANSION OF PUC AND PUC-UC SOLID SOLUTION

THERMAL EXPANSION CHARACTERISTICS FOR ARC MELTED PLUTONIUM-CARBON ALLOYS CONTAINING 41.1, 43.2, 44.9, 45.4, 45.8 A/O CARBON AND U SUB 0.87 PU SUB 0.13 C HAVE BEEN DETERMINED BETWEEN ROOM TEMPERATURE AND 900 DEG C. THE AVERAGE COEFFICIENTS OF LINEAR THERMAL EXPANSION FOR SINGLE PHASE ALLOYS CONTAINING 45.8 A/O CARBON AND U SUB 0.87 PU SUB 0.13C ARE PRESENTED, AS WELL AS RESULTS PERTAINING TO THE PLUTONIUM-CARBON PHASE DIAGRAM. A MECHANISM IS SUGGESTED TO EXPLAIN THE UNUSUAL CONTRACTION THAT WAS OBSERVED IN THE DILATOMETRIC CURVES FOR THE 43.2 TO 45.4 A/O CARBON ALLOYS.

ABSTRACT 525

OGARD A E

LA-4415 (1970)

PLUTONIUM CARBIDES

THE PREPARATION AND PROPERTIES OF THE PLUTONIUM CARBIDES ARE REVIEWED. THE PHASE DIAGRAM, LATTICE PARAMETERS AND THERMODYNAMIC PROPERTIES OF THE VARIOUS PHASES ARE GIVEN.

ABSTRACT 526

OGARD A E

LADC-4626 (1961)

THE POWDER METALLURGY OF PLUTONIUM FUEL MATERIALS

REVIEWS METHODS FOR SYNTHESIZING CARBIDES; RESULTS ON PREPARATION OF PUC, PU SUB 2 C SUB 3, AND (U,PU)C BY CARBOTHERMIC REDUCTION OF THE OXIDES; STRUCTURAL ANALYSIS BY X-RAY POWDER DIFFRACTION, PREPARATION OF DENSE PELLETS BY COLD COMPACTION AND SINTERING IN VACUUM AND HELIUM.

ABSTRACT 527

OGARD A E

LADC-5788 (1963)

THE THERMAL EXPANSION OF PUC AND UC-PUC SOLID SOLUTION

THERMAL EXPANSION CHARACTERISTICS FOR ARC-MELTED PLUTONIUM-CARBON ALLOYS CONTAINING 41.1, 43.2, 44.9, 45.4, 45.8 AT.% CARBON AND FOR U SUB 0.87 PU SUB 0.13 C HAVE BEEN DETERMINED BETWEEN ROOM TEMPERATURE AND 900 DEG C. THE AVERAGE COEFFICIENTS OF LINEAR THERMAL EXPANSION FOR A SINGLE PHASE ALLOY CONTAINING 45.8 AT.% CARBON AND FOR SINGLE PHASE U SUB 0.87 PU SUB 0.13 C ARE PRESENTED AS WELL AS RESULTS PERTAINING TO THE PLUTONIUM-CARBON PHASE DIAGRAM. A MECHANISM HAS BEEN SUGGESTED TO EXPLAIN THE UNUSUAL CONTRACTION THAT WAS OBSERVED IN THE DILATOMETRIC CURVES FOR THE ALLOYS THAT CONTAINED 43.2, 44.9, AND 45.4 AT.% CARBON.

ABSTRACT 528

OGARD A E

U S PATENT NO 3,082,163 (1963)

METHOD FOR PREPARING URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SOLID SOLUTION

CARBOTHERMIC REDUCTION OF MIXTURES OF UO SUB 2, PUO SUB 2, AND C TO PRODUCE SINGLE PHASE (U,PU)C FOR FAST BREEDER REACTOR APPLICATION.

ABSTRACT 529

OLSON W M

J PHYS CHEM 67,952 (1963)

THE DECOMPOSITION AND MELTING POINT OF URANIUM MONONITRIDE.

THE DECOMPOSITION PRESSURE OF UN WAS DETERMINED IN THE RANGE 2500 TO 2850 DEG C BY OBSERVING THE APPARENT MELTING POINT AS A FUNCTION OF N SUB 2 PRESSURE. THE CONGRUENT MELTING POINT WAS FOUND TO BE 2850±30 DEG C AT A N SUB 2 PRESSURE OF >2.5 ATM. AN EMPIRICAL EQUATION WAS FITTED TO THE DATA SO THAT ITS CURVE ASYMPTOTICALLY APPROACHES THE CALCULATED θ F LINE AS THE TEMPERATURE DECREASES: $\log P \text{ (ATM)} = 8.193 - (29.54 \times 10^{-3})/T + (5.27 \times 10^{-18})T^{*5}$. IT IS BELIEVED THAT THE SOLUBILITY OF N SUB 2 IN U AT ITS MELTING POINT IS VERY SMALL.

ABSTRACT 530

OLSON W M

J PHYS CHEM 68, 1048 (1964)

THE DECOMPOSITION PRESSURE OF PLUTONIUM NITRIDE.

DECOMPOSITION PRESSURES FOR THE REACTION $\text{PuN(s)} = \text{Pu(l)} + 0.5\text{N}_2\text{(g)}$ IN THE TEMPERATURE RANGE 2250 TO 2770 DEG ARE REPORTED, AND EXPERIMENTS THAT DEFINE SOME OF THE PROPERTIES AND METHODS OF PREPARATION OF PuN ARE DESCRIBED. AN EQUATION, $\log P(\text{ATM}) = 8.193 - (29.54 \times 10^3)/T + 11.28 \times 10^4 - 18 T^{0.5}$ (T IN DEG K), WAS FOUND TO FIT THE VARIATION OF THE DECOMPOSITION PRESSURE WITH TEMPERATURE OVER THE ABOVE RANGE.

ABSTRACT 531

OLSON W M

THERMO NUCL MATER (1967); LA-DC-8012

THERMODYNAMICS OF THE PLUTONIUM CARBIDES

THERMODYNAMIC QUANTITIES WERE DETERMINED FOR PUC SUB 0.87 AND PUC SUB 1.5 BY A PARTIAL KNUDSEN EFFUSION TECHNIQUE. SUPPORTING MASS SPECTROMETRIC MEASUREMENTS WERE MADE. THE RESULTS WERE PUC SUB 1.5: $\Delta H_{\text{SUB T DEG}} = 93.01 \text{ KCAL/GFW}$, $\Delta S_{\text{SUB T DEG}} = 20.09 \text{ CAL/ DEG K GFW}$, AND PUC SUB 0.87: $\Delta H_{\text{SUB T DEG}} = 87.6 \text{ KCAL/GFW}$ AND $\Delta S_{\text{SUB T DEG}} = 24.26 \text{ CAL/ DEG K GFW}$. USING KRUGER AND SAVAGE'S HEAT CAPACITY DATA FOR PUC SUB 0.87: $\Delta H_{\text{SUB 298}} = -10.0 \text{ KCAL/MOLE}$, $\Delta S_{\text{SUB 298}} = +3.5 \text{ CAL/ DEG K GFW}$ AND THE ABSOLUTE ENTROPY OF PLUTONIUM MONOCARBIDE $\Delta S_{\text{SUB 298}} = 18.2 \text{ CAL/ DEG K GFW}$.

ABSTRACT 532

ONDRACEK G

J NUCL MATER 25,132 (1968)

THERMOCHEMICAL AND TECHNOLOGICAL INVESTIGATIONS ON THE URANIUM MONONITRIDE-CARBON SYSTEM.

IN PREPARING URANIUM MONONITRIDE COMPACTS, THE CONCENTRATIONS AND TEMPERATURE AT WHICH URANIUM CARBONITRIDE IS IN EQUILIBRIUM WITH CARBON AND URANIUM DICARBIDE, AND TEMPERATURES AND CORRESPONDING NITROGEN PARTIAL PRESSURES AT WHICH A UC SUB X N SUB 1-X PHASE OF GIVEN CONCENTRATION DECOMPOSES IN ITS COMPONENTS OR TAKES UP FURTHER NITROGEN UNDER SIMULTANEOUS DEPLETION OF CARBON ARE DETERMINED AND STUDIED THERMOCHEMICALLY. AS RESULTS, THE STABILITY RANGES ARE PLOTTED VERSUS TEMPERATURE, CONCENTRATION AND NITROGEN PRESSURE, RESPECTIVELY. FURTHERMORE, THE LIQUIDUS AND SOLIDUS IN THE SYSTEM UC-UN ARE ESTIMATED. BASED ON THESE CONSIDERATIONS, PREPARATION CONDITIONS ARE DETERMINED FOR DENSE COMPACTS (APPROX= 90% TD) BY HOT-PRESSING: 1700 DEG C, 10^{-3} - 10^{-4} TORR NITROGEN PRESSURE, 420 MP/CM² PRESSURE. IN THIS WAY, SAMPLES IN THE CONCENTRATION RANGE BETWEEN CARBON AND URANIUM MONONITRIDE WERE PREPARED AND EXAMINED BY DENSITY MEASUREMENTS AS WELL AS X-RAY AND METALLOGRAPHIC METHODS. (AUTH)

ABSTRACT 533

ONDRACEK G

J NUCL MATER 46,253 (1973)

POROSITY DEPENDENCE OF THERMAL CONDUCTIVITY FOR NUCLEAR FUELS

A CRITICAL CONSIDERATION IS GIVEN TO EQUATIONS USED IN SEVERAL PAPERS TO DESCRIBE THE DEPENDENCE OF THERMAL CONDUCTIVITY ON POROSITY. IT IS SHOWN THAT THE ONLY METHOD OF DERIVATION JUSTIFIED PHYSICALLY IS THAT STARTING

ABSTRACT 533 (CONT'D)

FROM THE GENERAL FIELD EQUATION. IN THIS WAY FOLLOWING THE METHODS OF MAXWELL, BRUGGERMAN AND NIESFL TWO EQUATIONS HAVE BEEN DERIVED, THE CALCULATED VALUES OF WHICH AGREE CLOSELY WITH THE EXPERIMENTAL VALUES OF THE THERMAL CONDUCTIVITY FOR POROUS UD SUB 2 AND UN. IN THESE EQUATIONS TWO CLEARLY DEFINED STEREOMETRIC FACTORS APPEAR, WHICH TAKE INTO ACCOUNT THE EFFECT OF THE SHAPE AND THE ORIENTATION OF THE PORES ON THE THERMAL CONDUCTIVITY. THESE FACTORS CAN BE CALCULATED BY USING STEREOMETRIC DATA MEASURED IN THE MICROSTRUCTURAL SECTIONS. THE REASON ONE OBTAINS TWO EQUATIONS LIES IN THE FACT THAT TWO TYPES OF POROSITY OCCUR: CLOSED ISOLATED AS WELL AS INTERCONNECTED POROSITY. THE EQUATIONS AND THEIR MEANS OF DERIVATION ARE EXPLAINED.

ABSTRACT 534

OSAKI M

J JAP INST METALS 37, 100 (1973)

THERMODYNAMIC PROPERTIES OF TH-C-UC SOLID SOLUTIONS

THE PARTIAL MOLAR FREE ENERGIES OF THORIUM IN TH-C-UC SOLID SOLUTIONS WERE MEASURED FROM 700 TO 950 DEG C BY MEANS OF THE SOLID-STATE GALVANIC CELLS OF THE TYPE TH, THF SUB 4 / CAF SUB 2 / THF SUB 4, TH SUB 1-X U SUB X C. THE FOLLOWING RESULTS WERE OBTAINED: (1) THE PARTIAL MOLAR FREE ENERGY OF THORIUM IN TH-C-UC SOLID SOLUTION INCREASES NEGATIVELY WITH DECREASING THORIUM CONTENT, AND THE ABSOLUTE VALUE OF PARTIAL MOLAR ENTROPY OF THORIUM SHOWS A MAXIMUM NEAR TH SUB 0.5 U SUB 0.5 C. (2) AS THE TH-C-UC SOLID SOLUTION IS ASSUMED TO BE A QUASI-BINARY SYSTEM OF THORIUM AND URANIUM, THE PARTIAL MOLAR FREE ENERGY OF URANIUM WAS CALCULATED FROM THAT OF THORIUM, AND THE FREE ENERGY OF MIXING WAS ESTIMATED. (3) THE INTERACTION ENERGY BETWEEN THORIUM AND URANIUM IN TH-U-C SYSTEM WAS CALCULATED ACCORDING TO A MODEL OF THE STRICTLY REGULAR SOLUTION. THE INTERACTION BETWEEN THORIUM AND URANIUM IS ATTRACTIVE AND ITS TEMPERATURE DEPENDENCE CORRESPONDS FAIRLY WELL WITH PARTIAL MOLAR ENTROPY OF THORIUM IN TH-C-UC SOLID SOLUTION

ABSTRACT 535

QSHCHERIN B N

IZV VYSSH UCHEB ZAVED FIZ 9, 147 (1969)

ENTHALPY OF ACTIVATION FOR SELF-DIFFUSION OF INORGANIC SUBSTANCES HAVING THE NaCl STRUCTURE

A RELATION HAS BEEN DERIVED BETWEEN THE ACTIVATION ENERGY FOR SELF-DIFFUSION AND THE CHARACTERISTIC TEMPERATURE NEAR THE MELTING POINT FOR INORGANIC CRYSTALS HAVING THE NaCl STRUCTURE, ON THE BASIS OF A VACANCY DIFFUSION MECHANISM. A SIMPLIFIED RELATION HAS BEEN FOUND FOR DETERMINING EA FROM A MELTING POINT. CARBON DIFFUSION IN CARBIDES ON THE BASIS OF STRUCTURAL VACANCIES HAS BEEN DISCUSSED.

ABSTRACT 536

OSTHAGEN K H

BMI-1686 (1964)

CHEMICAL DIFFUSION IN UC SUB 2 AND UC AND THERMAL DIFFUSION IN UC

CHEMICAL DIFFUSIVITIES IN UC SUB 2 WERE DETERMINED AT 1900, 2000, AND 2050 DEG C ON THE BASIS OF LAYER-GROWTH MEASUREMENTS IN COUPLES OF UC PLUS UC SUB 2 VERSUS GRAPHITE. THE DIFFUSIVITIES CAN BE EXPRESSED BY $D_{UC\ SUB\ 2} = 0.082 \exp(-53,800/RT)$. PHASE BOUNDARY LIMITS USED IN THE DIFFUSION ANALYSIS WERE CHECKED IN DIFFUSION COUPLES PREPARED WITH ^{235}U . ESTIMATES OF DIFFUSIVITIES IN UC WERE ALSO MADE AND VALUES OF 1.8×10^{-6} AND $6.5 \times 10^{-6} \text{ CM}^2/\text{S}$ AT 1900 AND 2050 DEG C, RESPECTIVELY, WERE OBTAINED. EXPERIMENTS WERE PERFORMED TO STUDY THE CONDITIONS FOR THERMAL DIFFUSION IN UC. WITHIN THE LIMITS OF THE EXPERIMENTAL TECHNIQUES, NO EVIDENCE OF THERMAL DIFFUSION WAS DETECTED IN THERMAL-GRADIENT SPECIMENS WITH MAXIMUM HOT-END TEMPERATURES OF 1900 DEG C AND TEMPERATURE GRADIENTS OF 500 DEG C/CM AFTER HEATING FOR TIMES UP TO 93 H.

ABSTRACT 537

PADEL A

J NUCL MATER 33,40 (1969)

CONSTANTS ELASTIQUES DES CARBURES NITRURES ET OXYDES D'URANIUM ET DE PLUTONIUM

THE VELOCITY OF SOUND AND THE ELASTIC CONSTANTS OF POLYCRYSTALLINE UC, UN, UC SUB 2 AT ROOM TEMPERATURE VERSUS POROSITY WERE MEASURED. ALSO THE YOUNG MODULUS AND THE INTERNAL FRICTION (AT THE FUNDAMENTAL LONGITUDINAL RESONANCE FREQUENCY) OF UC, UN, UC SUB 2, (U SUB 0.82 PU 0.18) N, (U SUB 0.80 PU SUB 0.20) O SUB 2*X BETWEEN 25 AND 1300 DEG C WERE MEASURED BY RESONANCE TECHNIQUE.

ABSTRACT 538

PALFREYMAN M

CARBIDES IN NUCLEAR ENERGY 1, 336 (1964)

THE VOLATILITY OF PLUTONIUM CARBIDE

MEASUREMENTS OF THE RATE OF EVAPORATION FROM ARC-MELTED HYPOSTOICHIOMETRIC PLUTONIUM CARBIDE HAVE BEEN MADE BY THE VAPOR TRANSPIRATION TECHNIQUE USING ARGON AS THE FLOW GAS AT TEMPERATURES FROM 1500 DEG-1565 DEG C THE NATURE OF THE GASEOUS SPECIES IS DISCUSSED AND A POSSIBLE VAPOR PRESSURE COMPUTED.

ABSTRACT 539

PALLMER P G

HW-72245 (1962)

THERMAL EXPANSION OF PLUTONIUM CARBIDES

THE REACTION OF PLUTONIUM HYDRIDE WITH CARBON PRODUCED A MIXTURE OF PLUTONIUM MONOCARBIDE AND PLUTONIUM SESQUICARBIDE. A WRAPPED CONTAINER ENABLED THE THIN-WALLED QUARTZ CAPILLARY CONTAINING THE SPECIMEN TO BE HANDLED IN A GLOVED BOX AND TO BE REMOVED WITHOUT STRAY ALPHA-CONTAMINATION. WELDING OF THE SPECIMEN ROTATING MAGNET IN THE POWDER CAMERA AND LIMITATION OF THE TEMPERATURE OF PLUTONIUM COMPOUNDS TO 780 C ARE PRECAUTIONS WHICH SHOULD BE TAKEN TO AVOID BREAKAGE OF CAPILLARIES IN THE FUTURE. A LARGE POSSIBLE ERROR IN CALCULATED COEFFICIENTS WOULD RESULT FROM ANY DIFFERENCE IN THERMAL RADIATION

ABSTRACT 539 (CONT'D)

EQUILIBRIUM OF THERMOCOUPLE AND SAMPLE, PERHAPS AS MUCH AS 20 C. THE LATTICE THERMAL EXPANSIONS OF PLUTONIUM MONOCARBIDE AND PLUTONIUM SESQUICARBIDE WERE $10.8 \times 10^{-6}/C$, AND $14.8 \times 10^{-6}/C$, RESPECTIVELY.

ABSTRACT 540

PAPROCKI S J

BMI-1184 (1957)

FABRICATION OF DISPERSED URANIUM FUEL ELEMENTS USING POWDER - METALLURGY TECHNIQUES,

FABRICATION TECHNIQUES FOR PRODUCING DISPERSION FUEL ELEMENTS WITH CORES OF 30 VOLUME PER CENT OF UC, U SUB 2 TI, U SUB 3 SI, OR U SUB 6 NI DISPERSED IN ZIRCALOY 2 AND 30 VOLUME PER CENT OF UC OR UN DISPERSED IN TYPE 18-8 STAINLESS STEEL HAVE BEEN INVESTIGATED. ROLL-CLAD PLATE-TYPE ELEMENTS OF ALL THESE COMPOSITIONS MAY BE FABRICATED BY POWDER-METALLURGY METHODS IN SUCH A MANNER THAT GOOD CORE-TO-CLADDING BONDS AND CORES WITH UNIFORM DISPERSIONS OF DISCRETE URANIUM-COMPOUND PARTICLES ARE OBTAINED. FROM THE STANDPOINT OF FABRICABILITY, ELEMENTS CONTAINING UC IN ZIRCALOY 2, UC IN STAINLESS STEEL, AND UN IN STAINLESS STEEL ARE THE MOST PROMISING. THE UN IN STAINLESS STEEL HAS THE BEST CORROSION RESISTANCE IN 680 DEG F DEGASSED WATER; HOWEVER, UC IN STAINLESS STEEL HAS THE BEST RESISTANCE TO CORROSION IN 700 DEG F NAK.

ABSTRACT 541

PAPROCKI S J

BMI-1365 (1959)

DEVELOPMENT OF URANIUM NITRIDE - STAINLESS STEEL DISPERSION FUEL ELEMENTS

IN RESEARCH IN SUPPORT OF THE GCRC, PROCEDURES FOR THE FABRICATION OF STAINLESS STEEL-CLAD FLAT-PLATE FUEL ELEMENTS HAVING A CORE OF 28 W/O UN DISPERSED IN AN IRON-18 W/O CHROMIUM-14 W/O NICKEL-2.5 W/O MOLYBDENUM MATRIX WERE DEVELOPED. THE PREPARATION OF UN AND ITS COMPATIBILITY WITH THE COMPONENTS OF THE MATRIX ALLOY WERE STUDIED. THE UN FOR THE PROGRAM WAS PREPARED BY NITRIDING URANIUM METAL AT 850 DEG C AND THEN DISSOCIATING THE U SUB 2 N SUB 3 PRODUCED TO UN IN A VACUUM AT 1300 DEG C. IN COMPATIBILITY STUDIES, UN REACTED WITH NICKEL ALONE AT 1800 DEG F, BUT NO REACTION WITH NICKEL WAS OBSERVED WHEN THE OTHER MATRIX COMPONENTS WERE ALSO PRESENT. THE EFFECTS OF FABRICATION VARIABLES WERE EVALUATED BY METALLOGRAPHIC EXAMINATION, LONGITUDINAL AND TRANSVERSE TENSILE TESTS, BEND TESTS, AND CORROSION TESTS. STUDIES INDICATED THAT MINUS 200 PLUS 325-MESH UN DISPERSED IN A MINUS 325-MESH ELEMENTAL-POWDER MATRIX ROLLED GREEN WITH A 30 PER CENT INITIAL REDUCTION AT 2100 DEG F AND THEN ANNEALED 3 HR AT 2300 DEG F PRODUCED THE BEST FUEL CORE.

ABSTRACT 542

PARQUE W M

BMI-1693 (1964)

SYNTHESIS, FABRICATION, AND CHEMICAL REACTIVITY OF PLUTONIUM MONONITRIDE

SYNTHESIS OF PUN USING A HYDRIDE-NITRIDE CYCLE WAS FOUND TO BE THE MOST SUITABLE PREPARATION TECHNIQUE. DENSE PUN SPECIMENS WERE FABRICATED BY AN ISOSTATIC HOT-PRESSING TECHNIQUE IN WHICH CONSOLIDATED POWDER SEALED IN A REFRACTORY-METAL CONTAINER WAS SUBJECTED TO 10,000-PSI EXTERNAL GAS

ABSTRACT 542 (CONT'D)

PRESSURE AT 1370 TO 1540 DEG C FOR 3 HR. DENSITY AND MICROHARDNESS INCREASED WITH INCREASED ISOSTATIC HOTPRESSING TEMPERATURE. MINUS 80-MESH PUN POWDER WAS COMPLETELY CONVERTED TO OXIDE IN 1 TO 3 DAYS IN AIR, AND INCREASED IN OXYGEN CONTENT FROM 4,700 PPM TO 2.252 WT % WHEN STORED IN A NITROGEN-1 PER CENT OXYGEN GLOVE-BOX ATMOSPHERE FOR 30 DAYS (BOTH TESTS CONDUCTED AT ROOM TEMPERATURE). ATTACK OF PUN BY THE COMMON ACIDS DECREASED IN THE SEQUENCE HNO₃ SUB 3, HCL, H SUB 3 PO SUB 4, H SUB 2 SO SUB 4, AND HF. PUN APPEARED COMPATIBLE WITH SODIUM AND LITHIUM AT TEMPERATURES UP TO AT LEAST 800 DEG C BUT WAS DISINTEGRATED BY THESE METALS IN THE 950 TO 1000 DEG C TEMPERATURE RANGE. PUN WAS COMPATIBLE WITH IRON-BASE ALLOYS, INCONEL, AND REFRACTORY METALS AT TEMPERATURES OF 1300 DEG C.

ABSTRACT 543

PARDUE W M

RMI-1698 (1964)

AN EVALUATION OF PLUTONIUM COMPOUNDS AS NUCLEAR FUELS

NUCLEAR AND MATERIALS PROPERTIES OF INTEREST WERE CONSIDERED IN DEFINING THE MOST ATTRACTIVE PLUTONIUM COMPOUNDS FOR USE IN THERMAL AND FAST REACTORS. SOME CONSIDERATION WAS ALSO GIVEN TO THE USE OF THESE COMPOUNDS IN RADIOISOTOPE HEAT SOURCES. AFTER A PROCESS OF ELIMINATION, THE MOST PROMISING COMPOUNDS INCLUDED PUN, PUO SUB 2, PUC, PUS, PUP, PUAL SUB 2, PUSI SUB 2, PUAS, PUTE, AND PUB. THE FIRST THREE LISTED ARE BELIEVED TO POSSESS APPROXIMATELY EQUAL POTENTIAL AND NEXT TWO TO DESERVE FURTHER EVALUATION. CURSORY EXPERIMENTAL STUDIES ON THE SYSTEMS PLUTONIUM-ARSENIC, PLUTONIUM-PHOSPHORUS, AND PLUTONIUM-SILICON WERE CARRIED OUT, AND CERTAIN PHASE RELATIONSHIPS WERE DEFINED. TENTATIVE PHASE DIAGRAMS OF THE ARSENIDE AND PHOSPHIDE SYSTEMS WERE DRAWN. SINGLE-PHASE PUP SPECIMENS WERE PREPARED. THE PROPERTIES CONSIDERED ARE CRYSTAL STRUCTURE, DENSITY, MELTING POINT AND HARDNESS. AVAILABLE DATA ON THE COMPATIBILITY OF PUC WITH VARIOUS MATERIALS ARE BRIEFLY SUMMARIZED. HAS ALSO GIVEN THE ELECTRICAL RESISTIVITY OF PUC AT ROOM TEMPERATURE. COMPATIBILITY OF PUN WITH MO, W AND TA AT 1300 DEG C IS ALSO GIVEN. VALUE OF COEFFICIENT OF THERMAL EXPANSION IS ALSO REPORTED FOR PUN.

ABSTRACT 544

PARDUE W M

RMI-1733 SECT B (1965)

STUDIES OF PUN AND ITS ALLOYS

OXIDATION STUDIES OF PUN IN FLOWING NITROGEN OR CO SUB 2 ARE COMPARED WITH EARLIER OXIDATION DATA FOR PUN IN DRY AIR. MICROHARDNESS FOR (U SUB 0.85 PU SUB 0.15) N AND PU SUB 0.54 C SUB 0.29 N SUB 0.17 WAS MEASURED.

ABSTRACT 545

PARQUE W M

NUCL MET MET SOC AIME 13, 369 (1968)

U-PU NITRIDES: FABRICATION AND PROPERTIES

SYNTHESIS OF NITRIDE POWDERS HAS BEEN ACCOMPLISHED BY A SUCCESSIVE HYDRIDE-NITRIDE-VACUUM OUTGAS TREATMENT OF THE METALLIC ELEMENTS. DENSIFICATION OF THESE POWDERS INTO USEFUL PELLET OR ROD FORM CAN BE ACCOMPLISHED BY HOT PRESSING OR SINTERING. PROPERTIES OF IMPORTANCE FOR REACTOR DESIGN HAVE BEEN MEASURED AND INCLUDE VOLATILIZATION TENDENCIES RELATING TO VAPOR-PHASE TRANSPORT UNDER THERMAL INFLUENCES, THERMAL CONDUCTIVITY, AND CHEMICAL STABILITY OF THE FUELS IN CONTACT WITH POTENTIAL LMFBR CLADDING AND COOLANT MATERIALS. GRAIN-GROWTH BEHAVIOR OF HIGH-DENSITY SPECIMENS ALSO HAS BEEN DETERMINED.

ABSTRACT 546

PARQUE W M

PLUTONIUM 1965, P721

PROPERTIES OF PLUTONIUM MONONITRIDE AND ITS ALLOYS.

PREPARATION OF DENSE BODIES OF STOICHIOMETRIC PUN AND SYSTEMS OF THIS COMPOUND WITH UN, TIN, AND THN IS DESCRIBED. OUTLINES OF SOME OF THE SIMPLER PHASE RELATIONSHIPS IN THESE SYSTEMS ARE PRESENTED. PHYSICAL PROPERTY MEASUREMENTS OF PUN WERE UNDERTAKEN AND ARE COMPILED, INCLUDING DETERMINATIONS OF THE CHEMICAL REACTIVITY POTENTIAL BETWEEN PUN AND VARIOUS METALLIC CLADDINGS, LIQUID METALS, ORGANIC ACIDS, AND GASES. THE PREVIOUSLY REPORTED PHENOMENON OF VOLATILITY, OR DECOMPOSITION, WAS MORE COMPLETELY ANALYSED AND COMPARED WITH THAT OF OTHER PU MATERIALS. OTHER PROPERTIES SUCH AS THERMAL EXPANSION, USEFUL FOR REACTOR DESIGN AND RELIABILITY CONSIDERATIONS WERE INCLUDED. CURSORY MEASUREMENTS OF PROPERTIES FOR THOSE ALLOYS OF PUN THAT POSSESS POTENTIAL FOR BREEDER OR CONVERTER REACTOR SYSTEMS WERE UNDERTAKEN.

ABSTRACT 547

PARKINSON N

J BR NUCL ENERGY SOC 5, 551 (1966)

CHEMISTRY OF THE FAST REACTOR FUEL CYCLE

THE USE OF PLUTONIUM IN FAST REACTOR FUELS AND ITS EFFECTS ON THE CHEMISTRY OF FUEL PREPARATION AND FABRICATION, IN-PILE BEHAVIOR, AND REPROCESSING OF IRRADIATED FUEL ARE DISCUSSED. PREPARATION OF PLUTONIUM FUEL COMPOUNDS, CHEMICAL PROPERTIES OF MIXED OXIDES AND CARBIDES, EFFECT OF NEUTRON IRRADIATION ON CHEMICAL REACTIVITY, FABRICATION OF OXIDES AND CARBIDES, REACTIONS OF FUEL WITH CLADDING MATERIALS, CHEMISTRY OF IRRADIATED FUEL, AND REPROCESSING CHEMISTRY ARE CONSIDERED.

ABSTRACT 548

PASCARD R

NUCL MET 13, 345 (1968)

PROPERTIES OF CARBIDES AND CARBONITRIDES

WE HAVE STUDIED THE SYSTEM (U,PU) (CNO) IN ORDER TO HAVE A BASIS TO SELECT THE BEST COMPOSITION FOR A FAST REACTOR FUEL. THE STUDIES ARE THE FOLLOWING: A) DIAGRAM STUDIES B) COMPATIBILITY TESTS WITH STAINLESS STEEL IN SODIUM C) THERMAL DIFFUSIVITY MEASUREMENTS IT IS DIFFICULT TO WEIGH A PRIORI THE RELATIVE IMPORTANCE OF THE RESULTS AND THERE IS A STRONG

ABSTRACT 548 (CONT'D)

FEELING THAT DECISION, IF ANY, MUST COME FROM EXTENSIVE IRRADIATION EXPERIMENTS.

ABSTRACT 549

PASCARD R

POWDER METALLURGY IN THE NUCLEAR AGE PLANSEE PROCEEDINGS 387,419 (1961)
PRELIMINARY STUDIES ON THE SYSTEM PLUTONIUM-CARBON AND SOLID SOLUTIONS OF URANIUM CARBIDE-PLUTONIUM CARBIDE

THE ESSENTIAL RESULTS OF THE INVESTIGATION ON THE CARBIDES OF URANIUM AND PLUTONIUM AS WELL AS THEIR SOLID SOLUTIONS ARE DESCRIBED. EQUIMOLECULAR MIXTURES OF PU-C IN CONTRARY TO THE RELATION IN THE U-C SYSTEM DID NOT RESULT IN THE CARBIDE PUC, BUT IN A MIXTURE OF PUC SUB (1-X) + PU SUB 2 C SUB 3. PUC SUB (1-X) IS A DEFECT CARBIDE WITH ONLY 8% OF THE LATTICE SITES BEING OCCUPIED BY CARBON AT THE SATURATION LIMIT. THE SOLID SOLUBILITY BETWEEN UC AND PUC CAN THEREFORE NOT BE CONTINUOUS OVER THE WHOLE RANGE. UNIFORM SOLID SOLUTIONS BETWEEN UC AND PUC EXIST ONLY AT COMPOSITIONS WITH MORE THAN 36% UC. AT LOWER UC CONTENTS, THE SYSTEM CONSISTS OF TWO PHASES (U,PU) C SUB (1-X) + PU SUB 2 C SUB 3. CERTAIN DEVIATIONS ALSO EXIST WITH REGARD TO THE ZETA PHASE (PU SUB 2 C SUB 3) IN THE PLUTONIUM-CARBON SYSTEM. THE ELECTRICAL RESISTIVITY OF PUC (230 MICROHM.CM) WAS APPRECIABLY HIGHER THAN FOR UC (30 MICROHM.CM). THE ELECTRICAL RESISTIVITY OF A SOLID SOLUTION (U,PU)C WAS 150 MICROHM.CM. THE PREPARATION OF THE CARBIDE POWDERS WAS CARRIED OUT BY THE REDUCTION OF THE OXIDES FOLLOWED BY DIRECT CARBURIZATION OF THE METALS (OR HYDRIDES) WITH CARBON. EXCELLENT SINTERING RESULTS WERE OBTAINED IF THE CARBIDE POWDERS WERE PURE (ABSENCE OF OXIDES OR METAL TRACES). SMALL ADDITIONS OF BINDER METALS (0.5% NI) ALLOWED DENSITIES UP TO 98% OF THEORETICAL IN THE WHOLE RANGE OF COMPOSITIONS. THE RESULTS WITH (U,P)C-SOLID SOLUTION PREPARED FROM METAL POWDERS WERE SUPERIOR CONCERNING HOMOGENEITY AND ABSENCE OF PU SUB 2 C SUB 3.

ABSTRACT 550

PASHOS T J

THIRD UNITED NATIONS CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY, 1 (1964)
IRRADIATION BEHAVIOR OF CERAMIC FUELS

WORK ON CARBIDES AND NITRIDES OF URANIUM IS SUMMARIZED WHILE REVIEWING DIFFERENT CERAMIC FUELS FOR REACTOR APPLICATIONS.

ABSTRACT 551

PATRIARCA P

ORNL-TM-3416 (1971)
FUELS AND MATERIALS DEVELOPMENT PROGRAM

FROM THE EXPERIMENTAL WORK, A TERNARY PHASE DIAGRAM OF THE PU-CR-N SYSTEM BETWEEN 800 AND 1700 DEG C AND AT 1 ATM. TOTAL PRESSURE IS PRESENTED.

ABSTRACT 552
PATRIARCA P
ORNL-4520
DEVELOPMENT OF HIGH-PERFORMANCE LMFBR FUELS

THE LATTICE PARAMETERS ARE REPORTED FOR $\text{Pu}_{0.8}\text{U}_{0.2}\text{N}$. THE ELECTRICAL RESISTIVITY OF $\text{U}_{0.2}\text{N}$ WAS MEASURED AND COMPARED WITH THE AVAILABLE DATA IN THE LITERATURE OVER THE TEMPERATURE RANGE OF 295 TO 1675 DEG K.

ABSTRACT 553
PATRIARCA P
ORNL-4600
DEVELOPMENT OF ADVANCED LMFBR FUELS

FROM X-RAY DIFFRACTION STUDIES, LATTICE CONSTANTS OF $\text{Pu}_{0.81}\text{U}_{0.19}\text{N}$ ARE REPORTED FOR DIFFERENT BATCHES. VALUES OF LATTICE CONSTANTS ARE ALSO GIVEN AS A FUNCTION OF Pu CONTENT IN MIXED NITRIDES. THE COMPARISON IS ALSO MADE WITH THE AVAILABLE DATA IN THE LITERATURE. TO STUDY THE COMPATIBILITY OF MIXED-NITRIDE FUELS WITH LMFBR CLADDING ALLOYS, AN ATTEMPT WAS MADE TO TEST THE SAMPLE IN Pu-Cr-N SYSTEM WITH A Cr:Pu RATIO OF ABOUT 2:1 AT 1725 DEG C FOR 2 HR. UNDER 200 Torr N_2 SUB 2 PRESSURE.

ABSTRACT 554
PATTORET A
BULL SOC FR CERAM 77, 75 (1967)
MASS SPECTROMETRIC STUDY OF THE EVAPORATION OF THE CERAMICS UO_2 SUB 2 AND UC

BY KNUDSEN EFFUSION TECHNIQUE, EQUILIBRIUM URANIUM PRESSURE WITH UC SUB 1.04 WAS STUDIED IN THE TEMPERATURE RANGE OF 2248 TO 2512 DEG K. SIMILAR VALUE FOR UC SUB 2 AT 2500 DEG K WAS OBSERVED. THERMODYNAMIC PROPERTIES SUCH AS ENTHALPY AND ENTROPY FOR UC AND UC SUB 1.93 ARE TABULATED FROM 1500 TO 2600 DEG K. DATA ON THE CONGRUENT VAPORIZATION OF THE MONOCARBIDE IS ALSO PRESENTED. FOR HEAT OF SUBLIMATION OF URANIUM, A VALUE EQUAL TO 128.5#2.0 KCAL/G.ATOM IS GIVEN.

ABSTRACT 555
PATTORET A
THERMO NUCL MATER P613 (1967)
ETUDES THERMODYNAMIQUES PAR SPECTROMETRIE DE MASSE SUR LE SYSTEME URANIUM-OXYGEN.

THE COHERENCE BETWEEN THE HEAT OF SUBLIMATION OF URANIUM H DEG S,0 (U) = 128.5 KCAL/G.ATOM AND THE THERMODYNAMIC DATA FOR URANIUM CARBIDES IS DISCUSSED.

ABSTRACT 556

PATTORFI A

TRANS FARADAY SOC 65, 98 (1969)

MASS SPECTROMETRIC DETERMINATION OF HEAT OF SUBLIMATION OF URANIUM.

THE VAPOR PRESSURE OF URANIUM WAS DETERMINED BETWEEN 1720 AND 2340 DEG K:
 $-\log P(\text{ATM}) = (26,210 \pm 270)/T - (5.920 \pm 0.135)$. THE HEAT OF SUBLIMATION
CALCULATED THEREFROM IS 24 DEG SUB 5.0 (U) = 129.0 ± 2.0 KCAL/G ATOM. THIS
RESULT IS IN AGREEMENT WITH INDEPENDENT MEASUREMENTS OF THE VAPOR
PRESSURE OF URANIUM AS WELL AS WITH THE VALUES DERIVED FROM
THERMOCHEMICAL CYCLES BASED ON THE DISSOCIATION ENERGIES OF THE MONOXIDE
AND DIOXIDE OF URANIUM AND ON THE VAPORIZATION OF THE MONOCARBIDE, THE
DICARBIDE AND THE MONOSULPHIDE OF URANIUM.

ABSTRACT 557

PEARLMAN H

PRNC CONF THE PEACEFUL USES OF ATOMIC ENERGY 11 (1964)

CARBIDE FUEL FABRICATION AND PERFORMANCE

THE PHASE PROPERTIES OF THE U-C SYSTEM ARE OUTLINED. THE FABRICATION AND
IRRADIATION PERFORMANCE OF UC AND UC-PUC FUEL ELEMENTS ARE DESCRIBED.

ABSTRACT 558

PIALOUX A

STUDY OF CRYSTALLINE TRANSFORMATIONS AT HIGH TEMPERATURES ABOVE 2000K
P415 (1972)

U-C-O SYSTEM AT 1770 DEG C HIGH-TEMPERATURE X-RAY INVESTIGATIONS UNDER
THERMODYNAMIC EQUILIBRIUM CONDITIONS

SAMPLE PELLETS OF KNOWN WEIGHT AND VARIOUS INITIAL COMPOSITIONS: U SUB 2
+NC (0CNCS) WERE HEATED FOR SOME TIME AT 1769 DEG C IN THE PRESENCE OF CO
IN A LABORATORY-CONSTRUCTED X-RAY FURNACE, WHEN EQUILIBRIUM WAS REACHED,
THE SOLID PHASES WERE IDENTIFIED AND THEIR PARAMETERS CALCULATED. THE
OVERALL COMPOSITIONS OF THE SAMPLES WERE DEDUCED FROM THE QUANTITIES OF
CO RELEASED OR ABSORBED, A PREVIOUS CALIBRATION OF THE FURNACE HAVING
ALREADY BEEN MADE. THE P SUB (CO) = F(O/U) AND F(C/U) ISOTHERMS ARE IN
EXCELLENT AGREEMENT WITH THE DIFFRACTIONS PATTERNS OBTAINED. THESE
PATTERNS REVEAL THE EXISTENCE OF A NARROW INVARIANT DOMAIN (GRAPHITE, UO
SUB 2, CO) AND CONFIRM THE EXISTENCE OF TWO MONOVARIANT PLATEAUX
(GRAPHITE, UO SUB 2, UC SUB 2, CO) AND (UO SUB 2, UC SUB 2, UC, CO). THE
PARAMETERS OF THE PHASES IN EQUILIBRIUM AT 1760 DEG C ARE AS FOLLOWS: UO
SUB 2, A=5580±0.001; 2UC SUB 2, A=3.649±0.003, C=6.018±0.005; UC,
A=5.090±0.002. STUDIES OF THE ISOTHERMS INDICATE THAT THE UO SUB 2 OXYGEN
INDEX MUST BE IN THE 1.95 REGION AND THAT OF UC SUB 2 COMPARATIVELY
SMALL. CALCULATIONS SUGGEST THAT UC SUB 2 IS PROBABLY HIGHLY
STOICHIOMETRIC. THE PARAMETERS OF THE UC SUB 2 PHASE WERE DETERMINED
IN VACUO BETWEEN 1000 AND 2000 DEG C.

ABSTRACT 559

PIAZZA J R

J CHEM ENG DATA 7, 451 (1962)

HIGH TEMPERATURE PHASE EQUILIBRIA IN THE SYSTEM CARBON-OXYGEN-URANIUM.

THE OBJECTIVE OF THE WORK PERFORMED WAS TO ESTABLISH PHASE RELATIONS
INVOLVING URANIUM CARBIDES, URANIUM DIOXIDE, AND GRAPHITE. THE PRESSURE -
TEMPERATURE DATA FOR UNIVARIANT EQUILIBRIA AS WELL AS LATTICE PARAMETER

ABSTRACT 559 (CONT'D)

MEASUREMENTS FOR MONO CARBIDE - RICH PHASES ARE PRESENTED.

ABSTRACT 560

POTTER P E

AERE-R-5661 (1968)

INHOMOGENEITY IN SINTERED URANIUM-PLUTONIUM CARBIDES & OXYCARBIDES

ELECTRON MICROPROBE ANALYSIS HAS REVEALED CONSIDERABLE INHOMOGENEITY IN ARC-MELTED U SUB 0.85 PU SUB 0.15 -C ALLOYS WHICH CONTAINED A SECOND PHASE OF EITHER METAL OR SESQUICARBIDE. FOR AN ALLOY CONTAINING 4.0 WT % CARBON, THE PLUTONIUM CONCENTRATION IN METAL PHASE WAS 40 WT % AND FOR AN ALLOY WITH 5.3 WT % CARBON, THE SESQUICARBIDE PHASE CONTAINED APPROX 30 WT % PLUTONIUM. SINTERED PELLETS OF THESE MATERIALS WERE PREPARED FROM THE CRUSHED POWDERS; INHOMOGENEITIES WERE PRESENT AND ARE MOST PROBABLY ASSOCIATED WITH THE SECOND PHASE. THE MATERIAL CONTAINING METAL SHOWED REGIONS OF 30 WT % PLUTONIUM OVER DISTANCES OF 20-30 MICRONS, AND IN THE SESQUICARBIDE-CONTAINING MATERIAL THERE WERE REGIONS OF UP TO 20 WT % PLUTONIUM OVER DISTANCES OF 20 MICRONS. SOME CALCULATIONS BASED ON THE RECENTLY AVAILABLE THERMODYNAMIC DATA FOR PLUTONIUM CARBIDES SUGGEST THAT SEGREGATION OF THE ORDER OF THAT OBSERVED SHOULD BE PRESENT AT EQUILIBRIUM, AND THAT OXYGEN DISSOLVED IN THE MONOCARBIDE LATTICE SHOULD DECREASE THE MAGNITUDE OF THE SEGREGATION.

ABSTRACT 561

POTTER P E

AERE-R-5922 (1968)

THE PLUTONIUM-URANIUM-CARBON SYSTEM

STUDIES ON THE PHASE RELATIONSHIP AND THERMODYNAMIC PROPERTIES OF THE PLUTONIUM-URANIUM-CARBON TERNARY SYSTEM ARE REVIEWED AND AREAS FOR FUTURE WORK DEFINED. THE MAIN FEATURES OF THE SYSTEM ARE THAT THERE ARE NO TERNARY COMPOUNDS AND THAT THERE ARE REGIONS OF COMPLETE MISCIBILITY BETWEEN URANIUM AND PLUTONIUM MONOCARBIDES AND ALSO BETWEEN THE SESQUICARBIDES.

ABSTRACT 562

POTTER P E

J NUCL MATER 12, 345 (1964)

THE VOLATILITY OF PLUTONIUM CARBIDES

ON HEATING PU-C SYSTEMS CLOSE TO THE PUC COMPOSITION, CONSIDERABLE DECOMPOSITION OCCURRED AT 1550 DEG C. PLUTONIUM VAPORIZED AND THE REMAINING CARBON REACTED WITH THE MONOCARBIDE TO FORM PU SUB 2 C SUB 3. THE DIFFUSION OF PU THROUGH A LAYER OF PU SUB 2 C SUB 3 WAS A PROBABLE RATE-DETERMINING STEP FOR THE VAPORIZATION OF PU.

ABSTRACT 563

POTTER P E

J NUCL MATER 47, 7 (1973)

SOME EQUILIBRIA IN THE U-PU-N TERNARY SYSTEM: AN ASSESSMENT

SOME ASSESSMENTS OF POSSIBLE EQUILIBRIA FOR THE TERNARY SYSTEM URANIUM-PLUTONIUM-NITROGEN HAVE BEEN MADE AND FROM THESE EQUILIBRIA THE PRESSURES OF THE GAS PHASE SPECIES, PU, U AND N SUB 2 FOR THE SYSTEM HAVE BEEN CALCULATED. THE NATURE OF THE VAPORIZATION BEHAVIOR OF ALLOYS OF THE SYSTEM IS ALSO PREDICTED.

ABSTRACT 564

POTTER P E

PLUTONIUM 1970, PB59

ON THE U-PU-C-O SYSTEM

AN ANALYSIS IS MADE OF THE EQUILIBRIA IN THE U-C-O SYSTEM AND THESE EQUILIBRIA ARE CONSISTENT WITH THE THERMODYNAMIC DATA FOR THE BINARY U-C AND U-O SYSTEMS PROVIDING A REGULAR SOLUTION MODEL IS EMPLOYED TO DESCRIBE THE UC-UO SOLID SOLUTION. THE INTERACTION PARAMETER WAS ESTIMATED TO BE -20KCAL. AT THE TEMPERATURES WHERE UC SUB 2 IS A PHASE OF THE SYSTEM THE ACTIVITY MUST BE LESS THAN UNITY IN ORDER TO FIT THE EXPERIMENTAL DATA. THE CALCULATIONS ALSO PREDICT THAT C CAN NOT BE IN EQUILIBRIUM WITH THE UC-UO SOLID SOLUTION EVEN AT TEMPERATURES LOWER THAN 1000 DEG C. A SIMILAR ANALYSIS OF THE PU-C-O SYSTEM INDICATES THAT AN INTERACTION PARAMETER OF -2.5KCAL IS REQUIRED TO DESCRIBE THE PUC-PUO SOLID SOLUTION IN ORDER THAT THE BINARY THERMODYNAMIC DATA ARE CONSISTENT WITH THE EXPERIMENTALLY DETERMINED PHASE DIAGRAM. THE DATA FOR THE FREE ENERGIES OF FORMATION OF THE HYPOTHETICAL MONOXIDES OF U AND PU, TOGETHER WITH THE PUBLISHED DATA ON THE U-PU-C AND U-PU-C-O SYSTEMS HAVE BEEN UTILISED TO PREDICT SOME OF THE EQUILIBRIA IN THE QUATERNARY U-PU-C-O SYSTEM. IN A PHASE FIELD CONTAINING 3 CONDENSED PHASES THE AMOUNTS OF THE PHASES MUST BE KNOWN IN ORDER TO DETERMINE THE GAS PRESSURE ABOVE THE SYSTEM AT A GIVEN TEMPERATURE. THE U AND PU CONCENTRATIONS IN EACH OF THE COEXISTING CONDENSED PHASES WILL IN GENERAL BE DIFFERENT; THESE DIFFERENCES HAVE BEEN CALCULATED.

ABSTRACT 565

POWERS R

UNC-5229 (1968)

COMPATIBILITY OF SEVERAL CLADDING MATERIALS WITH U-PU CARBIDES IN SODIUM

THE COMPATIBILITY OF PLUTONIUM-URANIUM CARBIDE FUELS WITH TYPE 304 AND TYPE 316 STAINLESS STEEL AND WITH INCOLOY-800 WAS TESTED IN THE PRESENCE OF NA AT 900 DEG C FOR 1000 AND 4000 HR. NO CARBURIZATION OF THESE CLADS OR DECARBURIZATION OF FUEL WAS DETECTED METALLOGRAPHICALLY FOR MC CONTAINING 10 V/O M SUB 2 C SUB 3 OR FOR SINGLE-PHASE MC (M = U SUB 0.80 PU SUB 0.20). ALL FUELS WERE PREPARED BY REACTION OF THE OXIDES WITH CARBON FOLLOWED BY COLD PRESSING AND SINTERING TO MINIMUM DENSITIES OF 94% OF THEORETICAL. THE PRINCIPAL FUEL TESTED, MC + 10 V/O M SUB 2 C SUB 3, HAD AN EQUIVALENT CARBON CONTENT OF 5.08 WT %, A CARBON CONTENT OF 4.74 WT %, AND 0.1 WT % NICKEL SINTERING AID. SINGLE-PHASE MC, WITH NO SINTERING AID, HAD AN EQUIVALENT CARBON CONTENT OF 4.70 WT % AND A CARBON CONTENT OF 4.57 WT %. SINGLE PHASE M SUB 2 C SUB 3 (M = U SUB 0.85 PU SUB 0.15) WITH A 6.95 WT % EQUIVALENT CARBON AND 6.89 WT % CARBON CONTENT, HOWEVER, CARBURIZED TYPE 304 TO A DEPTH OF 0.010 IN. IN 1000 HR AND 0.020 IN. IN 4000 HR. THE FUEL SHOWED SURFACE ATTACK. OF THE DIFFUSION BARRIERS

ABSTRACT 565 (CONT'D)

TESTED, TUNGSTEN, CHROMIZED TYPE 316, ZIRCONIUM FOIL-LINED TYPE 316, CARBURIZED TANTALUM, AND CARBURIZED NIOBIUM, NONE WAS CARBURIZED IN SODIUM BY MC + 10 V/O M SUB 2 C SUB 3 AFTER 4000 HR AT 800 DEG C.

ABSTRACT 566

PRICE D E

BMI-1760 (1966)

THE COMPATIBILITY OF URANIUM NITRIDE WITH POTENTIAL CLADDING METALS

THE COMPATIBILITY OF UN WITH STAINLESS STEEL, FE, CR, NI, ZIRCALOY-2, ZR, AND AL WAS STUDIED. DISKS OF UN AND A METAL WERE COMPRESSIVELY LOADED IN CONTACT AT TEMPERATURES BETWEEN 400 AND 1350 DEG C FOR PERIODS OF TIME UP TO 5000 H. THE REACTION PRODUCTS THAT FORMED AT THE UN-METAL INTERFACES WERE STUDIED BY METALLOGRAPHIC EXAMINATION, ELECTRON-BEAM MICROPROBE ANALYSIS, X-RAY-DIFFRACTION ANALYSIS, AND HARDNESS MEASUREMENTS. OBSERVATIONS MADE ON NI-UN, AND ZIRCALOY-2-UN COUPLES ARE CORRELATED WITH HYPOTHETICAL NI-U-N AND ZR-U-N PHASE DIAGRAMS. REACTION RATES IN UN COUPLES WITH CR, NI, ZIRCALOY-2, AND ZR WERE OBTAINED BY MEASURING THE MAXIMUM THICKNESS OF REACTION LAYERS AFTER HEATING FOR VARIOUS TIMES AND TEMPERATURES. HEAT TREATMENTS WERE CARRIED OUT AT 1000 TO 1350 DEG C FOR TYPE 304 STAINLESS STEEL, 700 TO 1000 DEG C FOR FE, 800 TO 1000 DEG C FOR CR, 600 TO 1200 DEG C FOR NI, 600 TO 500 DEG C FOR ZIRCALOY-2, 600 TO 700 DEG C FOR ZR, AND 400 TO 600 DEG C FOR AL. REACTIONS WITH LIMITED AMOUNTS OF EXCESS NITROGEN AND OXYGEN PRESENT AS AN IMPURITY WERE OBSERVED BETWEEN UN AND TYPE 304 STAINLESS STEEL, FE, OR CR. (NO REACTION WAS OBSERVED BETWEEN NITROGEN AND FE). MORE EXTENSIVE REACTIONS WERE OBSERVED BETWEEN UN AND ZR, ZIRCALOY-2, NI, OR AL IN ORDER OF INCREASING REACTION RATES.

ABSTRACT 567

PRICE D E

BMI-1809 (1967)

ANNUAL REPORT, PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY, 1966 THROUGH JUNE, 1967

AN EVALUATION OF U-PU NITRIDES AND CARBONITRIDES FOR USE AS FUEL MATERIAL IN FAST BREEDER REACTORS IS PRESENTED. THE PREPARATION, PROPERTIES AND EFFECTS OF RADIATION ON THESE MATERIALS WERE STUDIED. EXPERIMENTAL STUDIES OF SODIUM BOILING, FILM FORMATION, AND WETTING ARE ALSO REPORTED.

ABSTRACT 568

PRICE D E

BMI-1819 (1967)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY THROUGH SEPTEMBER 1 1967

PROGRESS IS REPORTED ON UN-PU FUELS FOR LMFBR APPLICATIONS, RADIATION EFFECTS ON MATERIALS FOR FAST REACTORS, PROPERTIES OF CERAMIC-COATED PU-BASE FUELS, AND PROPERTIES OF CERAMIC COATED U-BASE FUELS.

ABSTRACT 569

RADDSFVICH L G

J AM CERAM SOC 52,514 (1969)

LOW-TEMPERATURE THERMAL CONDUCTIVITY OF URANIUM NITRIDE

THE THERMAL CONDUCTIVITY OF POLYCRYSTALLINE URANIUM NITRIDE WAS MEASURED FROM 2 TO 85 DEG K.

ABSTRACT 570

RAND M H

AERE-M-1360 (1964)

VARIATION OF SOME THERMODYNAMIC PROPERTIES ACROSS THE UC-UN SOLID SOLUTION RANGE.

THERMODYNAMIC CALCULATIONS ARE PRESENTED FOR THE STABILIZATION OF UC TOWARDS GRAPHITE BY UN, THE DECOMPOSITION OF UC-UN SOLID SOLUTIONS TO URANIUM AND NITROGEN, AND THE REACTION OF UC-UN SOLID SOLUTIONS WITH NITROGEN. THE CALCULATIONS ARE RELEVANT TO THE PREPARATION OF UC-UN SOLID SOLUTIONS AND THEIR USE AS NUCLEAR FUELS.

ABSTRACT 571

RAND M H

AERE-M-973 (1962)

HIGH TEMPERATURE X-RAY DIFFRACTION STUDIES, PART 3: PLUTONIUM NITRIDE AND PLUTONIUM SESQUICARBIDE

A HIGH TEMPERATURE X-RAY DIFFRACTION STUDY (20 TO 1000 DEG C) HAS BEEN MADE OF PLUTONIUM MONONITRIDE AND PLUTONIUM SESQUICARBIDE. NO PHASE CHANGES WERE OBSERVED, AND THE COEFFICIENTS OF THERMAL EXPANSION ARE 12.3×10^{-6} AND 16.2×10^{-6} PER DEG C RESPECTIVELY.

ABSTRACT 572

RAND M H

AT ENERGY REV 4, 1 (1966)

PLUTONIUM: PHYSICO-CHEMICAL PROPERTIES OF ITS COMPOUNDS AND ALLOYS.

DATA ARE TABULATED AND EVALUATED ON THE THERMODYNAMIC PROPERTIES, DENSITIES, CRYSTALLOGRAPHIC STRUCTURES, EQUILIBRIUM DIAGRAMS, AND DIFFUSION RATES OF PLUTONIUM. (296 REFERENCES).

ABSTRACT 573

RAND M H

CARBIDES IN NUCL ENERGY P108 (1964)

ANOMALOUS THERMAL EXPANSION IN THE PUC REGION.

THE CELL PARAMETER OF TWO PLUTONIUM CARBIDE ALLOYS OF LOW CARBON CONTENT, PREPARED BY POWDER METALLURGICAL TECHNIQUES AT 1500 DEG C, HAS BEEN SHOWN TO EXHIBIT A SERIES OF ABRUPT IRREVERSIBLE INCREASES TOTALLING 0.007 ANGSTROM, ON BEING HEAT CYCLED BETWEEN ROOM TEMPERATURE AND 450 DEG C; THEREAFTER, THEIR EXPANSION BETWEEN 20 DEG AND 700 DEG C IS NORMAL. A THIRD SAMPLE, WITHIN THE HOMOGENEITY RANGE OF THE 'MONOCARBIDE', GAVE A STRAIGHTFORWARD EXPANSION CURVE, WITH A COEFFICIENT OF EXPANSION OF 10.6×10^{-6} PER DEG C. THE ANOMALOUS EXPANSION MAY BE DUE TO AN INTERNAL ATOMIC REARRANGEMENT OF A RETAINED HIGH TEMPERATURE PHASE.

ABSTRACT 574

RAND M H

THERMO NUCL MATER 71 (1962)

SOME INCONSISTENCIES IN THE THERMODYNAMIC DATA FOR URANIUM COMPOUNDS

MANY OF THE THERMODYNAMIC DATA FOR URANIUM COMPOUNDS ARE RELIABLE AND CONSISTENT, BUT A NUMBER OF INCONSISTENCIES STILL REMAIN. SOME OF THESE ARE DISCUSSED AND SUGGESTIONS MADE FOR WORK AIMED AT RESOLVING THEM AND FOR OBTAINING THE MORE IMPORTANT THERMOCHEMICAL DATA STILL LACKING FOR URANIUM COMPOUNDS. SOME OF THE PROBLEMS REVIEWED ARE THE VAPOR PRESSURE OF LIQUID URANIUM, THE HEATS OF FORMATION AND STANDARD ENTROPIES OF THE AQUEOUS IONS, THE REACTION OF GRAPHITE WITH URANIUM DIOXIDE, THE URANIUM-BISMUTH SYSTEM, THE URANIUM-OXYGEN SYSTEM BETWEEN UO SUB 2.6 AND UO SUB 3 AND THE URANIUM-FLUORINE SYSTEM BETWEEN UF SUB 4 AND UF SUB 6.

ABSTRACT 575

RAY W E

WCAP-3791-8 (1967)

(U,PU) C DEVELOPMENT QUARTERLY PROGRESS REPORT

PRELIMINARY EVALUATION OF THE THERMAL SHOCK RESISTANCE OF U CARBIDE FUELS WAS MADE. PELLETS WERE EITHER HEATED TO 1600 DEG F AND QUENCHED IN OIL AT 720 DEG F, OR WERE HEATED TO 1800 DEG F AND QUENCHED INTO NA AT 280-395 DEG F. SEVERE CRACKING WAS OBSERVED AFTER THE FIRST QUENCH, BUT THEY DID NOT DISINTERGRATE. REPEATED QUENCHING AND HEAT UP TO 1800 DEG F CAUSED CR SUB 23 C SUB 6 MODIFIED PELLET TO FALL APART.

ABSTRACT 576

REAVIS J G

NUCL MET , MET SOC AIME 17,809 (1970)

DIFFERENTIAL THERMAL ANALYSIS OBSERVATIONS OF U-PU DICARBIDES

THE UC SUB 2-PUC SUB 2 PSEUDOBINARY HAS BEEN STUDIED BY DIFFERENTIAL THERMAL ANALYSIS TECHNIQUE THROUGHOUT THE COMPOSITION RANGE UC SUB 2 TO PUC SUB 2. X-RAY POWDER DIFFRACTION AND METALLOGRAPHIC STUDIES WERE USED TO OBTAIN INFORMATION ABOUT STRUCTURES OF SPECIES PRESENT IN THE SYSTEM. TRANSFORMATIONS WERE OBSERVED AT 1660#10 DEG AND 2230#20 DEG IN PUC SUB 2 (+C) AND AT 1785#20 DEG AND 2480#20 DEG IN UC SUB 2 (+C).

ABSTRACT 577

REAVIS J G

PLUTONIUM 1970, P791

MELTING BEHAVIOR OF (U,PU) MONOCARBIDES

SOLIDUS AND LIQUIDUS TEMPERATURES WERE DETERMINED FOR (U,PU)C SOLID SOLUTIONS CONTAINING 0-50 M/O PUC. DIFFERENTIAL THERMAL ANALYSIS AND METALLOGRAPHIC TECHNIQUES WERE USED. SOLIDUS AND LIQUIDUS TEMPERATURES OF UC WERE 2520 AND 2540 DEG C, RESPECTIVELY. SOLIDUS AND LIQUIDUS TEMPERATURES OF UC-20% PUC WERE 2275 AND 2485 DEG , RESPECTIVELY.

ABSTRACT 578

REAVIS J G

TRANS AM NUCL SOC 10, 111 (1967)

PHASE RELATIONS IN THE HIGH-CARBON PORTION OF THE U-PU-C SYSTEM.

HIGH - TEMPERATURE DIFFERENTIAL THERMAL ANALYSIS, X-RAY POWDER DIFFRACTION, AND METALLOGRAPHIC TECHNIQUES WERE USED TO STUDY THE HIGH CARBON REGIONS OF THE PU-C AND U-PU-C SYSTEMS. LATTICE PARAMETERS OF DICARBIDES EQUILIBRATED WITH EXCESS CARBON AT HIGH TEMPERATURE ARE ALSO GIVEN. TRANSITIONS OBSERVED IN THE PU-C AND U-PU-C SYSTEMS ARE ALSO TABULATED.

ABSTRACT 579

REAVIS J G

6TH US/JAPAN CERAM FUELS INFORMATION EXCHANGE, SEATTLE, 1-3 (1970)

DIFFERENTIAL THERMAL ANALYSIS STUDIES OF TRANSFORMATIONS IN THE PU-C AND (U,PU)-C SYSTEMS

DIFFERENTIAL THERMAL ANALYSIS STUDIES OF TRANSFORMATIONS OF MIXED URANIUM- PLUTONIUM DICARBIDES AND OF MELTING BEHAVIOR OF SINGLE PHASE (U,PU)C COMPOSITIONS CONTAINING 0 - 50 MOLE % PUC HAVE BEEN COMPLETED. THERMAL ARREST TEMPERATURES AND LIQUIDUS TEMPERATURES HAVE BEEN DETERMINED IN THE PUC SYSTEM OVER THE RANGE PUC SUB 0.75 TO PUC SUB 2. THE HEAT OF FUSION OF U SUB 0.8 PU SUB 0.2 C IS CALCULATED TO BE 18 KCAL/MOLE WITH AN ESTIMATED UNCERTAINTY OF ± 5 KCAL/MOLE. THE HEAT OF THE PUC SUB 2 TO PU SUB 2 C SUB 3 + C TRANSFORMATION AT 1660 DEG C WAS FOUND TO BE 5 ± 1.5 KCAL/MOLE OF PUC SUB 2 BY COMPARISON OF DTA TRACES FOR PUC SUB 2 WITH THOSE FOR UC SUB 2 WHICH HAS A REPORTED A-B TRANSFORMATION HEAT OF 2.9 KCAL/MOLE.

ABSTRACT 580

REIMANN D K

J METALS 20, 544 (1968)

DIFFUSION OF ^{233}U IN UN AND UN SUB 2 SINGLE CRYSTALS

URANIUM SELF-DIFFUSION IN UN WAS MEASURED AT TEMPERATURES FROM 1100 TO 1600 C WITH A LOW NITROGEN OVERPRESSURE AND FROM 1420 TO 1830 C WITH A HIGH NITROGEN OVERPRESSURE. THE D SUB 0 AND ACTIVATION ENERGY FOR DIFFUSION CALCULATED RESPECTIVELY FOR THE LOW AND HIGH NITROGEN PRESSURES WERE $3.24 \times 10^{-7} \text{ CM}^2/\text{SEC}$ AND 60 KCAL/MOLE AND $7.54 \times 10^{-2} \text{ CM}^2/\text{SEC}$ AND 105 KCAL/MOLE .

ABSTRACT 581

REIMANN D K

J NUCL MATER 38,191 (1971)

CARBON SELF-DIFFUSION IN UN SUB 1+X

TRACER DIFFUSION OF ^{233}U INTO LARGE-GRAINED POLYCRYSTALLINE UN WAS INVESTIGATED BY THE ALPHA ENERGY DEGRADATION METHOD. THIS WAS A NON-DESTRUCTIVE TECHNIQUE IN WHICH THE DIFFUSION COEFFICIENT WAS DEDUCED FROM THE SHAPE OF THE ENERGY SPECTRUM OF THE ^{233}U ALPHA PARTICLES EMITTED FROM THE SURFACE OF THE SAMPLE AFTER DIFFUSION IN THE RANGES OF 1600 TO 1850 DEG C AND 0.1 TO 200 TORR NITROGEN OVERPRESSURE. THE DIFFUSION COEFFICIENT WAS A STRONG FUNCTION OF NITROGEN PRESSURE AND ALMOST INDEPENDENT OF TEMPERATURE AT A GIVEN NITROGEN PRESSURE. THESE RESULTS AND THOSE OF HOLT AND ALMASSY FOR NITROGEN DIFFUSION IN UN ARE IN

ABSTRACT 581 (CONT'D)

QUALITATIVE BUT NOT QUANTITATIVE ACCORD WITH A SIMPLE DEFECT CHEMISTRY CALCULATION.

ABSTRACT 582

RESHETNIKOV F G

PLUTONIUM 1965 P751 (1967)

PREPARATION AND STUDIES OF SOME PROPERTIES OF PLUTONIUM MONOCARBIDES

A STUDY OF THE PROCESSES USED TO PREPARE PLUTONIUM MONOCARBIDE BY THE INTERACTION OF PLUTONIUM HYDRIDE WITH CARBON AND TO FABRICATE IT INTO DENSE BODIES. INVESTIGATIONS HAVE INCLUDED EXAMINATION OF THE EFFECT OF NICKEL ADDITIONS ON THE DENSITY OF PLUTONIUM CARBIDE, AND THE INFLUENCE OF CARBON, THE CONTENT IN NICKEL DISTRIBUTION IN SINTERED PLUTONIUM CARBIDE SPECIMENS. THE THERMAL EXPANSION COEFFICIENT HAS BEEN MEASURED FOR PLUTONIUM CARBIDE. SOME DATA ARE GIVEN ON PLUTONIUM CARBIDE COMPATIBILITY WITH PROMISING STRUCTURAL MATERIALS.

ABSTRACT 583

RICE P A

SYMP THERMO NUCL MATER P331, (1962)

THERMODYNAMICS OF THE URANIUM-BISMUTH SYSTEM

IN A STUDY OF THE THERMODYNAMIC PROPERTIES OF A NUMBER OF THE INTERMETALLIC PHASES IN THE U-BI DIAGRAM AN OPTICAL ABSORPTION TECHNIQUE WAS USED AT 1018-1115 DEG K. THE FREE ENERGIES OF FORMATION, ENTHALPIES, AND ENTROPIES OF FORMATION OF UBI, U SUB 3 BI SUP 4, AND UBI SUB 2 WERE DETERMINED. IN ADDITION, BY CARRYING OUT THE DISSOCIATION OF UC IN A BI SOLUTION IN A GRAPHITE CRUCIBLE, THE FREE ENERGY OF FORMATION OF THE CARBIDE IN EQUILIBRIUM WITH GRAPHITE WAS DETERMINED. THE FREE ENRGY VALUES WERE GIVEN BY THE FOLLOWING EXPRESSIONS: UBI G SUB F = -12320 + 4.40T, U SUB 3 BI SUB 4 G SUB F = -12980 + 5.10T, AND UBI SUB 2 G SUB F = -11440 + 4.90T CAL/G ATOM. AT 773-1115 DEG K THE ACTIVITY COEFFICIENT OF U IN DILUTE SOLUTION IN BI WAS GIVEN BY: LOG Y = 2.670 - 5625/T. THE FREE ENERGY OF FORMATION OF UC WAS GIVEN AS -22000 CAL/MOLE OF U RELATIVE TO GRAPHITE AND PURE LIQUID U.

ABSTRACT 584

RICHARDS H K

NUCL TECHNOL 10, 54 (1971)

THERMAL EXPANSION OF URANIUM AND TANTALUM MONOCARBIDES UP TO 2700 DEG C

DATA ARE REPORTED FROM EXPERIMENTS PERFORMED TO MEASURE THERMAL EXPANSION OF URANIUM CARBIDE UP TO THE MELTING POINT, THE EXPANSION ACCOMPANYING THE TRANSITION FROM SOLID TO LIQUID, AND THERMAL EXPANSION IN THE LIQUID PHASE. THE THERMAL EXPANSION OF THE TANTALUM CARBIDE CRUCIBLES, USED TO HOLD THE URANIUM CARBIDE SPECIMENS, WAS ALSO MEASURED. EXPERIMENTS WERE PERFORMED USING A HIGH-TEMPERATURE, HELIUM-ATMOSPHERE, TUNGSTEN FILAMENT FURNACE. COMPATIBILITY TESTS SHOWED THAT TUNGSTEN- GRAPHITE AND TUNGSTEN-TANTALUM CARBIDE PAIRS FUSED TOGETHER AT APPROX 2500 DEG C OVER THE TIME SCALE NECESSARY FOR THE EXPANSION MEASUREMENTS. CHANGES IN THE LENGTH OF EACH EXPANSION SAMPLE WERE MEASURED BY DETECTING ELECTRICAL CONTACT BETWEEN THE SAMPLE AND A GRAPHITE ROD. FOR MEASUREMENTS IN WHICH THE URANIUM CARBIDE WAS MOLTEN, A TANTALUM CARBIDE DISK WAS PLACED AT THE

ABSTRACT 584 (CONT'D)

END OF THE GRAPHITE ROD TO PREVENT ATTACK OF THE SENSING ROD BY THE MOLTEN URANIUM CARBIDE. MELTING POINT OF THE URANIUM CARBIDE SAMPLES WAS 2550 DEG C. THE AVERAGE URANIUM CARBIDE LINEAR THERMAL EXPANSION FROM ROOM TEMPERATURE TO THE MELTING POINT IS 17×10^{-6} / DEG C. VOLUME EXPANSION UPON MELTING OF URANIUM CARBIDE IS 11.4%. A PROVISIONAL LINEAR THERMAL EXPANSION OF 53.2×10^{-6} / DEG C WAS MEASURED FOR MOLTEN URANIUM CARBIDE THERMAL EXPANSION BETWEEN 2650 AND 2740 DEG C.

ABSTRACT 585

RICHTER K

PROCEEDINGS OF IAEA SYMP ON FUEL AND FUEL ELEMENTS FOR FAST REACTORS
JULY 2-6, (1973)

PREPARATION OF HIGH-PERFORMANCE NON-OXIDE FUELS: FIRST RESULTS OF FAST FLUX EXPERIMENT DN-1

GENERAL DATA FOR CARBOTHERMIC REDUCTION PRESSURES ARE DISCUSSED (INFLUENCE OF STARTING MATERIAL, HOMOGENEITY, CONTROL OF DEGREE OF REACTION, ETC.). A SURVEY OF DIFFERENT PREPARATION METHODS INVESTIGATED AT THE EUROPEAN INSTITUTE FOR TRANSURANIUM ELEMENTS IS GIVEN FOR THE COMPOUNDS: MC SUB 0.9-0.7 N SUB 0.1-0.3; MC SUB 0.5 N SUB 0.5; MC SUB 0.2 N SUB 0.8. LIMITATIONS OF TEMPERATURE AND ATMOSPHERE FOR BOTH CARBOTHERMIC REDUCTION AND SINTERING ARE SUMMARIZED. PHYSICO-CHEMICAL CHARACTERISTICS OF REACTED AND SINTERED PRODUCTS ARE GIVEN. A SPECIAL PREPARATION PROCESS FOR MC SUB 0.7 N SUB 0.3 DEVELOPED AT THE INSTITUTE IS DESCRIBED AND THE RESULTS DISCUSSED. TO PROVE THE POTENTIAL OF THE ADVANCED FUELS, AN IRRADIATION EXPERIMENT OF MIXED CARBIDE, CARBONITRIDE AND NITRIDE FUELS AT 1250 W/CM IS UNDER WAY IN THE DOWNEY FAST REACTOR. THE REPORT SUMMARIZES THE FIRST RESULTS OF POST-IRRADIATION EXAMINATIONS ON THE LOW BURN-UP SERIES OF THIS EXPERIMENT. THE MOST STRIKING RESULT IS THE HIGH FISSION-GAS RELEASE MEASURED (60%), ESPECIALLY FOR (U,PU)C AND (U,PU)C SUB 0.5 SUB N SUB 0.5 FUEL.

ABSTRACT 586

RITCHIE E E

NAA-SR-10768 (1965)

NONEQUILIBRIUM URANIUM CARBIDE PHASE RELATIONSHIPS

BECAUSE THE SOLUBILITY OF URANIUM IN URANIUM MONOCARBIDE, AND THE VARIATION OF THIS SOLUBILITY WITH TEMPERATURE, MAY HAVE AN INFLUENCE ON THE HIGH-TEMPERATURE IRRADIATION BEHAVIOR OF HYPOSTOICHIOMETRIC URANIUM CARBIDE, A STUDY OF THE URANIUM-CARBON PHASE RELATIONSHIPS WAS PERFORMED. AS PART OF THE STUDY, EFFECTS OF RAPID COOLING FROM HIGH TEMPERATURES WERE INVESTIGATED. FUEL SPECIMENS, IN THE COMPOSITION RANGE OF 4.0-4.8 WT.% C, WERE HEAT TREATED AT 1300, 1600, AND 1800 DEG C, FOLLOWED BY RAPID (75 DEG C/S), MEDIUM (20 DEG C/S), AND SLOW (0.4 DEG C/S) COOLING RATES. SELECTED SPECIMENS WERE SUBSEQUENTLY VACUUM ANNEALED AT 650 AND 1000 DEG C FOR PERIODS UP TO 500 H. MICROSTRUCTURAL OBSERVATIONS INDICATED THAT THE METASTABLE DISTRIBUTION OF PHASES IS DEPENDENT ON HEAT TREATMENT, AND THAT MICROSTRUCTURAL CHANGES CAN OCCUR AT EXPECTED SERVICE TEMPERATURES. A TWO-PHASE GRAIN BOUNDARY STRUCTURE, OBSERVED IN BOTH AS-CAST AND HEAT-TREATED FUEL SAMPLES, WAS TENTATIVELY IDENTIFIED AS ALPHA URANIUM CONTAINING SMALL GRAINS OF UC SUB (1-X).

ABSTRACT 587

ROBINSON W C

J LESS COMMON METALS 10, 190 (1966)

REACTIONS OF URANIUM CARBIDE IN A KCL-LICL-ZINC SYSTEM

THE REACTIONS OF URANIUM MONOCARBIDE WITH LIQUID ZINC AND IN A KCL-LICL-ZNCL SUB 2/ZINC SYSTEM HAVE BEEN INVESTIGATED FOR THE TEMPERATURE RANGE 500-800 DEG C. AT TEMPERATURES ABOVE 725 DEG C THERE IS NO NOTICEABLE REACTION BETWEEN ZINC AND UC. AT TEMPERATURES BELOW 725 DEG C ONLY PARTIAL CONVERSION OF THE CARBIDE TO U SUB 2 ZN SUB 17 WAS OBSERVED AND A MONOCARBIDE RESIDUE REMAINED AT TEMPERATURES DOWN TO 500 DEG C. THE RESIDUE WAS SHOWN TO BE AN OXYGEN-STABILIZED CARBIDE PHASE, UO SUB X C SUB 1-X. THE OXYCARBIDE WAS FOUND TO EXIST IN EQUILIBRIUM WITH GRAPHITE AND NO EVIDENCE WAS OBSERVED FOR EITHER U SUB 2 C SUB 3 OR UC SUB 2 AS A REACTION- OR EQUILIBRIUM PRODUCT. EQUILIBRATIONS CARRIED OUT IN A KCL-LICL-ZNCL SUB 2/ZINC SYSTEM SHOWED THAT THE OXIDATION OF THE CARBIDE RESULTED IN THE FORMATION OF AN OXYCARBIDE IN EQUILIBRIUM WITH UO SUB 2. THE RELATIVE, PARTIAL MOLAL FREE ENERGY OF UC AT 700 DEG C IN THIS OXYCARBIDE WAS ESTIMATED TO BE -18.0 KCAL/MOLE.

ABSTRACT 588

ROSEN S

ANL-FGF-345 (1962)

THE URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SYSTEM

THE (U,PU)C PHASE FIELD OF THE U-PU-C TERNARY SYSTEM FOR TEMPERATURES BELOW 635 DEG C WAS CONSTRUCTED FROM METALLOGRAPHIC AND X-RAY DIFFRACTION DATA. URANIUM MONOCARBIDE FORMED A COMPLETE SERIES OF SOLID SOLUTIONS WITH PLUTONIUM MONOCARBIDE. THE (U,PU)C PHASE WAS STOICHIOMETRIC AS REGARDS ITS CARBON CONTENT IN A COMPOSITION RANGE FROM 0 TO 35 AT.% PU. WITH A FURTHER INCREASE IN PU CONTENT IT DEVIATED FROM IDEAL STOICHIOMETRY TOWARD GREATER METAL TO CARBON RATIOS TO FORM THE DEFECT (U,PU)C PHASE. PU EXPANDED THE UNIT CELL OF THE MONOCARBIDE OVER THE COMPOSITION RANGE IN WHICH IT RETAINED ITS STOICHIOMETRIC CHARACTER. IN THE REGION OF THE DEFECT STRUCTURE THE LATTICE PARAMETER DECREASED WITH INCREASING PU CONTENT, THE EXTENT OF THE DECREASE BEING DEPENDENT UPON THE CARBON CONTENT. METALLOGRAPHIC OBSERVATIONS ON CAST ALLOYS SHOWED THAT A TRANSITION OCCURS IN THE MICROSTRUCTURES BETWEEN U-RICH ALLOYS WHICH SHOW A HOMOGENEOUS CARBIDE PHASE AND PU-RICH ALLOYS WHICH SHOW A CORED CARBIDE PHASE.

ABSTRACT 589

ROSEN S

ANL-6435 (1964)

U-PU-C TERNARY PHASE DIAGRAM BELOW 50 ATOMIC PERCENT CARBON.

THE 400, 570, AND 635 DEG ISOTHERMAL SECTIONS OF THE U-PU-C SYSTEM WERE DETERMINED BY METALLOGRAPHIC, X-RAY DIFFRACTION, AND MELTING-RANGE TECHNIQUES. THE TERNARY SYSTEM IS CHARACTERIZED BY NEGLIGIBLE SOLID SOLUBILITY OF C IN THE BINARY PHASES, BY THE COMPLETE SERIES OF SOLID SOLUTIONS FORMED BETWEEN UC AND PUC, AND BY THE FACT THAT ALL THE BINARY PHASES COME INTO EQUILIBRIUM WITH (U,PU)C. ALL PHASE BOUNDARIES OTHER THAN THOSE OF THE MONOCARBIDE PHASE REPRESENT THE SIDES OF A 3-PHASE TIE-TRIANGLE WITH ONE SIDE COINCIDENT WITH EITHER THE U-PU OR THE PU-C BINARY SIDE AND AN OPPOSITE APEX TOUCHING THE PHASE BOUNDARY OF (U,PU)C. THE (U,PU)C PHASE IS STOICHIOMETRIC WITH REGARD TO C CONTENT IN THE RANGE 0-35 AT.% PU. AT HIGHER PU CONCENTRATION INCREASES THE LATTICE PARAMETER

ABSTRACT 589 (CONT'D)

OF THE MONOCARBIDE IN THE STOICHIOMETRIC REGION AND CAUSES IT TO DECREASE IN THE DEFECT REGION. THE MINIMUM ON THE LIQUIDUS OF THE U-PU BINARY DIAGRAM OCCURS AT 9 AT.% U AND 624 ± 2 DEG.

ABSTRACT 590

ROSEN S

J NUCL MATER 10, 90 (1963)

METALLOGRAPHIC AND X-RAY OBSERVATIONS OF PU-C ALLOYS

METALLOGRAPHIC, X-RAY DIFFRACTION AND INCIPIENT MELTING TECHNIQUES HAVE BEEN USED TO INVESTIGATE THE PU-C PHASE DIAGRAM BELOW 50 AT % C AND FOR TEMPERATURES BETWEEN 500 AND 1500 DEG C. THE VARIATION OF LATTICE PARAMETER WITH COMPOSITION FOR PU-C ALLOYS IS PRESENTED AND USED TO DEFINE PORTIONS OF THE LOW CARBON BOUNDARY OF THE PUC PHASE FIELD. UNIQUE MICROSTRUCTURAL CHARACTERISTICS ARE DETAILED FOR THE δ PU + PUC = PU SUB 3 C SUB 2 PERITECTOID REACTION, NAMELY THE PREFERENCE OF THE PU SUB 3 C SUB 2 PHASE TO GROW AS PLATELETS RATHER THAN AS AN INTERFACIAL ENVELOPE SURROUNDING THE PUC REACTANT. SOME ASPECTS OF CORING IN CAST ALLOYS CONTAINING THE MONOCARBIDE PHASE ARE DISCUSSED.

ABSTRACT 591

ROSEN S

J NUCL MATER 9, 137 (1963)

THE URANIUM MONOCARBIDE-PLUTONIUM MONOCARBIDE SYSTEM.

THE (U,PU)C PHASE FIELD OF THE U-PU-C TERNARY SYSTEM FOR TEMPERATURES BELOW 635 DEG C WAS CONSTRUCTED FROM METALLOGRAPHIC AND X-RAY DIFFRACTION DATA. URANIUM MONOCARBIDE FORMS A COMPLETE SERIES OF SOLID SOLUTIONS WITH PLUTONIUM MONOCARBIDE. THE (U,PU)C PHASE IS STOICHIOMETRIC AS REGARDS ITS CARBON CONTENT IN A COMPOSITION RANGE FROM 0 TO 35 AT.% PU. WITH A FURTHER INCREASE IN PU CONTENT IT DEVIATES FROM IDEAL STOICHIOMETRY TOWARD METAL-TO-CARBON RATIOS TO FORM THE DEFECT (U,PU)C PHASE. PU EXPANDS THE UNIT CELL OF THE MONOCARBIDE OVER THE COMPOSITION RANGE IN WHICH IT RETAINS ITS STOICHIOMETRIC CHARACTER IN THE REGION OF THE DEFECT STRUCTURE THE LATTICE PARAMETER DECREASES WITH INCREASING PU CONTENT, THE EXTENT OF THE DECREASE BEING DEPENDENT UPON THE C CONTENT. METALLOGRAPHIC OBSERVATIONS ON CAST ALLOYS SHOW THAT A TRANSITION IN THE MICROSTRUCTURES OCCURS AT ABOUT 10 AT.% PU. ALLOYS CONTAINING LESS PU SHOW A HOMOGENEOUS CARBIDE PHASE WHILE ALLOYS OF HIGHER PU CONTENT HAVE A CORED CARBIDE PHASE.

ABSTRACT 592

ROSEN S

NUCL MATER 9, 128 (1963)

THE U-PU-C TERNARY PHASE DIAGRAM BELOW 50 ATOMIC PERCENT CARBON

THE U-PU-C TERNARY PHASE DIAGRAM FOR THE COMPOSITION RANGE FROM 0 TO 50 AT.% CARBON AND FOR TEMPERATURE BELOW 635 DEG C WAS CONSTRUCTED FROM METALLOGRAPHIC, X-RAY DIFFRACTION, AND MELTING RANGE DATA. ISOTHERMAL SECTIONS AT 400, 570, AND 635 DEG C ARE PRESENTED AND CERTAIN FOUR PHASE REACTIONS ARE OUTLINED. URANIUM MONOCARBIDE FORMS A COMPLETE SERIES OF SOLID SOLUTIONS WITH PLUTONIUM MONOCARBIDE. ALL PHASE BOUNDARIES OTHER THAN OF THE MONOCARBIDE PHASE REPRESENT THE SIDES OF THREE-PHASE

ABSTRACT 592 (CONT'D)

TIE-TRIANGLES, WHICH HAVE ONE SIDE COINCIDENT WITH EITHER THE U-PU OR THE PU-C BINARY SIDE AND HAVE THE OPPOSITE APEX TOUCHING THE PHASE BOUNDARY OF THE MONOCARBIDE SOLID SOLUTION, (U,PU)C. THE METAL: CARBON STOICHIOMETRY OF THE MONOCARBIDE IS INFLUENCED BY THE U: PU RATIO.

ABSTRACT 593

ROTHMAN A J

UCID-15135 PT 1 (1967)

CONTRIBUTION TO THE 24TH MEETING OF THE HIGH-TEMPERATURE FUELS COMMITTEE, MAY 16-18, 1967

THIS SUMMARY REPORTS HIGHLIGHTS OF ONGOING WORK TO DEVELOP UN AS A NUCLEAR FUEL. N SUB 2-SELF DIFFUSION DATA WAS REPORTED AND THE CREEP PROGRAM WAS DESCRIBED.

ABSTRACT 594

ROTHMAN A J

UCID-15238, PT 1 (1967)

CONTRIBUTION TO THE 25TH MEETING OF THE HIGH-TEMPERATURE FUELS COMMITTEE, DEC 5-7, 1967.

AS PART OF THE DEVELOPMENT OF UN AS A NUCLEAR FUEL DIFFUSION AND GRAIN GROWTH STUDIES WERE CARRIED OUT. THIS REPORT PRESENTS A SUMMARY OF HIGHLIGHTS.

ABSTRACT 595

ROUGH F A

BMI-1441 (1960)

AN EVALUATION OF DATA ON NUCLEAR CARBIDES

AVAILABLE DATA ON THE PHYSICAL AND MECHANICAL PROPERTIES, CONSTITUTION, COMPATIBILITY, AND RADIATION BEHAVIOR AND ON FABRICATION METHODS FOR URANIUM, THORIUM, AND PLUTONIUM CARBIDES WERE REVIEWED. VERY INCOMPLETE DATA ON THORIUM AND PLUTONIUM CARBIDES WERE LOCATED. ONLY LIMITED DATA ON THE PHYSICAL AND MECHANICAL PROPERTIES OF URANIUM CARBIDES WERE DISCOVERED. NO INFORMATION ON HIGH-TEMPERATURE MECHANICAL PROPERTIES WAS FOUND. CONSIDERABLE INFORMATION CONCERNING THE CONSTITUTION OF THE CARBIDES WAS OBTAINED, HOWEVER, AND TERNARY DIAGRAMS WERE CONSTRUCTED. THE INCOMPLETE DATA ON THE COMPATIBILITY AND CORROSION BEHAVIOR OF THE CARBIDES THAT WERE FOUND IN THE LITERATURE WERE SUPPLEMENTED BY THERMODYNAMIC CALCULATIONS FOR VARIOUS POSSIBLE REACTIONS WITH COOLANTS AND CLADDINGS. AVAILABLE INFORMATION ON PREPARATION OF BULK CARBIDES WAS REVIEWED AND DATA ON THERMODYNAMICS, PREPARATION BY CHEMICAL REACTIONS, MELTING AND CASTING, SOLID-PHASE FABRICATION, AND STORAGE AND HANDLING WERE ASSEMBLED. SOME INFORMATION ON THE EFFECTS OF IRRADIATION OF CAST URANIUM MONOCARBIDE TO BURNUPS OF UP TO 1.7 A/C OF THE URANIUM WAS COLLECTED AND EVALUATED. THE RESULTS OF THE SURVEY INDICATE THAT COMMERCIAL PRODUCTION OF BULK URANIUM CARBIDE IS FEASIBLE AND THAT, ON THE BASIS OF ITS RADIATION BEHAVIOR, THIS MATERIAL HAS EXCELLENT POTENTIAL AS A REACTOR FUEL.

ABSTRACT 596

ROUGH F A

BMI-1554 (1961)

PROGRESS ON DEVELOPMENT OF URANIUM CARBIDE TYPE FUELS

THE MEASUREMENT OF MECHANICAL AND PHYSICAL PROPERTIES OF URANIUM-CARBON ALLOYS WAS THE PRIME CONCERN. OF PARTICULAR INTEREST WERE STRENGTH, HARDNESS, THERMAL EXPANSION, ELECTRICAL RESISTIVITY, AND THERMAL CONDUCTIVITY MEASURED AT ROOM AND ELEVATED TEMPERATURES. THE DIFFUSION COEFFICIENTS WERE OBTAINED FOR SELF-DIFFUSION OF CARBON AND URANIUM IN URANIUM MONOCARBIDE. MEASUREMENTS OF PROPERTY CHANGES SUCH AS ELECTRICAL RESISTIVITY, LATTICE EXPANSION, AND ELASTIC STRAIN AS A FUNCTION OF IRRADIATION EXPOSURE AND TEMPERATURE WERE MADE.

ABSTRACT 597

ROUTBORT J L

J NUCL MATER 40:17 (1971)

ADIABATIC ELASTIC CONSTANTS OF URANIUM MONOCARBIDE

USING THE PHASE-COMPARISON TECHNIQUE, THE ROOM-TEMPERATURE ADIABATIC ELASTIC CONSTANTS OF UC SINGLE CRYSTALS GROWN BY THE RADIO-FREQUENCY, INDUCTION-HEATED FLOATING-ZONE TECHNIQUE HAVE BEEN MEASURED AS A FUNCTION OF CARBON COMPOSITION (4.52-4.96 WT % C). THE TEMPERATURE DEPENDENCE OF THE MODULI WAS MEASURED FROM 80 TO 900 DEG K IN A HYPOSTOICHIOMETRIC SAMPLE. THERE IS A SYSTEMATIC INCREASE OF C_{44} WITH INCREASING CARBON CONCENTRATION. THE ELASTIC-MODULI VALUES ARE COMPARED WITH PUBLISHED VALUES FOR SOME ALKALI HALIDES AND REFRACTORY METAL MONOCARBIDES. AN INCREASE IN TEMPERATURE RESULTS IN A LINEAR DECREASE IN C_{11} AND C'_{11} , BUT C_{44} INCREASES WITH TEMPERATURE TO A MAXIMUM AT 80 DEG C. THE TEMPERATURE COEFFICIENTS OF THE MODULI AT $T > 80$ DEG C ARE COMPARABLE TO THOSE OBSERVED IN THE ALKALI HALIDES. THESE RESULTS INDICATE THAT THE IONIC CRYSTAL CHARACTER OF THE INTERATOMIC BONDS INCREASES WITH TEMPERATURE AND THAT THE CARBON CONCENTRATION IN THE UC PHASE CAN DEVIATE FROM STOICHIOMETRIC COMPOSITION.

ABSTRACT 598

ROUTBORT J L

J NUCL MATER 44:24 (1972)

HIGH-TEMPERATURE DEFORMATION OF POLYCRYSTALLINE URANIUM CARBIDE

THE PROPORTIONAL LIMIT σ_p OF ARC-CAST HYPOSTOICHIOMETRIC (4.60 WT % C) AND ARC-CAST HYPERSTOICHIOMETRIC (5.00 WT % C) URANIUM CARBIDE WAS MEASURED IN COMPRESSION IN THE TEMPERATURE RANGES 700 TO 1300 DEG C AND 1120 TO 1600 DEG C AT A STRAIN RATE OF APPROX 3×10^{-5} SEC $^{-1}$. THE PROPORTIONAL LIMIT IS STRONGLY DEPENDENT ON COMPOSITION, ITS MAGNITUDE FOR UC SUB 1+X BEING MUCH GREATER THAN FOR UC SUB 1-X. YIELDING IN UC IS THERMALLY ACTIVATED SINCE THE PROPORTIONAL LIMIT DEPENDS EXPONENTIALLY ON THE INVERSE OF THE ABSOLUTE TEMPERATURE FOR BOTH UC SUB 1-X AND UC SUB 1+X, EXCEPT IN THE CASE OF UC SUB 1-X AT $T < 1130$ DEG C, WHEN FREE URANIUM MELTS AND APPARENTLY FACILITATES GRAIN-BOUNDARY SEPARATION. THE APPARENT ACTIVATION VOLUME AND SENSITIVITY OF THE STRAIN RATE TO STRESS WERE MEASURED BY PERFORMING STRESS-RELAXATION TESTS. THE RESULTS SUGGEST THAT THERE IS A GOOD CORRELATION BETWEEN THE HIGH INITIAL YIELDING IN UC SUB 1+X COMPARED TO UC SUB 1-X AND THE MAGNITUDE OF THE INTERNAL STRESSES.

ABSTRACT 599

ROUTHBORT J L
LIBBY-COCKCROFT MEETING, ANL (1970)
ELASTIC CONSTANTS AND FRACTURE OF UC

ELASTIC MODULI OF UC SINGLE CRYSTALS HAVE BEEN MEASURED BY THE PHASE COMPARISON TECHNIQUE FROM 80 TO 900 DEG K AS A FUNCTION OF STOICHIOMETRY (4.52 TO 4.96 WT % C).

ABSTRACT 600

RUDY E
THERMO NUCL MATER 243 (1962)
THERMODYNAMICS OF HIGH-MELTING URANIUM AND THORIUM COMPOUNDS.

AN IMPORTANT FACTOR IN THE CHOICE OF MATERIALS FOR USE AS FUEL INSERTS IN HIGH-TEMPERATURE REACTORS IS THEIR COMPATIBILITY TOWARDS THE IMMEDIATE SURROUNDING AT OPERATING CONDITIONS. MUCH OF THE THERMODYNAMICAL DATA OF INTERESTING PHASES KNOWN AT PRESENT ARE NOT RELIABLE OR HAVE NOT YET BEEN DETERMINED. THIS IS PARTLY DUE TO THE GREAT EXPERIMENTAL DIFFICULTIES INVOLVED IN DIRECT HIGH-TEMPERATURE CALORIMETRIC MEASUREMENTS. EXPERIMENTAL DETERMINED PHASE EQUILIBRIA PROVIDE A GOOD MEANS IN DERIVING FREE ENERGIES OF FORMATION OF CERTAIN COMPOUNDS. THE BASIC EQUATIONS FOR SETTING UP PHASE EQUILIBRIA IN MULTICOMPONENT SYSTEMS ARE DERIVED BY MEANS OF THE LAGRANGIAN THEOREM, USING THE POSTULATE OF THE MINIMUM OF THE INTEGRAL FREE ENERGY. THE RESULTING EQUATIONS ARE APPLIED TO VARIOUS TERNARY URANIUM AND THORIUM SYSTEMS (E.G. U-ZR-C, U-HF-C, U-NB-C, U-TA-C, U-MO-C, U-W-C, TH-U-C, TH-ZR-C, TH-MO-C, TH-W-C) AND THE DATA OBTAINED ARE COMPARED WITH THE VALUES GIVEN IN THE LITERATURE. THE DATA, AS DERIVED FROM PHASE RELATIONSHIPS, MAY BE USED TO PREDICT PHASE EQUILIBRIA IN MULTICOMPONENT SYSTEMS AND THE CHANGE OF EQUILIBRIA WITH TEMPERATURE, THEREFORE SIGNIFICANTLY FACILITATING THE CHOICE OF PROPER ALLOY COMBINATIONS FOR THE DESIRED PURPOSE OR FOR INTENDED EXPERIMENTAL INVESTIGATIONS.

ABSTRACT 601

RUNDLE R W
J AM CHEM SOC 70, 998 (1948)
THE STRUCTURES OF THE CARBIDES NITRIDES AND THE OXIDES OF URANIUM

1. URANIUM MONOCARBIDE IS FACE-CENTERED CUBIC, $A = 4.951 \text{ \AA}$, AND HAS THE SODIUM CHLORIDE-TYPE STRUCTURE. URANIUM DICARBIDE IS BODY-CENTERED TETRAGONAL, $A = 3.517 \text{ \AA}$, $C = 5.987 \text{ \AA}$, AND HAS THE CALCIUM CARBIDE STRUCTURE. CARBON IS SOLUBLE IN THE DICARBIDE AT HIGH TEMPERATURES, AND THE DICARBIDE DECOMPOSES INTO THE MONOCARBIDE AND CARBON AT INTERMEDIATE TEMPERATURES. URANIUM SESQUICARBIDE PROBABLY EXISTS AT TEMPERATURES ABOVE 2000 DEG. IT DOES NOT EXIST AT ROOM TEMPERATURE. 2. URANIUM MONONITRIDE IS FACE-CENTERED CUBIC, $A = 4.880 \text{ \AA}$, AND HAS THE SODIUM CHLORIDE-TYPE STRUCTURE. URANIUM SESQUINITRIDE IS BODY-CENTERED CUBIC, $A = 10.678 \text{ \AA}$, AND HAS THE MANGANESE SESQUIOXIDE STRUCTURE. THE URANIUM SESQUINITRIDE STRUCTURE GRADUALLY CHANGES TOWARD THE IDEAL DINITRIDE STRUCTURE IN A ONE PHASE REGION EXTENDING TO THE COMPOSITION $\text{UN}_{1.75}$. HIGH PRESSURE IS NEEDED TO FORM THE DINITRIDE WHICH IS FACE-CENTERED CUBIC, $A = 5.31 \text{ \AA}$, AND HAS THE FLUORITE STRUCTURE.

ABSTRACT 602

RUSSELL L E

PROGR NUCL ENERGY SER IV 4, 147 (1961)

PLUTONIUM CERAMICS AS NUCLEAR FUELS

PLUTONIUM CERAMIC FUEL DEVELOPMENT WORK IS REVIEWED. THIS IS A LOGICAL EXTENSION OF WORK ON URANIUM-BASED CERAMICS WHEN IT IS CONSIDERED THAT ALL REACTORS NOW IN OPERATION CONTAINING URANIUM-238 ARE PRODUCING PLUTONIUM. THE MOST EFFICIENT UTILIZATION OF PLUTONIUM CERAMICS, WHETHER IN THERMAL OR FAST REACTOR, WILL DEPEND ON THE COST OF PLUTONIUM RELATIVE TO URANIUM-235, AND ON THE BEHAVIOR OF THE HIGHER ISOTOPES OF PLUTONIUM IN NEUTRON FLUXES OF FAST OR THERMAL ENERGIES. CARBIDE-BASED FUELS MAY HAVE THERMAL CONDUCTIVITIES UP TO FIVE TIMES GREATER THAN THE OXIDES, A FACT IMPORTANT FOR FAST REACTORS. PHASE DIAGRAMS, STRUCTURE, AND OTHER PROPERTIES ARE PRESENTED.

ABSTRACT 603

RUSSELL L E

AERE-4330 (1963)

THE STRUCTURE AND PROPERTIES OF U-C AND (U,PU)-C ALLOYS

THE FOLLOWING SUBJECTS ARE DISCUSSED: THE U-PU-C SYSTEM; SOLUBILITY OF OXYGEN AND NITROGEN IN UC AND (U,PU)-C; THERMAL CONDUCTIVITY OF U-C AND (U,PU)-C; THERMAL EXPANSION OF U-C, PU-C AND (UO_{0.85}PUO_{0.15})C; THERMAL SHOCK RESISTANCE.

ABSTRACT 604

RUSSELL L E

PROC THE CONF NUCL MATER TECH, P409 (1963)

THE STRUCTURE AND PROPERTIES OF U-C AND (UPU)-C ALLOYS

STUDIES OF THE U-PU-C SYSTEM BETWEEN 50 AND 60 WT.% C HAVE BEEN CARRIED OUT OVER THE TEMPERATURE RANGE 1500-2100 DEG C USING CERAMOGRAPHIC AND X-RAY TECHNIQUES. THE EXISTENCE OF COMPLETE SOLID SOLUBILITY BETWEEN U SUB 2 C SUB 3 AND PU SUB 2 C SUB 3 HAS BEEN ESTABLISHED. IT HAS BEEN SHOWN THAT THE DECOMPOSITION TEMPERATURE FOR M SUB 2 C SUB 3=MC+MC SUB 2 INCREASES WITH THE INCREASE OF PU CONTENT OVER THE RANGE 0-30 MOL.%PU SUB 2 C SUB 3. THE EQUILIBRIUM PHASES PRESENT BELOW 1700 DEG C ARE MC+M SUB 2 C SUB 3 BUT CONSIDERABLE SEGREGATION OF PU AND U HAS BEEN OBSERVED IN MELTED AND QUENCHED ALLOYS. THE SOLUBILITY OF OXYGEN IN THE MONOCARBIDES TO FORM MC SUB (1-X) O SUB X PHASES HAS BEEN STUDIED BY HEAT TREATING 1+C+UO SUB 2 IN VACUO AND BY HEAT TREATING OXIDIZED MC POWDERS IN FLOWING HIGH-PURITY ARGON ATMOSPHERES. THE MAXIMUM SOLUBILITY CORRESPONDS TO 0.25<X<0.935 AND THIS SOLUTION, WHICH APPEARS TO BE UNAFFECTED BY VARIATIONS IN TEMPERATURE BETWEEN 1100 AND 1600 DEG C, IS ACCOMPANIED BY A DECREASE IN LATTICE PARAMETER TO 4.949 A. THE AMOUNT OF OXYGEN WHICH CAN BE DISSOLVED BY HEAT TREATMENT IN ARGON IS SMALL AND OF THE ORDER OF 0.2-0.3 WT.%. SOLUTION OF THE FIRST SMALL AMOUNTS OF OXYGEN IN HYPOSTOICHIOMETRIC M-C IS ACCOMPANIED BY AN INCREASE IN LATTICE PARAMETER. THE STABILITY OF MC PHASES HEATED IN NITROGEN DEPENDS ON THE PARTIAL PRESSURE OF NITROGEN IN THE HEAT TREATMENT ATMOSPHERES. NO INCREASE IN NITROGEN CONTENT OCCURS IN ALLOYS HEATED AT 1500 DEG C IN ARGON CONTAINING .5.PPM N SUB 2 BUT WHEN THE N SUB 2 CONCENTRATION IS >0.05 ATM THERE IS COMPLETE CONVERSION TO MONONITRIDE WITH THE PRECIPITATION OF FREE CARBON. VARIATIONS IN THE THERMAL CONDUCTIVITY AND THERMAL EXPANSION OF U-C AND (U SUB 0.85 PU SUB 0.15)-C ALLOYS AT 70 DEG C HAVE BEEN STUDIED AS A FUNCTION OF THE CARBON CONTENTS AND THE METHOD OF

ABSTRACT 604 (CONT'D)

MANUFACTURE. THE THERMAL EXPANSION OF THESE MONOCARBIDES IS NOT SIGNIFICANTLY AFFECTED BY VARIATIONS IN THE CONTENT OF PUC, AT 0 AND 15 MOL.%, OR BY VARIATIONS IN THE C OR OXYGEN CONTENT OR THE METHOD OF FABRICATION. THE THERMAL CONDUCTIVITY OF THE PU-CONTAINING ALLOYS IS LOWER THAN THAT OF THE CORRESPONDING U-C ALLOYS AND THE MAXIMUM CONDUCTIVITY IN BOTH CASES IS FOUND IN ALLOYS CONTAINING CLOSE TO THE STOICHIOMETRIC AMOUNT OF CARBON.

ABSTRACT 605

RUSSELL W D

BMI-1469 (1960)

PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING SEPTEMBER 1960

THE STUDY OF POSSIBLE REACTIONS INDUCED BY THE APPLICATION OF HIGH PRESSURES AT HIGH TEMPERATURES WAS CONCENTRATED ON U SUB 3 O SUB 8 - AL SUB 2 O SUB 3. DATA ARE REPORTED ON THE EFFECTS OF TEMPERATURE ON THE TENSILE PROPERTIES OF FULLY RECRYSTALLIZED CR-NB, NB-V, NB-ZR, AND CR-NB-ZR ALLOYS. THE EFFECT OF RADIATION ON THE CREEP PROPERTIES OF ZIRCALOY-2 AT ELEVATED TEMPERATURES IS BEING STUDIED. MAGNESIUM OXIDES ARE BEING EVALUATED AS A FUEL MATRIX MATERIAL FOR URANIUM DIOXIDE. SPECIMENS OF NIOBIUM-BASE BINARY ALLOYS CONTAINING 10, 20, AND 30 WT.%, URANIUM AND TERNARY ALLOYS CONTAINING 20 WT.% URANIUM WITH 10 OR 20 WT.% ZR WERE PREPARED WITH ENRICHED URANIUM FOR IRRADIATION TESTS. PU-NB, PU-TH, MO-PU-U, AND NB-PU-U ALLOYS WERE SELECTED AS CANDIDATES IN THE SEARCH FOR IMPROVED IRRADIATION RESISTANCE. SPECIMENS CONSISTING OF URANIUM NITRIDE DISPERSED IN C, CR, FE, MO, NB, TA, TI, W, AND ZR WERE FABRICATED AND HEAT-TREATED TO EVALUATE COMPATIBILITY. A SUMMARY OF RESULTS IS PRESENTED FROM 3 HR, 1430 DEG C, 5 TSI HYDROSTATIC PRESSINGS OF VARIOUS TYPES OF URANIUM CARBIDE AND U-C- NB SYSTEMS. THE EFFECTS OF HEAT-TREATMENT ON SOME PROPERTIES OF U-C SYSTEMS ARE PRESENTED. DATA ARE PRESENTED ON THE CORROSION RESISTANCE OF UC-MO SUB 2C, UC-NBC, UC- TIC, UC-VC, UC-ZRC-MO SUB 2C, AND UC-ZRC-VC TO SANTOWAX P AT 350 DEG C FOR 7 DAYS. THE DEVELOPMENT OF POWDER METALLURGY AND MELTING AND CASTING TECHNIQUES FOR URANIUM NITRIDES IS REPORTED. CREEP AND STRESS-RUPTURE TESTS ARE REPORTED ON ZIRCALOY-2 SHEET SPECIMENS. FISSION GAS RELEASE EXPERIMENTS ARE REPORTED ON FUELED-GRAPHITE SPHERES IN SUPPORT OF THE PEBBLE-BED REACTOR. IN THE DEVELOPMENT OF CONTAINER MATERIALS FOR LAMPRE APPLICATIONS, THE FABRICATION BEHAVIOR OF 13 BINARY TANTALUM-BASE ALLOYS WAS INVESTIGATED. RADIATION-EFFECTS STUDIES OF FUEL SPECIMENS OF UO SUB 2 DISPERSED IN BEO AND AL SUB 2 O SUB 3 AND UC AND UC SUB 2 DISPERSED IN GRAPHITE ARE REPORTED. STUDIES ARE BEING CONDUCTED TO DEVELOP AN INSTRUMENTED FUEL PLATE FOR IRRADIATION IN THE SM-1 AND TO DEVELOP FUEL, ABSORBER, AND SUPPRESSOR MATERIALS FOR THE SM-2. A PROCESS IS BEING INVESTIGATED FOR THE FABRICATION OF DENSE BEO-UN SUB 2 FUEL PELLETS BY COLD PRESSING AND SINTERING. A PROGRAM TO STUDY THE EFFECTS OF IRRADIATION ON HASTELLOY-X-CLAD COMPACTS OF HIGHLY ENRICHED UN SUB 2 IS IN PROGRESS. THORIUM SAMPLES WERE NICKEL PLATED FOR CORROSION TESTING UNDER ATMOSPHERIC CONDITIONS AND IN WATERSATURATED AIR AT 120 AND 200 DEG F. DATA ARE REPORTED ON THE CORROSION OF THORIUM, URANIUM, AND U-10 WT.% MO ALLOY UNDER THREE TYPES OF CONDITIONS.

ABSTRACT 606

SANDENAW T A

NUCL MET, MET SOC AIME 17, 104 (1970)

LOW-TEMPERATURE HEAT-CAPACITY OF PUC SUB 0.81

THE COMPOSITION PUC SUB 0.81 PLACES IT CLOSE TO THE LOWER C/PU ATOM RATIO PHASE BOUNDARY AND MOST RUNS APPEAR TO BE REPRESENTATIVE OF AN IRREPRODUCIBLY VARYING PHASE MIXTURE OF PUC AND PU SUB 3 C SUB 2 AND/ OR TRACES OF PU METAL. EASE IN CROSSING THE PHASE BOUNDARY ON COOLING BELOW ROOM TEMPERATURE MAY BE ATTRIBUTED IN PART TO RADIOACTIVE DECAY ENERGY AND ALSO IN PART TO THE PROPERTIES OF NON-STOICHIOMETRIC COMPOUNDS. THE HEAT CAPACITY DATA INDICATES THAT PUC SUB 0.81 IS SINGLE PHASE AT ROOM TEMPERATURE UNDER SOME CONDITIONS AND BECOMES SINGLE PHASE ABOVE 320 K UNDER MOST PROCESSING CONDITIONS. A PUBLISHED CORRELATION BETWEEN LATTICE PARAMETER AND MAGNETIC SUSCEPTIBILITY BEHAVIOR EXPLAINS THE ABSENCE OF HEAT CAPACITY PEAKS IN RAPIDLY QUENCHED PUC SUB 0.81. COOLING IN A 300 OE FIELD ONLY EFFECTS HEAT CAPACITY VALUES BELOW 75 K. THERMODYNAMIC PROPERTY VALUES AT 299 K ARE VERY CLOSE TO PREVIOUSLY MADE ESTIMATES. A COMPARISON OF THE LOW TEMPERATURE HEAT CAPACITY CURVES OF UC (WESTRUM ET AL), NPC SUB 0.89 AND PUC SUB 0.81 IS SHOWN.

ABSTRACT 607

SAND T

THERMO NUCL MATER P301 (1967)

THE STABLE COMPOSITION RANGE AND DECOMPOSITION PRESSURE OF UC-UN SOLID SOLUTION

THE OBJECT WAS TO CLARIFY THE EFFECT OF TEMPERATURE AND NITROGEN PRESSURE ON THE COMPOSITION RANGE AND TO DETERMINE THE DECOMPOSITION PRESSURE OF UC SUB 1-X N SUB X AS A FUNCTION OF TEMPERATURE AND X. A POWDERED SAMPLE, UC OR UC SUB 1-X N SUB X WITH THE VALUES OF X 0.35, 0.50, OR 0.90, WAS PLACED ON A TUNGSTEN SHEET HEATED BY RESISTANCE IN A CONTROLLED PRESSURE CHAMBER. AFTER HEATING A SAMPLE TO ABOUT 1600 DEG C IN VACUO, PURIFIED NITROGEN WAS ADMITTED TO THE DESIRED PRESSURE. TEMPERATURE WAS THEN INCREASED RAPIDLY TO THE CHOSEN TEMPERATURE BETWEEN 1600 DEG C AND 2500 DEG C, WHERE THE SAMPLE WAS HELD FOR TEN MINUTES. LATTICE PARAMETERS WERE OBTAINED FROM X-RAY DIFFRACTION DATA FOR THE SOLID SOLUTIONS COOLED QUICKLY TO ROOM TEMPERATURE FROM SEVERAL TEMPERATURES ABOVE 1600 DEG C. THE LATTICE PARAMETERS VARY WITH PRESSURE OF NITROGEN AND COMPOSITION OF STARTING SOLID SOLUTION, BUT THEY ARE NEARLY INDEPENDENT OF THE TEMPERATURE AT WHICH THE SOLID SOLUTIONS HAD BEEN HELD. THE DECOMPOSITION TEMPERATURE OF UC, UC SUB 1-X N SUB X OR UN WAS DETERMINED IN THE TEMPERATURE RANGE 2000-2500 DEG C BY OBSERVING THE APPARENT MELTING POINT. THERMODYNAMIC DISCUSSIONS HAVE BEEN MADE FOR THE DECOMPOSITION OF UC SUB 1-X N SUB X ON THE BASIS OF THE EXPERIMENTAL RESULTS.

ABSTRACT 608

SARIAN S

BULL AM CERAM SOC 366 (1974)

SOME CONSIDERATIONS OF ATOMISTIC MECHANISMS RATE-CONTROLLING MASS TRANSPORT IN URANIUM CARBIDES I: STEADY STATE CREEP

SELF-DIFFUSION KINETICS AND MECHANISMS, STEADY-STATE CREEP RATES, AND THE DEFECT STRUCTURES OF URANIUM CARBIDES ARE REVIEWED AND DISCUSSED. IT IS SHOWN THAT THE CREEP IS RATE-CONTROLLED BY CARBON VACANCY DIFFUSION REGARDLESS OF THE CARBON-TO-URANIUM RATIO; THE ATOMISTIC MECHANISM SEEMS TO INVOLVE THE UNPINNING OF SHOCKLEY PARTIAL DISLOCATIONS BY THE

ABSTRACT 608 (CONT'D)

DIFFUSION OF C SUB 2 GROUPS AND SINGLE CARBON ATOMS FROM OCTAHEDRAL SITES IN THE CARBON SUB-LATTICE. WHEN THE COMPOSITION IS HYPOSTOICHIOMETRIC, THE CARBON VACANCIES ARE CONSTITUTIONAL. ON THE OTHER HAND, WHEN THE COMPOSITION IS STOICHIOMETRIC OR HYPERSTOICHIOMETRIC THE CARBON VACANCIES MUST BE FORMED THROUGH SCHOTTKY DISORDER; THE CARBON VACANCY FORMATION ENERGY IS ABOUT 45 KCAL/MOLE. THE CREEP RATE OF STOICHIOMETRIC URANIUM CARBIDE IS PROPORTIONAL TO $\exp(-130,000/RT)$; THE CREEP ACTIVATION ENERGY EQUALS THE ENERGY OF FORMATION AND MOTION OF CARBON VACANCIES. THE CREEP RATE OF HYPERSTOICHIOMETRIC UC SUB X INCREASES WITH INCREASING VALUES OF THE CARBON-TO URANIUM RATIO. THIS BEHAVIOR CAN BE EXPLAINED BY A DIFFUSION MECHANISM WHICH INVOLVES THE CONCERTED MOTION OF C SUB 2 GROUPS, SINGLE CARBON ATOMS, AND THERMALLY ACTIVATED CARBON VACANCIES. CREEP RATE-CONTROL BY A NABARRO-HERRING TYPE MECHANISM MUST BE GOVERNED BY URANIUM DIFFUSION; HOWEVER, A DIFFUSIONAL CREEP IS UNLIKELY TO OCCUR AT THE LOW TEMPERATURES IN QUESTION (I.E., $T < 1600$ DEG C).

ABSTRACT 609

SARTAN S

BULL AM CERAM SOC 366 (1974)

SOME CONSIDERATIONS OF ATOMIC MECHANISMS RATE-CONTROLLING MASS TRANSPORT IN URANIUM CARBIDES II. SINTERING AND RELATED PHENOMENA

PUBLISHED SINTERING DATA FROM, CARBIDES IN NUCLEAR ENERGY VOL 2, EDS. L.E. RUSSELL ET AL. (MCMILLAN AND CO., LTD., LOND. 1964), IS USED TO SHOW THAT THEY SUPPORT A SINTERING MECHANISM THAT IS CONTROLLED BY U VACANCY BULK DIFFUSION.

ABSTRACT 610

SARTAN S

J NUCL MATER 48, 351 (1973)

URANIUM SELF-DIFFUSION IN STOICHIOMETRIC URANIUM MONOCARBIDE

URANIUM-233 SELF-DIFFUSION WAS STUDIED IN STOICHIOMETRIC URANIUM MONOCARBIDE; THE DIFFUSION COEFFICIENTS CAN BE REPRESENTED BY THE EXPRESSION $D_{\text{SUB U}} = 2.58 \times 10^{-13} \exp(-157000/RT)$ CM²/SEC IN THE TEMPERATURE RANGE FROM 1900 TO 2260 DEG C. SELF-DIFFUSION OF URANIUM AND CARBON, IN STOICHIOMETRIC AND HYPOSTOICHIOMETRIC URANIUM CARBIDES OCCURS BY A VACANCY MECHANISM. IT IS SHOWN THAT THE KINETICS AND MECHANISM ARE SIMILAR TO THOSE FOR SELF-DIFFUSION IN THE GROUP IVB AND VB TRANSITION ELEMENT MONOCARBIDES; FOR THESE B1 (FCC) TYPE CARBIDES IN GENERAL, THE ACTIVATION ENERGY FOR DIFFUSION IS EMPIRICALLY CORRELATED TO THE CONGRUENT MELTING TEMPERATURE: FOR CARBON $\partial H_{\text{SUB M}} \text{ APPROX} = 31 \cdot (T_{\text{SUB M}})$ AND FOR THE METAL, $(\partial H_{\text{SUB F}} + \partial H_{\text{SUB M}}) \text{ APPROX} = 54 \cdot (T_{\text{SUB M}})$. IN ADDITION, THE ACTIVATION ENTROPIES CORRELATE WELL TO THE TEMPERATURE DERIVATIVE OF THE SHEAR MODULUS; THIS BEHAVIOR IS CONSISTENT WITH THE FAMILIAR ZENER MODEL. MICROSTRUCTURAL EFFECTS HAVE PROBABLY BEEN THE PRINCIPAL UNDERLYING CAUSE OF THE PREPONDERANT DISCORDANCE IN THE RESULTS OF OTHER INVESTIGATORS.

ABSTRACT 611

SASA Y

J AM CERAM SOC 53, 102 (1970)

NONSTOICHIOMETRIC HEXAGONAL CLOSE-PACKED URANIUM SESQUINITRIDE

WHEN URANIUM METAL IS NITRIFIED IN 1 ATM N SUB 2, THE WELL-KNOWN URANIUM SESQUINITRIDE WITH THE BCC STRUCTURE IS OBTAINED AS A SINGLE PHASE AT 1150 DEG TO 1175 DEG C AND BELOW. A SINGLE PHASE OF ANOTHER SESQUINITRIDE WITH THE HCP STRUCTURE IS FORMED AT 1330 DEG TO 1350 DEG C. BETWEEN THESE TEMPERATURES, A KINETICALLY STABLE MIXTURE OF SESQUINITRIDES IS OBTAINED. BOTH SESQUINITRIDES ARE NONSTOICHIOMETRIC; THE BCC SESQUINITRIDE IS UN SUB 1.66-1.56 AND THE HCP ONE UN SUB 1.11-1.43. ABOVE 1350 DEG C, THE SESQUINITRIDE DECOMPOSES INTO THE MONONITRIDE. THE TRANSFORMATION BETWEEN THE BCC AND HCP PHASES IS NOT ALLOTROPIC; A CHANGE IN STOICHIOMETRY ACCOMPANIES THE TRANSFORMATION. FOR THE SESQUINITRIDES AND THE MONONITRIDE, THE INTERPLANAR SPACINGS AND RELATIVE INTENSITIES OF THE X-RAY REFLECTION LINES ARE REPORTED AND THE LATTICE CONSTANTS ARE PRESENTED. FOR THE BCC SESQUINITRIDE, AN APPROXIMATE LINEAR RELATION BETWEEN STOICHIOMETRY AND LATTICE CONSTANT IS ILLUSTRATED.

ABSTRACT 612

SCARBROUGH J O

PHYS REV 174,666 (1968)

SPECIFIC HEAT OF UN FROM 1.3 TO 4.6 DEG K

THE SPECIFIC HEAT OF URANIUM MONONITRIDE WAS MEASURED AT TEMPERATURES FROM 1.3 TO 4.6 DEG K AND WAS FOUND TO BE OF THE FORM $Y + B(T/0 \text{ SUB } 0)^{**3}$, WHERE Y IS 24.79#0.05 MJ/G AT WT, DEG**2 AND THE DEBYE C IS 324# 7 DEG K. THE LARGE VALUE OF Y (35 TIMES THE VALUE FOR COPPER) APPARENTLY RESULTS FROM THE FERMI SURFACE INTERSECTING NARROW 5F ELECTRONIC BANDS. THE ABOVE VALUES REFER TO A UN SAMPLE HEAT-TREATED IN AN ATMOSPHERE OF NITROGEN FOR 6.5 H AT 2250 DEG C. THE SAME SAMPLE, BEFORE THIS HEAT TREATMENT, HAS A MEASURED $Y=24.07\#0.08$ MJ/G AT WT, DEG**2 AND $\theta=322\#13$ DEG K. THE SHIFT IN Y MAY BE DUE TO A SMALL CHANGE IN STOICHIOMETRY CAUSED BY THE HEAT TREATMENT. ALTHOUGH THE DEBYE TEMPERATURE OBTAINED FROM THE PRESENT WORK, 324 DEG K, IS LARGER THAN PREVIOUS SPECIFIC HEAT ESTIMATES OF 276-289 DEG K, IT IS LOWER THAN THE VALUE OF 364 DEG K OBTAINED FROM VELOCITY OF SOUND MEASUREMENTS. NO CHANGES WERE OBSERVED IN THE SPECIFIC HEAT UPON APPLICATION OF MAGNETIC FIELDS UP TO 35 KG, SUGGESTING THE ABSENCE OF ANY APPRECIABLE MAGNETIC CONTRIBUTION TO THE TOTAL SPECIFIC HEAT FOR TEMPERATURE BELOW 4.7 DEG K.

ABSTRACT 613

SCHNEIDER F H

J NUCL MATER 43, 175 (1972)

UBER DIE BILDUNG VON U SUB 2 C SUB 3 DURCH ZERFALL DES URANDICARBIDES

THE STABILITY OF THE UC SUB 2-PHASE IS OF GREAT INTEREST WITH REGARD TO OPERATING HTR'S USING DICARBIDE COATED-PARTICLE FUEL. IN THE LITERATURE THE REACTION $2 \text{ UC SUB } 2 = \text{ U SUB } 2 \text{ C SUB } 3 + \text{ C}$ IS MENTIONED. THERE IS, HOWEVER, PARTIAL DISAGREEMENT ON THE DETAILED DESCRIPTION OF THE CONDITIONS AT WHICH U SUB 2 C SUB 3 IS FORMED. THIS PAPER PRESENTS EXPERIMENTAL RESULTS OF THE REACTION OF DECOMPOSITION WITH SPECIAL EMPHASIS ON THE PRESENCE OF CERTAIN MODERATING OR ACCELERATING FORCES. THE ENHANCEMENT OF THE DECOMPOSITION, OCCURRING WHEN ADDITIONAL MECHANICAL ENERGY IS BROUGHT INTO THE UC SUB 2 MATRIX, WAS STUDIED. A MAXIMUM IN THE U SUB 2 C SUB 3 FORMING RATE OF REACTION WAS OBSERVED IN

ABSTRACT 613 (CONT'D)

THE TEMPERATURE RANGE 1300-1400 DEG C. WITH A MATERIAL PRE-HEAT TREATED AT 1900 DEG C HOWEVER NO TRANSFORMATION WAS DETECTED. U SUB 2 C SUB 3 FORMATION IS REPORTED AFTER HEAT TREATMENT OF IRRADIATED COATED PARTICLES, AND A STABILIZATION OF THE DICARBIDE FUEL THEREFORE IS ADVANTAGEOUS. IN THIS RESPECT THE CONTAMINATION OF THE UC SUB 2 BY N SUB 2, OF ABOUT 1500 PPM, SEEMS MOST EFFECTIVE, WHILE OXYGEN CONTAMINATION HAS LITTLE OR NO EFFECT. OF GREAT INFLUENCE ON THE REACTION IS THE SHAPE AND QUANTITY OF THE PRIMARY GRAPHITE PRECIPITATION: A LARGE AMOUNT OF LAMINAR GRAPHITE FAVOURS THE TRANSFORMATION WHILE GLOBULAR GRAPHITE, PREFERABLY FORMING DURING RAPID COOLING, INHIBITS THE REACTION.

ABSTRACT 614

SCHULE W

J NUCL MATER 32, 20 (1969)

PROPERTIES OF VACANCIES IN URANIUM CARBIDE

FROM MEASUREMENTS OF CHANGES IN ELECTRICAL RESISTIVITY OF URANIUM CARBIDE DUE TO QUENCHING AND ANNEALING, A VACANCY FORMATION ENERGY OF 1.0 ± 0.1 EV AND A MIGRATION ACTIVATION ENERGY OF 1.45 ± 0.3 EV WERE DETERMINED WHICH ARE ATTRIBUTED TO C-VACANCIES. IT IS SHOWN THAT IN URANIUM CARBIDE THE MIGRATION OF C-AND U-VACANCIES OCCURS VERY LIKELY IN THE SUBLATTICES OF CARBON AND URANIUM, RESPECTIVELY. FOR U-VACANCIES A FORMATION ENERGY BETWEEN 1.4 AND 1.7 EV AND A MIGRATION ACTIVATION ENERGY OF 2.2 EV ARE ESTIMATED. FURTHERMORE IT IS CONCLUDED THAT IN THE LOWER TEMPERATURE RANGE (< 1400 DEG C) THE DIFFUSION RATE OF CARBON IS DETERMINED BY A SINGLE VACANCY DIFFUSION MECHANISM AND IN THE HIGHER TEMPERATURE RANGE (> 1400 DEG C) BY A DIVACANCY DIFFUSION MECHANISM IN THE CARBON SUBLATTICE THE DIFFUSION OF U-ATOMS IS ASSUMED TO BE DETERMINED BY A SINGLE VACANCY MECHANISM IN THE URANIUM SUBLATTICE IN THE ENTIRE TEMPERATURE RANGE INVESTIGATED.

ABSTRACT 615

SCOTT J L

CRNL-4470 P76 (1969)

NITRIDE FUELS DEVELOPMENT

OAK RIDGE NATIONAL LABORATORY

NITRIDE FUELS ARE BEING DEVELOPED FOR SPACE-NUCLEAR AND LIQUID-METAL FAST BREEDER REACTORS(LMFBR). PROPERLY DESIGNED (U,PU)N LMFBR FUEL PINS CAN OPERATE AT SIGNIFICANTLY HIGHER LINEAR HEAT RATINGS AND POWER DENSITIES THAN CAN MIXED OXIDES. NITRIDE FUELS ALSO APPEAR MORE FABRICABLE AND MORE COMPATIBLE WITH CLADDING ALLOYS THAN ARE CARBIDES. A PROGRAM WHICH INCLUDES SYNTHESIS, FABRICATION, CHARACTERIZATION, THERMODYNAMIC STUDIES, COMPATIBILITY STUDIES, AND IRRADIATION TESTING IS REPORTED. PROCESSES FOR FABRICATING VARIOUS SIZES AND SHAPES, DEVELOPMENT OF POWDER CHARACTERIZATION METHODS AND EQUIPMENT IMPROVEMENT ARE DESCRIBED. SPECIMENS OF U**15N WERE PREPARED FOR IRRADIATION AND OTHER TESTS. SYNTHESIS AND FABRICATION OF MIXED (U,PU)N BEGAN. CONVERSION OF SOL-GEL OXIDE TO CARBONITRIDE WAS GREATLY ENHANCED WHEN CARBON WAS INCORPORATED IN THE SOL. THE KINETICS OF SOL-GEL CONVERSION REACTIONS ARE STUDIED IN DETAIL TO OPTIMIZE EFFICIENCY. COMPATIBILITY AND THERMODYNAMIC STUDIES DEALING PRIMARILY WITH VANADIUM-BASE LMFBR CLADDING ALLOYS ARE DESCRIBED. THE EFFECTS OF OXYGEN CONTAMINATION, TEMPERATURE GRADIENTS, AND NUCLEAR BURNUP ON COMPATIBILITY WERE INVESTIGATED. OXYGEN CONTAMINATION MAY BE

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ABSTRACT 615 (CONT'D)

DESIRABLE IN NITRIDE FUELS BECAUSE IT CAN REDUCE TWENTY-FOLD THE NITROGEN PRESSURE IN UN-U SUB 2 N SUB 3 AND THUS MIGHT PREVENT REACTION WITH THE CLADDING. THE EXISTENCE OF UVC SUB 2 WAS CONFIRMED AND EVIDENCE FOR A MORE ACTIVE FORM OF CARBON IN THE V-C-N SYSTEM WAS FOUND. TO DETERMINE ITS BASIC IRRADIATION BEHAVIOR UNDER LWR CONDITIONS UN WAS IRRADIATED AT CENTRAL FUEL TEMPERATURES OF 1200 TO 1400 DEG C TO A BURNUP OF 1.8 AT.%. CLADDING RESTRAINT SIGNIFICANTLY REDUCED FUEL SWELLING.

ABSTRACT 616

SEARS M B

J ELECTROCHEM SOC 113, 269 (1966)

HIGH-TEMPERATURE IMMISCIBILITY OF URANIUM MONO-AND DICARBIDES

THE HIGH-TEMPERATURE, URANIUM MONOCARBIDE-DICARBIDE IMMISCIBILITY REGION WAS DETERMINED BY EXAMINING THE MICROSTRUCTURES OF SPECIMENS WITH COMPOSITIONS FROM UC SUB 1.1 TO UC SUB 1.8, WHICH WERE PREPARED BY DECOMPOSING MIXTURES CONTAINING THE SESQUICARBIDE AT 1820-2130 DEG C. THE LOW CARBON MISCIBILITY BOUNDARY, WHICH OCCURS BETWEEN UC SUB 1.2 (5.2 AND 5.7% CARBON), IS NEARLY COMPOSITION INVARIANT BETWEEN 1820 AND 2070 DEG C. THE HIGH CARBON MISCIBILITY BOUNDARY OCCURS AT ABOUT UC SUB 1.65 (7.7% CARBON) AT 1820 DEG C, AND THE SOLUBILITY OF THE MONOCARBIDE IN THE DICARBIDE PHASE INCREASES LINEARLY WITH INCREASING TEMPERATURE. THE PEAK OF THE IMMISCIBLE REGION OCCURS AT ABOUT UC SUB 1.2 (5.7% CARBON) AND A TEMPERATURE ABOVE 2070 DEG C.

ABSTRACT 617

SEARS M B

J NUCL MATER 32, 101 (1969)

STUDIES ON THE U-C CONSTITUTIONAL DIAGRAM BETWEEN UC AND UC SUB 2

THE U-C SYSTEM FROM UC SUB 1.0 TO UC SUB 2.4 (4.8 TO 10.8 WT % CARBON), WITH MAJOR EMPHASIS ON THE REGION BETWEEN 1820 AND 1275 DEG C, WAS STUDIED BY IDENTIFYING THE PHASES PRESENT IN ARC-CAST AND HEAT-TREATED SPECIMENS THAT HAD BEEN COOLED TO ROOM TEMPERATURE. URANIUM SESQUICARBIDE WAS FOUND TO HAVE A LINE COMPOSITION VERY CLOSE TO UC SUB 1.50 AND AN UPPER STABILITY LIMIT OF ABOUT 1800 DEG C. BELOW 1800 SUB C, THE URANIUM MONOCARBIDE LATTICE ACCOMMODATED A MAXIMUM OF ABOUT 1.02 CARBON ATOMS PER URANIUM ATOM. THE DICARBIDE PHASE EXISTED OVER A MUCH WIDER COMPOSITION RANGE, FROM ABOUT UC SUB 1.7 TO UC SUB 1.9 AT 1765 DEG C; THIS RANGE NARROWED AS THE TEMPERATURE DECREASED. THE MAXIMUM CARBON CONTENT OF THE CUBIC DICARBIDE PHASE DECREASED WITH TEMPERATURE FROM 1.89 CARBON ATOMS PER URANIUM ATOM AT THE MELTING POINT TO A MINIMUM OF 1.85 AT ABOUT THE CUBIC-TO-TETRAGONAL TRANSFORMATION TEMPERATURE. COMBINED-CARBON/URANIUM ATOM RATIOS ABOVE 1.85 COULD BE OBTAINED AT ROOM TEMPERATURE ONLY BY QUENCHING SPECIMENS CONTAINING LESS THAN 0.2 WT % FREE CARBON BECAUSE THE FREE CARBON ACTED AS PRECIPITATION CENTERS IN THE METASTABLE SOLUTIONS. WHEN COOLED FROM THE CUBIC TO THE TETRAGONAL REGION, THE DICARBIDE DISPROPORTIONATED INTO MONOCARBIDE AND A TETRAGONAL DICARBIDE THAT HAD AN ESTIMATED COMPOSITION OF UC SUB 1.89 AT ROOM TEMPERATURE. NO THERMAL DECOMPOSITION OF THE TETRAGONAL URANIUM DICARBIDE WAS OBSERVED AFTER HEAT-TREATMENT AT 1260 TO 1600 DEG C.

ABSTRACT 618

SEARS M B

ORNL-3515 (1968)

CORRELATION OF COMPOSITION AND HEAT-TREATMENT WITH THE MICROSTRUCTURES OF URANIUM CARBIDES

OPTICAL PHOTOMICROGRAPHS, AT MAGNIFICATIONS OF 250X AND 1000X, OF 78 DIFFERENT ARC-CAST AND HEAT-TREATED URANIUM CARBIDE SPECIMENS ARE PRESENTED. SPECIMENS WITH TOTAL C/U ATOM RATIOS RANGING FROM 0.4 TO 2.4 (2 TO 11 WT % CARBON) ARE INCLUDED; HOWEVER, THE MAJOR EMPHASIS IS ON THE MONOCARBIDE-DICARBIDE, MONOCARBIDE-SESQUICARBIDE, AND SESQUICARBIDE-DICARBIDE REGIONS OF THE PHASE DIAGRAM. THE PHASES PRESENT WERE IDENTIFIED BY X-RAY DIFFRACTION ANALYSIS OF THE SPECIMENS AT ROOM TEMPERATURE AND, IN MANY INSTANCES, WERE FURTHER CONFIRMED BY DETERMINING THE PRODUCTS OF HYDROLYSIS. THE SPECIMENS WERE ANALYZED FOR URANIUM, TOTAL CARBON, FREE CARBON, OXYGEN, NITROGEN, AND TUNGSTEN TO PROVIDE AS COMPLETE A CHARACTERIZATION AS POSSIBLE.

ABSTRACT 619

SECRET A C

8MI-1309 (1959)

PREPARATION AND PROPERTIES OF URANIUM MONOCARBIDE CASTINGS

USING A SPECIAL ARC-MELTING TECHNIQUE, SOUND, HOMOGENEOUS 100-G CYLINDRICAL CASTINGS OF UC OF NEAR STOICHIOMETRIC COMPOSITION WERE CONSISTENTLY PRODUCED. IN THE CASTING PROCESS DEVELOPED, UC BUTTONS PREVIOUSLY PREPARED BY ARC MELTING THE ELEMENTS WERE PLACED OVER THE OPENING OF A GRAPHITE MOLD IN A HELIUM-ATMOSPHERE ARC FURNACE. WHEN THE UC BUTTON BECAME FULLY MOLTEN UNDER THE ARC, IT DROPPED BY GRAVITY INTO THE MOLD. THE DENSITIES OF THE RESULTANT CASTINGS WERE ABOUT 98 PER CENT OF THEORETICAL. THE CASTINGS COULD BE SUCCESSFULLY MACHINE GROUND USING A WATER-BASE CUTTING FLUID. IN A PRELIMINARY DETERMINATION OF SOME PHYSICAL PROPERTIES OF CAST UC, THE THERMAL CONDUCTIVITY MEASURED AT 100, 400, AND 700 C WAS 0.060, 0.053, AND 0.060 CAL/(SEC)(CM)(C), RESPECTIVELY. THE MEAN LINEAR THERMAL-EXPANSION COEFFICIENT IN THE TEMPERATURE RANGE FROM 20 TO 950 C WAS 11.4×10^{-6} /DEG C. CAST UC ENCAPSULED IN STAINLESS STEEL EXHIBITED GOOD RESISTANCE TO THERMAL STRESS AND SHOCK IN TWO SERIES OF TESTS OF 100 THERMAL CYCLES TO 900 C AND 100 CYCLES TO 1100 C. HEAT TREATING A CASTING SPECIMEN FOR 1 HR AT 1000 C PRODUCED NO SIGNIFICANT CHANGE IN MICROSTRUCTURE, BUT AFTER A SUBSEQUENT EXPOSURE OF 1 HR AT 1500 C HARDENING AND THE APPEARANCE OF THE U SUB 2 C SUB 3 PHASE WERE EVIDENT. IN TESTS OF COMPRESSIVE STRENGTH ON A SINGLE SPECIMEN RUPTURE OCCURRED AT 54,500 PSI.

ABSTRACT 620

SECTION 9 J

TRG-REPORT-1601 (1967)

PHYSICAL PROPERTIES OF SOME PLUTONIUM CERAMIC COMPOUNDS
A DATA MANUAL

THE BEST AVAILABLE DATA ON THE PHYSICAL PROPERTIES OF PLUTONIUM COMPOUNDS OF INTEREST AS FUEL MATERIALS ARE TABULATED. THESE ARE THE DIOXIDE, MONOCARBIDE, MONONITRIDE, MONOSULPHIDE AND MONOPHOSPHIDE OF PU, (UPU)N SUB 2, (UPU)C, (UPU)N, AND THE PU SILICIDES.

ABSTRACT 621

SELTZER M S

REACTOR TECHNOL 14,99 (1971)

REVIEW OF CREEP BEHAVIOR OF CERAMIC NUCLEAR FUELS

RESULTS OF BOTH OUT-OF-PILE AND IN-PILE CREEP STUDIES ARE PRESENTED AND DISCUSSED. THE MATERIALS REVIEWED INCLUDE UO SUB 2, UO SUB 2- PUO SUB 2, UO SUB 2-THO SUB 2, UO SUB 2-ZRO SUB 2, BEO-UO SUB 2, THO SUB 2, UC, AND UN. THE VARIABLES THAT ARE CONSIDERED INCLUDE TEMPERATURE, STRESS, GRAIN SIZE, STOICHIOMETRY, DENSITY, IMPURITIES, AND IN THE CASE OF IN-PILE CREEP TESTS, FISSION RATE. IN ADDITION, CURRENTLY PROPOSED IN-PILE CREEP MECHANISMS ARE DISCUSSED AND RELATED TO OUT-OF-PILE CREEP MECHANISMS.

ABSTRACT 622

SHEINHARTZ I

SCNC-266 (1958)

DISPERSION-TYPE MATERIALS FOR FUEL ELEMENTS, PART I: URANIUM MONONITRIDE AND URANIUM SILICIDE DISPERSION MATERIALS
SYLVANIA-CORNING NUCLEAR CORPORATION

THE BASIC REQUIREMENTS FOR DISPERSION-TYPE FUEL ELEMENTS AND THE BASIS FOR THE SELECTION OF THE COMPONENTS, I.E., MELTING TEMPERATURE, DENSITY, AND URANIUM-CONTENT OF THE URANIUM COMPOUNDS, AND MELTING TEMPERATURE AND ABSORPTION CROSS SECTION OF THE MATRIX MATERIALS ARE DESCRIBED. TWO TYPES OF DISPERSIONS ARE INVESTIGATED: URANIUM NITRIDE AND URANIUM SILICIDE. THEIR REACTIONS WITH ZIRCALOY-2 AND OTHER MATRIX MATERIALS, SUCH AS MOLYBDENUM, NIOBIUM, NICHROME-V, TI-NB ALLOYS, OR VANADIUM, ARE SHOWN IN SOME CHARACTERISTIC PHOTOMICROGRAPHS. THE CORROSION RATE OF SOME OF THESE DISPERSION-TYPE MATERIALS IN 600 DEG C WATER IS BRIEFLY DISCUSSED.

ABSTRACT 623

SHERIDAN W

NDA-2126-5 1 AND 2 (1961)

CARBIDE FUEL DEVELOPMENT

UC-PUC SOLID SOLUTION POWDERS CONTAINING ONLY MINOR AMOUNTS OF IMPURITIES WERE OBTAINED BY REACTING A MIXTURE OF UO SUB 2 AND PUO SUB 2 WITH CARBON OR BY HEATING TOGETHER A MIXTURE OF UC, PU SUB 2 C SUB 3, AND U. UC-PUC PELLETS WITH THE DESIRED HIGH DENSITIES OF 95% OF THEORETICAL WERE OBTAINED BY COLD PRESSING AND SINTERING. USING 0.1 WT.% NICKEL AS A SINTERING AID. WITHOUT NICKEL, THE DENSITIES WERE MUCH LOWER FOR THE SAME SINTERING CONDITIONS. PRIOR TO EXPERIMENTS WITH SOLID SOLUTION CARBIDES, ESSENTIALLY STOICHIOMETRIC UC POWDER WAS PREPARED IN THE PLUTONIUM FACILITY BY THE CARBON REDUCTION OF UO SUB 2 IN A HELIUM ATMOSPHERE. ATTEMPTS TO PREPARE STOICHIOMETRIC PUC BY THE CARBON REDUCTION OF PUO SUB 2 FAILED, THE PRODUCT CONSISTING OF A MIXTURE OF PLUTONIUM CARBIDES AND OXIDES. PU SUB 2C SUB 3 WAS READILY OBTAINED BY REACTING STOICHIOMETRIC AMOUNTS OF PUO SUB 2 AND CARBON. ADDITIONAL EVALUATION OF TEST SAMPLES, USING X-RAY DIFFRACTION AND A MICROPROBE ANALYZER, CONFIRMED THAT TYPE 304 STAINLESS STEEL, 2 1/4 CR-1 MO STEEL, AND NIOBIUM ARE SATISFACTORY UC CLADDING MATERIALS AT 820 DEG C, FOR 4000 H, WHILE INCONEL-X, ZIRCALOY-2, AND BERYLLIUM ARE NOT SATISFACTORY. THE IRRADIATION OF TWO CLAD UC SPECIMENS WAS COMPLETED. THE UC PELLETS WERE MADE BY COLD PRESSING AND SINTERING UC POWDER, WHICH IN TURN WAS MADE BY REACTING UO SUB 2 WITH CARBON. IRRADIATION CONDITIONS WERE 18500 MWD/T AVERAGE BURNUP, 760 DEG C AVERAGE CENTRAL FUEL TEMPERATURE., AND 315 W/CM AVERAGE HEAT GENERATION RATE. IN-PILE MEASUREMENTS OF THE COMBINED FUEL PLUS HELIUM GAP

ABSTRACT 623 (CONT'D)

CONDUCTIVITY GAVE AN AVERAGE VALUE OF 0.02 G-CAL/SEC-CM**2- DEG C/CM. THE UC CONDUCTIVITY WAS SIMILAR TO OUT-OF-PILE VALUES FOR A CAST UC, IF REASONABLE HELIUM GAP CONDUCTANCES WERE ASSUMED.

ABSTRACT 624

SHUPE M W

LA-4283 (1970)

SYNTHESIS AND FABRICATION OF PURE, SINGLE-PHASE, URANIUM-PLUTONIUM MONOCARBIDE PELLETS

A PROCESS FOR PRODUCING PURE, SINGLE-PHASE, URANIUM-PLUTONIUM MONOCARBIDE SOLID SOLUTION PELLETS IS DESCRIBED. PELLET DIMENSIONS, DENSITY, CHEMICAL COMPOSITION, AND MICROSTRUCTURE HAVE BEEN DETERMINED AS FUNCTIONS OF PROCESSING CONDITIONS.

ABSTRACT 625

SOBON J T

CNLM-5621 (1964)

THE THERMAL CONDUCTIVITY OF URANIUM MONOCARBIDE

THE HIGH TEMPERATURE THERMAL CONDUCTIVITY OF URANIUM CARBIDE CONTAINING SMALL AMOUNTS OF EXCESS CARBON VARIES FROM APPROXIMATELY 0.180-0.165 W/CM/ DEG C OVER THE TEMPERATURE RANGE 950-1600 DEG C. THE THERMAL CONDUCTIVITY OF UC IS TYPICAL OF METALLIC MATERIALS IN THAT AT HIGH TEMPERATURES THE CONDUCTIVITY IS PREDOMINANTLY BY ELECTRONS. THE THERMAL CONDUCTIVITY DECREASED WITH INCREASING TEMPERATURE UP TO 1600 DEG C. THE MEASURED CONDUCTIVITY IS VERY DEPENDENT UPON THE DENSITY AND DOES NOT FOLLOW THE 1-P RELATIONSHIP, WHERE P = POROSITY. ALTHOUGH THE RESULTS OF THIS INVESTIGATION ARE IN FAIR AGREEMENT WITH THE RESULTS OF OTHER INVESTIGATORS, A DEFINITE CORRELATION CANNOT BE MADE AT THIS TIME BECAUSE MOST INVESTIGATORS WERE WORKING WITH FULLY DENSE MATERIALS OR THEY DID NOT CHARACTERIZE THEIR SAMPLES AND/OR TEST APPARATUS WELL ENOUGH TO EXPLAIN VARIATIONS IN THEIR DATA.

ABSTRACT 626

SOLOV'EV G I

MET METALLOVED CHIST METAL, SB NAUCH RAROT 9, 80 (1971)

VAPOR PRESSURE OF URANIUM OVER URANIUM MONOCARBIDE

THE LANGMUIR METHOD WAS USED TO DETERMINE THE VAPOR PRESSURE OF U OVER UC SUB 0.97 AND UC SUB 1.0. THE TEMPERATURE-VAPOR PRESSURE EQUATIONS ARE: $\log P = 8.73 - 27,000/T$ AND $\log P = 8.50 - 29,500/T$, RESPECTIVELY (P IN TORR), FROM WHICH HEATS OF SUBLIMATION OF 124 AND 135 KCAL/G ATOM, RESPECTIVELY ARE OBTAINED.

ABSTRACT 627

SPEAR K E

HIGH TEMP SCI 2, 175 (1970)

PHASE BEHAVIOR OF THE U-V-C SYSTEM AND THE THERMODYNAMIC PROPERTIES AND CRYSTAL STRUCTURE OF UVC SUB 2

THE SOLID-STATE PHASE BEHAVIOR AND MELTING CHARACTERISTICS OF THE TERNARY U-V-C SYSTEM WERE INVESTIGATED BY X-RAY AND METALLOGRAPHIC TECHNIQUES. THE EQUILIBRIUM TIE LINES WERE ESTABLISHED, AND LATTICE PARAMETER DATA INDICATED TERNARY SOLID SOLUTIONS INVOLVING UC AND VC WERE SLIGHT. THE EXISTENCE OF A TERNARY PHASE UVC SUB 2 WAS CONFIRMED, AND ITS CRYSTAL STRUCTURE WAS DETERMINED TO BE ISOMORPHOUS WITH UMOG SUB 2 BY X-RAY POWDER DIFFRACTION DATA AND INTENSITY CALCULATIONS. THE TERNARY COMPOUND IS UNSTABLE WITH RESPECT TO THE BINARY PHASES AT TEMPERATURES ABOVE 1900±100 DEG C. THE DECOMPOSITION REACTION AND TERNARY REACTIONS AT LOWER TEMPERATURES WERE USED TO DETERMINE THE FREE ENERGY, ENTHALPY, AND ENTROPY OF FORMATION OF UVC SUB 2.

ABSTRACT 628

SPEAR K E

HIGH TEMP SCI 3, 26 (1971)

PHASE INVESTIGATIONS IN THE U-CR-N SYSTEMS

THE POSSIBLE USE OF NITRIDE REACTOR FUELS CONTAINED IN STAINLESS STEEL HAS GENERATED INTEREST IN U-CR-N SYSTEM. A TENTATIVE TERNARY PHASE DIAGRAM AND X-RAY DIFFRACTION DATA FOR A NEW TERNARY COMPOUND ARE PRESENTED.

ABSTRACT 629

SPEAR K E

HIGH TEMP SCI 3, 29 (1971)

PHASE BEHAVIOR OF THE U-V-N SYSTEM AND PROPERTIES OF UVN SUB 2

THE PHASE BEHAVIOR OF THE TERNARY U-V-N SYSTEM WAS INVESTIGATED BY ANNEALING TERNARY COMPOSITIONS AT CONSTANT TEMPERATURES FROM 1400 TO 2000 DEG C AND CONSTANT PRESSURES FROM VACUUM TO 650 TORR N SUB 2. THE PRODUCTS WERE EXAMINED BY X-RAY DIFFRACTION TECHNIQUES AND THE EQUILIBRIUM TIE LINES IN THE TERNARY SYSTEM WERE ESTABLISHED. QUALITATIVE DATA INDICATED THAT TERNARY SOLID SOLUBILITIES WERE SMALL. A TERNARY PHASE UVN SUB 2 WAS DISCOVERED AND FOUND TO BE ISOMORPHOUS WITH UMOG SUB 2 BY X-RAY POWDER DIFFRACTION DATA AND INTENSITY CALCULATIONS. THE TERNARY COMPOUND APPEARS TO BE STABLE WITH RESPECT TO DECOMPOSITION TO THE BINARY NITRIDES OVER THE ENTIRE TEMPERATURE RANGE STUDIED. ΔH SUB F.298 AND S SUB 298 OF UVN SUB 2 WERE CALCULATED TO BE -129±8 KCAL/MOLE AND 23.5±3.0 E.U., RESPECTIVELY.

ABSTRACT 630

SPEAR K E

J AM CERAM SOC 51, 706 (1968)

A CONSISTENT SET OF THERMODYNAMIC VALUES FOR PUN

VALUES GIVEN IN THE LITERATURE FOR THE HEAT OF FORMATION OF PLUTONIUM MONONITRIDE RANGE FROM -70 TO -76 KCAL MOLE. THIS PAPER SHOWS THAT IF ESTIMATED ENTROPY AND HIGH-TEMPERATURE HEAT CAPACITY DATA ARE USED TO DERIVE A REASONABLE SET OF HIGH-TEMPERATURE THERMAL FUNCTIONS FOR THE MONONITRIDE, ΔH DEG SUB F.298(PUN) VALUES OBTAINED BY BOTH SECOND- AND

ABSTRACT 630 (CONT'D)

THIRD-LAW METHODS FROM EQUILIBRIUM DATA AGREE. THE EQUILIBRIUM DATA ARE FROM MEASUREMENTS REPORTED IN THE LITERATURE AND COVER A RANGE FROM 700 DEG TO ABOUT 3040 DEG K. PUN HEAT OF FORMATION APPEARS TO BE IN DISAGREEMENT WITH THE DERIVED EQUILIBRIUM VALUE OF -76.0 KCAL/MOLE, BUT THIS DIFFERENCE CAN BE EXPLAINED BY A COMPOSITION UNCERTAINTY.

ABSTRACT 631

SPEAR K E

ORNL-TM-2106 (1968)

REVIEW AND ANALYSIS OF PHASE BEHAVIOR AND THERMODYNAMIC PROPERTIES OF THE PLUTONIUM-NITROGEN SYSTEM

THE PHASE BEHAVIOR AND THERMODYNAMIC PROPERTIES OF THE PLUTONIUM-NITROGEN SYSTEM ARE REVIEWED AND ANALYZED IN THIS REPORT. THE SECTION ON PHASE BEHAVIOR INCLUDES THE SUBJECTS: INTERMEDIATE PHASES, COMPOSITION LIMITS AND LATTICE PARAMETERS, PHASE TRANSITIONS, MELTING BEHAVIOR AND VAPORIZATION BEHAVIOR. TERNARY OR MORE COMPLEX SYSTEMS INVOLVING PLUTONIUM AND NITROGEN ARE NOT CONSIDERED IN THIS ANALYSIS. IN THE SECTION ON THE THERMODYNAMIC PROPERTIES OF PLUTONIUM NITRIDE, IT IS SHOWN THAT WITH THE USE OF REASONABLE VALUES ESTIMATED FOR THE ENTROPY AND HIGH-TEMPERATURE HEAT CAPACITY OF PUN, ALL EXISTING EXPERIMENTAL DATA CAN BE READILY EXPLAINED AND COMBINED INTO A CONSISTENT SET OF THERMODYNAMIC VALUES FOR THE MONONITRIDE.

ABSTRACT 632

SPEAR K E

TRANS AM NUCL SOC 12, 593 (1969)

CHEMICAL EFFECTS OF NUCLEAR BURNUP ON FAST REACTOR FUELS

THE EFFECT OF BURNUP ON (U,PU)C FUELS IS DIFFICULT TO PREDICT BECAUSE OF THE LACK OF DATA FOR RE-(U,PU)-C SYSTEMS. IF, IN ANALOGY WITH THE U-CE-C SYSTEM, THE RARE EARTHS FORM RE SUB 2 C SUB 3 COMPOUNDS, THEN ALL OF THE CARBON RELEASED BY PLUTONIUM FISSIONING WILL BE BOUND AS FISSION PRODUCT CARBIDES. PART OF THE FUEL CAN, HOWEVER, REACT WITH MOLYBDENUM CARBIDES TO FORM THE (U,PU)MOC SUB 2 TERNARY PHASE, AND WITH RUTHENIUM AND RHODIUM TO FORM U SUB MC SUB 2 -TYPE COMPOUNDS. THE CARBURIZING TENDENCY OF THE FUEL WILL BE FIXED BY THE FREE ENERGY FOR THE REDUCTION OF THE RE SUB 2 C SUB 3 PHASES TO RE SUB 3 C. AFTER A NITRIDE FUEL HAS BEEN IN A REACTOR FOR TWO YEARS UNDER THE CONDITIONS WE HAVE CONSIDERED, ABOUT 80% OF THE NITROGEN WILL BE BOUND AS (U,PU)N, 8% AS U SUB 2 N SUB 3, AND 12% AS FISSION PRODUCT NITRIDES. THE NITRIDING TENDENCY OF THE FUEL WILL BE FIXED BY THE FREE ENERGY FOR THE REDUCTION OF U SUB 2 N SUB 3 TO THE MONONITRIDE. AS WE POINTED OUT PREVIOUSLY, DISSOLVED OXYGEN IN THE FUEL REDUCES THE NITRIDING POTENTIAL OF U SUB 2 N SUB 3.

ABSTRACT 633

SPEIDEL E O

BMI-1633 (1963)

FABRICATION AND PROPERTIES OF HOT-PRESSED URANIUM MONONITRIDE

DENSE UN SPECIMENS FOR PROPERTY TESTS WERE FABRICATED PRIMARILY BY AN ISOSTATIC HOT-PRESSING TECHNIQUE IN WHICH CONSOLIDATED POWDER SEALED IN A REFRACTORY METAL CONTAINER WAS SUBJECTED TO A 10000-LB/IN**2 EXTERNAL GAS PRESSURE AT 1480 TO 1540 DEG C FOR 3 TO 4 H. THE THERMAL CONDUCTIVITY OF URANIUM MONONITRIDE INCREASED FROM FROM 0.04 CAL/(CM)(SEC)(DEG C) AT 200 DEG C TO 0.06 CAL/(SEC)(CM**2) (DEG C) AT 1000 DEG C, WHICH BY AN INTEGRATED THERMAL-CONDUCTIVITY CRITERION, MAKES IT SOME EIGHT TIMES MORE EFFECTIVE THAN UO SUB 2 IN TRANSFERRING HEAT. THERMAL-EXPANSION COEFFICIENTS OF 9.0×10^{-6} / DEG C AND 9.9×10^{-6} / DEG C OVER THE RANGES 20 TO 800 DEG C AND 20 TO 1600 DEG C, RESPECTIVELY, WERE MEASURED. UN RETAINED ABOUT 80% OF ITS ROOM-TEMPERATURE HARDNESS AT 1100 DEG C. ABOVE THIS TEMPERATURE, THE HARDNESS DROPPED RAPIDLY WITH INCREASING TEMPERATURE. THE SPECIFIC HEAT IN CAL PER G MOLE CAN BE CONVENIENTLY DESCRIBED BY THE EQUATION $C_{SUB P} = 13.32 + 1.19 \times 10^{-3}T - 2.10 \times 10^{-5}T^2$ OVER THE RANGE 273 TO 1423 DEG K. ELECTRICAL CONDUCTIVITY DROPPED WITH INCREASING TEMPERATURE, A METALLIC CHARACTERISTIC. ANOMALIES WERE NOTED IN ATTEMPTS TO MEASURE THE HYDROGEN SOLUBILITY AND THE RESISTANCE TO WATER CORROSION. UN IS APPARENTLY NOT ATTACKED BY NAK WITHIN 1500 H AT TEMPERATURES UP TO 480 DEG C.

ABSTRACT 634

SPEIDEL E O

BMI-1842 (1968)

PREPARATION AND PROPERTIES OF UO SUB 2, UN, AND UC CERMET FUELS

HOT ISOSTATIC PRESSING WAS USED AS THE TECHNIQUE FOR PREPARING CERMETS CONTAINING AT LEAST 50 VOL % UO SUB 2, UN, OR UC AND HAVING MINIMUM DENSITIES OF 90% OF THEORETICAL. TUNGSTEN, MOLYBDENUM, CHROMIUM, AND NIOBIUM WERE EMPLOYED AS MATRIX MATERIALS. SPHERICAL UO SUB 2 AND UC AND ANGULAR UC AND UN POWDERS WERE EVALUATED. COMPRESSION TESTS WERE CONDUCTED AT ROOM TEMPERATURE AND 1000 DEG C TO EVALUATE THE EFFECT OF TEMPERATURE ON STRENGTH. REDUCTIONS IN LENGTH OF 1.2 TO 2.1% WERE MEASURED ON THE CERMETS AT 1000 DEG C AT THEIR MAXIMUM COMPRESSIVE LOAD. THE LOADING, DENSITY, AND UNIFORMITY OF STRUCTURES APPEARED TO AFFECT STRENGTH. THE THERMAL CONDUCTIVITY OF UO SUB 2 CERMETS WAS UP TO 14 TIMES GREATER THAN THAT REPORTED FOR BULK UO SUB 2. THE CONDUCTIVITIES OF UN AND UC CERMETS WERE SLIGHTLY HIGHER OR EQUAL TO THOSE OF BULK UN AND UC, RESPECTIVELY. THERMAL-EXPANSION DATA INDICATED THAT THE CERMET FUELS MATCHED POTENTIAL CLADDING MATERIALS BETTER THAN THE PURE CERAMIC FUELS. ELECTRICAL-RESISTIVITY DATA CONFIRMED THE METALLIC NATURE OF THE CERMETS.

ABSTRACT 635

STAHL D

CARBIDES IN NUCL ENERGY, HARWELL C11 (1963)

PROPERTIES OF SOLID SOLUTION URANIUM PLUTONIUM CARBIDES

OUT OF PILE PROPERTIES OF (U SUB 0.8 PU SUB 0.2)-C AND (U SUB 0.95 PU SUB 0.05)-C MEASURED CARBIDES CONTAINES 2000-4000 PPM OXYGEN. MELTING POINT: (U SUB 0.8 PU SUB 0.2)C SUB 0.95, 2450 - 2490 DEG C. COEFFICIENT OF EXPANSION: (U SUB 0.95 PU SUB 0.05)C SUB 0.98+0.1 WT.%NI 25 DEG-1400 DEG C 12.2 (U SUB 0.95 PU SUB 0.05)C SUB 0.98, 25 -1400 DEG C, 12.6×10^{-6} /DEG, (U SUB 0.8 PU SUB 0.2)C SUB 0.95, 25-1400 DEG C,

ABSTRACT 635 (CONT'D)

11.9×10^{-6} /DEG, (U SUB 0.8 PU SUB 0.2)C SUB 0.95 + 0.1 WT.% NI, 25-1400 DEG C, 12.3×10^{-6} /DEG. VAPOR PRESSURE: THE KNUDSEN EFFUSION CELL METHOD IS BEING USED. THERMAL CONDUCTIVITY: A CALORIMETER IS BEING USED TO DETERMINE THERMAL DIFFUSIVITY AND SPECIFIC HEAT, FROM WHICH THERMAL CONDUCTIVITY IS CALCULATED. COMPATIBILITY: COMPATIBILITY TESTS MADE AT 590 DEG C AND 820 DEG C, FOR 1000 AND 4000 HOURS. NO REACTION BETWEEN (U SUB 0.8 PU SUB 0.2)C SUB 0.95 OR (U SUB 0.95 PU SUB 0.05)C SUB 0.98 AND TYPE 316 STAINLESS STEEL, NIOBIUM, NIOBIUM-1 WT.% ZIRCONIUM, AND VANADIUM. REACTIONS WERE NOTED BETWEEN THE FUELS AND ZIRCALOY 2 AND INCONEL X.

ABSTRACT 636

STAHL D

UNC-5074 (1963)

OUT-OF-PILE PROPERTIES OF MIXED URANIUM-PLUTONIUM CARBIDES

SOLID SOLUTION (U,PU)C POWDER WAS PRODUCED BY THE OXIDE-CARBON REACTION, AND THE POWDERS WERE CONSOLIDATED BY COLD PRESSING AND SINTERING. TWO TYPES OF MATERIAL WERE PRODUCED: 1. (U SUB 0.8 PU SUB 0.2) C SUB 0.95, SINGLE-PHASE MONOCARBIDE PELLETS WITH AVERAGE DENSITIES OF 12.8 G/CM^3 (94% OF THEORETICAL), SINTERED AT 1925 DEG C; 2. (U SUB 0.8 PU SUB 0.2) C SUB 0.95 + 0.1 WT.% NI SINTERING AID, MAJOR MONOCARBIDE PHASE AND MINOR AMOUNT OF SESQUICARBIDE PHASE PELLETS, WITH AVERAGE DENSITIES OF 13.1 G/CM^3 (96.5% OF THEORETICAL), SINTERED AT 1550 DEG C. THE COEFFICIENT OF THERMAL EXPANSION WAS MEASURED AS 11.9×10^{-6} / DEG C FOR (U SUB 0.8 PU SUB 0.2) C SUB 0.95 AT 25-1400 DEG C AND 12.3×10^{-6} / DEG C FOR (U SUB 0.8 PU SUB 0.2) C SUB 0.95 + 0.1 WT.% NI AT 25 - 1400 DEG C. THE VALUES ARE SIMILAR TO THOSE OF UC, COMPARED AT 950 DEG C, THE MAXIMUM TEMPERATURE TO WHICH UC HAS BEEN MEASURED. THE MELTING POINT OF (U SUB 0.8 PU SUB 0.2) C SUB 0.95 WAS FOUND TO BE 2480 ± 20 DEG C. THE SOLIDUS IS ESTIMATED TO BE ABOUT 2430 DEG C. THE VAPOR PRESSURE DATA IN THE TEMPERATURE RANGE OF 2100 - 2600 DEG K SHOW THAT THE PRESSURE OF PLUTONIUM IS ABOUT THE SAME AS URANIUM OVER (U SUB 0.8 PU SUB 0.2) C SUB 0.95. WHILE THE URANIUM DATA ARE ABOUT AN ORDER OF MAGNITUDE HIGHER THAN ANTICIPATED, BASED ON DATA FOR U OVER UC (PROBABLY DUE TO CARBON DIFFUSION ACROSS THE CELL), THE THERMAL STABILITY OF THE FUEL IN THE TEMPERATURE RANGE OF POWER REACTORS IS STILL QUITE GOOD. THERMAL CONDUCTIVITY CAPSULES CONTAINING (U SUB 0.8 PU SUB 0.2) C SUB 0.95, (U SUB 0.8 PU SUB 0.2) C SUB 0.95 PLUS 0.12 WT.% NI, AND UC PLUS 0.12 WT.% NI (STANDARD) WERE FABRICATED. (U SUB 0.8 PU SUB 0.2)C SUB 0.95, WITH AND WITHOUT NICKEL SINTERING AID, WAS COMPATIBLE WITH TYPE 316 STAINLESS STEEL, NIOBIUM, NIOBIUM-1% ZIRCONIUM, 2 1/4 CR-1 MO STEEL, AND VANADIUM AT 593 DEG C AND 816 DEG C FOR 1000 AND 4000 H. THERE WAS NO REACTION WITH INCONEL-X AFTER 1000 H AT 593 DEG C, BUT THERE WAS A SLIGHT REACTION AFTER 1000 H AT 816 DEG C. A REACTION WAS NOTED WITH ZIRCALOY-2 AFTER 1000 H AT BOTH 593 DEG AND 816 DEG C.

ABSTRACT 637

STAHL D

UNC-5198 (1968)

POST-IRRADIATION EXAMINATION OF HIGH-DENSITY (U,PU) C PELLET-FUELED
EBR-II RODS IRRADIATED TO 30,000 MWD/T

EXPERIMENTAL BREEDER REACTOR -II--FUEL ELEMENT IRRADIATION OPERATIONS IN,
DESCRIPTION OF METAL-CLAD HELIUM-BONDED PLUTONIUM CARBIDE (PUC)-URANIUM
CARBIDE (UC) REACTOR FUEL ELEMENTS--RADIATION EFFECTS ON PHYSICAL
PROPERTIES OF METAL-CLAD HELIUM-BONDED PLUTONIUM CARBIDE (PUC)-URANIUM
CARBIDE (UC) PELLET-TYPE, ANALYSIS OF FAST NEUTRON NEUTRONS,
FAST--EFFECTS ON PHYSICAL PROPERTIES OF METAL-CLAD HELIUM-BONDED
PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) PELLET-TYPE FUEL ELEMENTS,
ANALYSIS OF RADIATION TARGET CANS-CONFIGURATION OF EBR-2, FOR METAL-CLAD
HELIUM-BONDED PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) PELLET-TYPE
FUEL ELEMENTS URANIUM CARBIDES-PUC-UC, RADIATION EFFECTS ON PHYSICAL
PROPERTIES OF METAL-CLAD HELIUM-BONDED, ANALYSIS OF FAST NEUTRON VANADIUM
ALLOYS AND SYSTEMS-TI-V, RADIATION EFFECTS ON PHYSICAL PROPERTIES OF
PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) FUEL CLADDING OF, ANALYSIS
OF FAST NEUTRON VANADIUM-RADIATION EFFECTS ON PHYSICAL PROPERTIES OF
PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) FUEL CLADDING OF, ANALYSIS
OF FAST NEUTRON STAINLESS STEEL-RADIATION EFFECTS ON PHYSICAL PROPERTIES
OF PLUTONIUM CARBIDE (PUC)-URANIUM CARBIDE (UC) FUEL CLADDING OF TYPE 316,
ANALYSIS OF FAST NEUTRON

ABSTRACT 638

STELLRECHT D E

J AM CERAM SOC 51,455 (1968)

COMPRESSIVE CREEP OF URANIUM CARBIDE

THE COMPRESSIVE CREEP RATES OF SLIGHTLY HYPERSTOICHIOMETRIC URANIUM
CARBIDE WERE DETERMINED IN VACUUM AT 1200 DEG TO 1600 DEG C AND 3000 TO
10,000 PSI. THE EQUATION BEST DESCRIBING THE MINIMUM CREEP RATES OF
URANIUM CARBIDE OVER THIS RANGE IS: $\dot{\epsilon} = 1.8 \times 10^{-3} (0.033) \exp$
(-90,000/RT)

ABSTRACT 639

STOECKER H J

BER DT KERAM GES 43,130 (1966)

SYSTEM URANIUM-NITROGEN

THE URANIUM MONOCARBIDE, URANIUM MONONITRIDE, AND THE MIXED CRYSTAL
U(CN), THE CARBONITRIDE, POSSESS GOOD THERMAL CONDUCTIVITY AND HIGH
MELTING POINTS. THERMODYNAMIC CALCULATIONS WERE MADE TO DETERMINE THE
PHASE BOUNDARIES AND THE PURITIES THEORETICALLY OBTAINABLE IN THE
MONONITRIDE AND THE CARBONITRIDE. THE RESULTS ARE TABULATED. THE MINIMUM
AND MAXIMUM LIMITING PRESSURE FOR N SUB 2 AND CO SUB 2 ARE GIVEN AS A
FUNCTION OF THE CARBON CONCENTRATION OF THE MIXED CRYSTALS FOR A
TEMPERATURE OF 2000 DEG K. THE OXYGEN CONCENTRATIONS OBTAINED FROM THE
INTERACTION OF UO SUB 2 WITH VARIOUS AMOUNTS OF CARBON WERE CALCULATED
AND TABULATED. EXPERIMENTAL RESULTS AGREE SATISFACTORILY WITH THEORY.

ABSTRACT 640

STORPS R F

J AM CERAM SOC 47, 55 (1964)

PHASE RELATIONS IN THE SYSTEM URANIUM-CARBON-OXYGEN.

INVESTIGATIONS IN THE TERNARY SYSTEM U-C-O SHOW THAT ONLY 25% OF THE C ATOMS IN UC CAN BE REPLACED BY O ATOMS. THE O-SATURATED UC PHASE, UC SUB 0.75 O SUB 0.25 HAS A LATTICE PARAMETER OF 4.950 ± 0.001 Å. THIS MATERIAL IS MORE RESISTANT TO H SUB 2 O THAN UC, AND IS BEING EVALUATED AS A NUCLEAR FUEL.

ABSTRACT 641

STORMS E K

FUNDAMENTALS OF REFRACTORY COMPOUNDS, P67 (1968)

THERMODYNAMICS OF REFRACTORY MATERIALS

THE HEAT OF FORMATION OF REFRACTORY MATERIALS CHANGES WITH COMPOSITION. THE CHANGE HAS BEEN DEFINED IN THE VC, NBC, TAC, AND HFC SYSTEMS. DATA ON THESE SYSTEMS ARE PRESENTED GRAPHICALLY. THE INFORMATION FOR THE ZRC AND UC SYSTEMS IS LIMITED. HIGH TEMPERATURE ENTHALPY AND HEAT CAPACITY OF NB, TA, MO, TIC, ZRC, TAC, NBC, NB-C, AND HFC ARE SUMMARIZED IN GRAPHS. THE HIGH TEMPERATURE HEAT CAPACITY OF UC AND UC SUB 1.9 IS PRESENTED. DATA ON THE SOLUBILITY OF OXYGEN IN REFRACTORY COMPOUNDS ARE SUMMARIZED IN THE REACTIONS ASSOCIATED WITH HEATING THE TI-C AND ZR-C ALLOYS. THE DISSOLUTION OF OXYGEN IN CARBIDES AFFECTS THE THERMODYNAMIC PROPERTIES. VAPOR PRESSURE DATA AND MEASUREMENTS OF TIC, ZRC, HFC, NBC, TAC, MOC, THC SUB 2, AND UC ARE SUMMARIZED. THE THERMAL FUNCTIONS OF THE CARBIDES AND URANIUM ARE TABULATED.

ABSTRACT 642

STORMS E K

J NUCL MATER 23, 19 (1967)

HEAT OF FORMATION OF URANIUM CARBIDE

THE HEAT OF COMBUSTION FOR UC SUB 0.996 $\pm$ 0.005 AND UC SUB 1.032 $\pm$ 0.005 WAS DETERMINED AND -23.3 ± 0.9 AND -23.0 ± 1.0 KCAL/MOLE WERE CALCULATED AS THE RESPECTIVE HEATS OF FORMATION AT 298.15 DEG K. BY COMPARING THIS WITH PREVIOUS COMBUSTION AND VAPOR PRESSURE MEASUREMENTS, THE CHANGE IN THE HEAT OF FORMATION AS A FUNCTION OF COMPOSITION CAN BE DEFINED. STRONG EVIDENCE IS PROVIDED THAT THE HEAT OF VAPORIZATION OF U IS NEAR 126.5 KCAL/MOLE AT 298.15 DEG K.

ABSTRACT 643

STORMS F K

LA-DC-8790 (1967)

AN EVALUATION OF THE HEAT OF VAPORIZATION OF URANIUM FROM THE BEHAVIOR OF THE U-C SYSTEM

THE HEAT OF EVAPORIZATION BEHAVIOR OF PURE U HAS NOT BEEN DEDUCED BY DIRECT MEASUREMENTS. AN EVALUATION OF THE HEAT OF VAPORIZATION OF U FROM THE BEHAVIOR OF THE U-C SYSTEM IS GIVEN. SOME DIRECT VAPOR PRESSURE MEASUREMENTS HAVE BEEN MADE IN THE U-C SYSTEM.

ABSTRACT 644

STORMS E K

LA-DC-9724 (1968)

THE URANIUM-CARBON AND PLUTONIUM-CARBON SYSTEMS

HAS REVIEWED U-C, U-C-O AND PU-C SYSTEM. THE PROPERTIES DISCUSSED ARE PHASE EQUILIBRIUM, LATTICE PARAMETERS, HEAT CAPACITY, ENTHALPY, ENTROPY, HEAT OF FORMATION, FREE ENERGY OF FORMATION, EVAPORATION BEHAVIOR AND HEAT OF VAPORIZATION.

ABSTRACT 645

STORMS E K

LA-UR-73-769

VAPORIZATION BEHAVIOR OF THE ZIRCONIUM-URANIUM-CARBON SYSTEM

FREE ENERGY OF MIXING IS CALCULATED FOR ZR-U-C SYSTEM. THE EXPRESSION IS ALSO GIVEN TO CALCULATE FREE ENERGY OF FORMATION BETWEEN UC SUB 2 AND UC.

ABSTRACT 646

STORMS E K

LA-2942 (1964)

A CRITICAL REVIEW OF REFRACTORIES

SUPERSEDES LAMS-2674, PARTS I AND II. THE LITERATURE CONCERNING THE GROUP-4A, -5A AND -6A CARBIDES AND NITRIDES, AND THE CARBIDES AND NITRIDES OF TH, U, AND PU HAS BEEN REVIEWED CRITICALLY. THE FOLLOWING PROPERTIES HAVE BEEN DISCUSSED: PREPARATION, PHASE RELATIONSHIP, LATTICE PARAMETER AND STRUCTURE, APPEARANCE, CHEMICAL STABILITY, HARDNESS, RESISTIVITY, SUPERCONDUCTIVITY, THERMODYNAMIC PROPERTIES AND VAPORIZATION. WHEN POSSIBLE, EACH PROPERTY HAS BEEN CONSIDERED IN THE LIGHT OF THE WIDE HOMOGENEITY RANGE EXHIBITED BY THESE COMPOUNDS. PARTICULAR ATTENTION HAS BEEN PAID TO METHODS BY WHICH THE MATERIALS CAN BE MADE OXYGEN-AND NITROGEN-FREE.

ABSTRACT 647

STORMS E K

THE REFRACTORY CARBIDES, P171 (1967)

THE URANIUM-URANIUM DICARBIDE SYSTEM

WORK FROM THE LITERATURE ABOUT VARIOUS PROPERTIES SUCH AS PHASE RELATIONSHIP, LATTICE PARAMETERS, CRYSTAL STRUCTURE, CHEMICAL REACTIVITY, HARDNESS AND THERMO-CHEMICAL PROPERTIES SUCH AS ENTHALPY SPECIFIC HEAT, ENTROPY, HEAT OF FORMATION, FREE ENERGY OF FORMATION, VAPOR PRESSURE AND HEAT OF VAPORIZATION HAS BEEN COMPILED AND ASSESSED. THE SYSTEM CONSIDERED IS URANIUM-URANIUM DICARBIDE SYSTEM.

ABSTRACT 648

STORMS E K

THE REFRACTORY CARBIDES, P214 (1967)

THE PLUTONIUM-PLUTONIUM DICARBIDE SYSTEM

REVIEW OF PHASE DIAGRAM OF THE PU-C SYSTEM, LATTICE PARAMETERS FOR PLUTONIUM METAL AND ITS CARBIDES, AND THERMOCHEMICAL PROPERTIES SUCH AS HEAT OF FORMATION, ENTHALPY, SPECIFIC HEAT, AND ENTROPY FOR PUC SUB 0.77 (BETWEEN 400 DEG AND 1300 DEG K) ARE GIVEN. AUTHOR HAS ALSO GIVEN THE

ABSTRACT 648 (CONT'D)

EQUATIONS FROM THE LITERATURE FOR PRESSURE OF PU OVER PUC SUB 2 AND C FROM 1773 DEG TO 2500 DEG K. HE HAS ALSO DISCUSSED THE VAPORIZATION BEHAVIOR OF PU-C SYSTEM.

ABSTRACT 649

STORMS E K

THERMODYNAMICS VOL 1, 309 (1966); LA-DC-6953 (1965)

A MASS SPECTROMETRIC STUDY OF THE VAPOUR PRESSURE OF U(G) AND UC SUB 2 (G) OVER VARIOUS COMPOSITIONS IN THE URANIUM-CARBON SYSTEM

THE PRESSURE OF U(G) AND UC SUB 2 (G), AND THE RESULTING PARTIAL HEATS OF VAPORIZATION OF U(G) AND C(G) HAVE BEEN MEASURED AS A FUNCTION OF COMPOSITION FROM UC + U(L) TO UC SUB 2 + C. AN ABRUPT PRESSURE CHANGE WITH COMPOSITION WAS FOUND NEAR UC SUB 1.0 AND A MUCH LESSER CHANGE WITHIN THE UC SUB 2 REGION. THE PARTIAL HEAT OF VAPORIZATION OF U(G) AT APPROX 2200 DEG K SHOWS A SIMILAR RAPID CHANGE IN VALUE THROUGH UC SUB 1.0 WITH A MAXIMUM NEAR UC SUB 1.2 AT 167 #2 KCAL/MOLE. ANOTHER MAXIMUM OCCURS IN THE UC SUB 2 REGION AT 147#2 KCAL/MOLE AND UC SUB 1.85. THE HEAT OF VAPORIZATION BASED ON THE UC SUB 2 + C REGION IS TOO LOW SINCE THE UC SUB 2 PHASE CHANGES COMPOSITION WITH TEMPERATURE. THE MEASURED PRESSURES ARE CONSISTENT WITH CONGRUENT VAPORIZATION NEAR UC SUB 1.1. EVIDENCE IS PRESENTED SUPPORTING A VALUE FOR THE HEAT OF VAPORIZATION OF URANIUM NEAR 126 KCAL/MOLE. USING THIS VALUE, THE MEASURED PRESSURES IN THE U-C SYSTEM SHOW EXCELLENT AGREEMENT WITH THE OTHER THERMODYNAMIC MEASUREMENTS. A RE-EVALUATION HAS BEEN MADE OF THE HIGH TEMPERATURE THERMAL FUNCTIONS OF U, UC, AND UC SUB 2 WITH THE RESULT THAT SIGNIFICANT CHANGES MUST BE MADE IN THE CURRENTLY USED VALUES. SEVERAL AREAS OF THE PHASE DIAGRAM HAVE BEEN DETERMINED BOTH DIRECTLY AND FROM THE PRESSURE MEASUREMENTS AND ARE COMPILED INTO A PHASE DIAGRAM OF THE SYSTEM.

ABSTRACT 650

STRASSER A

CONF-671005-7 (1967)

IRRADIATION PERFORMANCE OF URANIUM-PLUTONIUM CARBIDE FUELS:
THE USA EXPERIENCE

THE UNITED STATES IRRADIATION EXPERIENCE WITH URANIUM-PLUTONIUM CARBIDES IS PRESENTED, AND THEIR PERFORMANCE POTENTIAL IS EVALUATED. URANIUM-PLUTONIUM CARBIDES HAVE BEEN IRRADIATED IN THE FORM OF HIGH-DENSITY PELLETS TO 114,000 MWD/T, LOW-DENSITY PELLETS TO 18,000 MWD/T, AND VIRATORY COMPACTED PARTICLES TO 62,000 MWD/T AT POWERS UP TO 330 W/G, 260 W/G, AND 470 W/G, RESPECTIVELY, IN THERMAL AND FAST REACTORS. ALL RODS WERE HELIUM BONDED. THE FUEL PERFORMED WITHOUT SIGNIFICANT MICROSTRUCTURAL CHANGES, SUCH AS MELTING OR GRAIN GROWTH. PLUTONIUM REDISTRIBUTION OR FISSION PRODUCT SEGREGATION DID NOT OCCUR. VOIDS DUE TO FISSION GAS AGGLOMERATION FORMED AT THE CENTER OF HIGH-DENSITY PELLETS ABOVE 250 W/G OR ABOVE 100,000 MWD/T. THE MAXIMUM CLAD CD INCREASE WAS 0.9% PER 10,000 MWD/T. ONE PERCENT OF THE FISSION GASES WERE RELEASED FROM HIGH-DENSITY PELLETS BELOW 16×10^{20} FISSIONS/CC, AND 40% ABOVE 32×10^{20} FISSIONS/CC. ALL CLADS WERE INTACT BELOW APPROX 30,000 MWD/T. ABOVE THIS LEVEL, BRITTLE FRACTURES OF STAINLESS STEEL CLADS OCCURRED-ALTHOUGH ALL REFRACTORY CLADS WERE INTACT. THE THERMODYNAMIC COMPATIBILITY OF THE CARBIDES WITH STAINLESS STEEL, NIOBIUM, AND VANADIUM CLADS WAS EXCELLENT UP TO 10,600 HR OF OPERATION. SIX FULL-LENGTH FUEL

ABSTRACT 650 (CONT'D)

RODS CONTAINING SOLID-SOLUTION PELLETS, VIBRATORILY COMPACTED MIXED PARTICLES, AND VIBRATORILY COMPACTED SOLID-SOLUTION PARTICLES WERE RECENTLY REMOVED FROM EBR-II AFTER IRRADIATION UP TO 28,000 MWD/T. THE ELEMENTS HAVE BEEN IRRADIATED AT A MAXIMUM LINEAR HEAT RATING OF 950 W/CM (29 KW/FT) IN TYPE 316 STAINLESS STEEL, VANADIUM, AND VANADIUM-20 WT % TITANIUM CLADDING. EXAMINATION OF THE FUEL RODS INDICATED THAT THE CLADDING OF ALL THREE ELEMENTS WAS INTACT EXCEPT FOR A HELD CRACK IN THE V-20 WT % TI. MEASUREMENTS SHOW THAT LESS THAN 0.5% OF THE FISSION GAS WAS RELEASED BY THE HIGH-DENSITY PELLETS, AND LESS THAN 20% FROM THE VIBRATORY COMPACTED PARTICLES. PRELIMINARY METALLOGRAPHIC EXAMINATIONS INDICATED NO MELTING OR GRAIN GROWTH IN THE HIGH-DENSITY PELLETS. SMALL FISSION GAS VOIDS FORM IN THE CENTER OF THE RODS AT THE HIGHER POWERS. SINTERING OF VIBRATORY COMPACTED MATERIAL OCCURRED IN SOLID SOLUTION MATERIAL AT 950 W/CM (29 KW/FT), BUT NOT IN PHYSICALLY MIXED PARTICLES AT 820 W/CM.

ABSTRACT 651

STRASSER A

NUCL MET MET SOC AIME 13, 460 (1968)

IRRADIATION PERFORMANCE OF URANIUM-PLUTONIUM CARBIDE FUELS-
THE U.S.A EXPERIENCE

URANIUM-PLUTONIUM CARBIDES HAVE BEEN IRRADIATED IN THERMAL AND FAST REACTORS, IN THE FORM OF HIGH AND LOW DENSITY PELLETS AND VIBRATORY COMPACTED POWDERS. MAXIMUM PERFORMANCE LEVELS ACHIEVED ARE 36×10^{20} FISSION/CC ($114,000$ MWD/T), AND 470 W/G. THE FUEL PERFORMED WITHOUT SIGNIFICANT MICROSTRUCTURAL CHANGES, SUCH AS MELTING OR GRAIN GROWTH. PLUTONIUM REDISTRIBUTION OR SIGNIFICANT FISSION PRODUCT SEGREGATION DID NOT OCCUR. VOIDS DUE TO FISSION GAS AGGLOMERATION FORMED AT HIGH TEMPERATURES AND BURNUPS. THE MAXIMUM CLAD OD INCREASE WAS 0.9% PER $10,000$ MWD/T. ONE PERCENT OF THE FISSION GASES WAS RELEASED FROM HIGH DENSITY PELLETS BELOW 16×10^{20} FISSION/CC, AND 40% ABOVE 32×10^{20} FISSION/CC. THE THERMODYNAMIC COMPATIBILITY OF THE CARBIDES WITH STAINLESS STEEL, NIOBIUM, AND VANADIUM CLADS WAS EXCELLENT UP TO $10,600$ HOURS OF OPERATION.

ABSTRACT 652

STRASSER A

NUCLEAR METALLURGY. AIME 10,729 (1964)

IRRADIATION BEHAVIOR OF SOLID SOLUTION U-PU-MOND CARBIDES

EIGHT CLAD SPECIMENS OF (U SUB 0.8 PU SUB 0.2) C SUB 0.95 WERE IRRADIATED TO TWO BURNUP LEVELS (APPROX 5×10^{20} AND 11×10^{20} FISSION/CC AVERAGE) AT AVERAGE POWER LEVELS OF 330 TO 530 W/CM. THE DESCRIPTION OF THE EXPERIMENTS AND THEIR RESULTS ARE GIVEN HERE.

ABSTRACT 653

STRASSER A

PROC ON THE CONF ON FAST REACTOR FUEL ELEMENT TECHNOLOGY, 849 (1971)
IRRADIATION OF HIGH-DENSITY (U,PU)C PELLET FUEL RODS TO 65,000 MWD/MT
BURNUP IN EBR-II

THIS REPORT SUMMARIZES THE RESULTS OF A SERIES OF HELIUM-BONDED, AUSTENITIC-CLAD, FUEL ROD IRRADIATIONS WITH HIGH-DENSITY URANIUM-PLUTONIUM CARBIDE (U,PU)C PELLETS IN THE FAST REACTOR, EBR-II. THE % Δ V/V OF THE FUEL AND CLADDING RANGED FROM 0.6 TO 0.9 PER 10**20 FISS/CM**3. THE CLADDING DIAMETER INCREASE ABOVE WHICH FAILURE OCCURRED WAS SLIGHTLY OVER 1%. INCOLOY-800 PERFORMED BETTER THAN TYPE 316 STAINLESS STEEL CLADDING. THE IRRADIATED FUEL MICROSTRUCTURE WAS SIMILAR TO THE PRE-IRRADIATION STRUCTURE, WITH THE EXCEPTION OF THE FORMATION OF FISSION GAS BUBBLES AND THE DISAPPEARANCE OF THE SESQUICARBIDE PHASE IN THE CENTER OF THE HIGH- POWER, HIGH-BURNUP RODS. THE PLUTONIUM AND FISSION PRODUCT DISTRIBUTION IN THE FUEL WAS UNIFORM AFTER IRRADIATION. THERE WERE NO IDENTIFIABLE REACTIONS BETWEEN THE FUEL, FISSION PRODUCTS, AND THE CLADDINGS. THE RESULTS INDICATE THAT TO REACH A GOAL OF 100,000 MWD/MT, FUEL RODS WITH HIGH-DENSITY PELLETS WILL HAVE TO HAVE A MINIMUM OF AN 11% HOT VOID WHICH IS AN EQUIVALENT OF 0.014 IN. IN DIAMETRAL COLD FUEL-CLADDING GAP FOR 0.25-IN.-DIAM PELLETS. (HOT VOID IS THE AMOUNT OF VOID SPACE INSIDE THE CLADDING, WITHIN THE FUELED LENGTH, AT THE BEGINNING-OF-LIFE TEMPERATURE DISTRIBUTION. FOR THESE FUEL RODS, IT IS APPROX 1% LESS THAN THE COLD SMEARED DENSITY.)

ABSTRACT 654

STRASSER A

TRANS AM NUCL SOC 12, 597 (1969)

IRRADIATION OF U-PU CARBIDES

HELIUM-BONDED, HIGH-DENSITY MIXED-CARBIDE PELLET RODS PERFORM EXCELLENTLY UP TO 40,000 MWD/T AT 28 KW/FT WITH ORIGINAL FUEL-CLAD GAPS OF 0.006 IN. OR HIGHER WITH EITHER TYPE-316 OR INCOLOY-800 CLAD. THE SWELLING Δ V/V OF (U,PU)C RANGES FROM <2.0 TO 2.5%/10,000 MWD/T. THIS CHECKS REASONABLY WITH 1.8% MEASURED AT LOWER POWERS. INCOLOY-800 HAS DUCTILITY AT LEAST AS GOOD AS TYPE-316. THE EFFECT OF POWER ON CLAD O.D. CHANGE MAY BE GREATER THAN THE EFFECT OF INITIAL FUEL-TO-CLAD GAP.

ABSTRACT 655

STRASSER A

UCC-MTL-4470 (1965)

URANIUM-PLUTONIUM CARBIDE FUELS FOR FAST BREEDER REACTORS, FAST REACTOR TECHNOLOGY NATIONAL TOPICAL MEETING, DETROIT, MICHIGAN.

URANIUM-PLUTONIUM CARBIDE FUEL HAS AN EXCELLENT POTENTIAL FOR PRODUCING THE LOWEST FUEL CYCLE COST AMONG THE THREE MAJOR FAST BREEDER REACTOR FUELS: METAL, OXIDE, AND CARBIDE. ENCOURAGING RESULTS HAVE BEEN OBTAINED BY IRRADIATING THE FUEL UP TO AN AVERAGE OF 37.6*10**20 FISS/CM**3 (114,000 MWD/T) AND 150 TO 330 KW/KG (U + PU). THE MICROSTRUCTURE IS STABLE, DIAMETER INCREASE IS 0.6% PER A/D BURNUP, AND FISSION GAS RELEASE IS LESS THAN FOR MIXED OXIDES. THE COMPATIBILITY OF THE FUEL WITH CLAD IS EXCELLENT UP TO A MINIMUM OF 870 DEG C. THE (U,PU)C AND SOME OF THE SIGNIFICANT UC PROPERTY DATA ARE REVIEWED, AND THE CONCLUSION REACHED THAT IMMEDIATE GOALS CAN BEST BE ACHIEVED BY THE USE OF HYPERSTOICHIOMETRIC, HELIUM CONTACT-BONDED AND POSSIBLY HYPOSTOICHIOMETRIC, SODIUM-BONDED (U,PU)C, AND FUTURE GOALS BY

ABSTRACT 655 (CONT'D)

STOICHIOMETRIC OR HYPERSTOICHIOMETRIC (U,PU)C, SODIUM OR HELIUM BONDED.

ABSTRACT 656

STRASSER A

UNC-5056 (1963)

CARBIDE FUEL DEVELOPMENT

FUEL FABRICATION AND EVALUATION. THE SYNTHESIS AND FABRICATION OF (U SUB 0.95 PU SUB 0.05)C SUB 0.98 TEST SPECIMENS BY COLD PRESSING AND SINTERING FOR OUT-OF-PILE PROPERTY MEASUREMENTS WERE COMPLETED. THEORETICAL DENSITIES OF 91% (AVG) WERE OBTAINED WITHOUT SINTERING AID AND 96% (AVG) WITH 0.1 WT % NICKEL SINTERING AID. MIXED SESQUICARBIDE, (U SUB 0.8 PU SUB 0.2) SUB 2 C SUB 3, WAS SYNTHESIZED AND FABRICATED INTO PELLETS 94% OF THEORETICAL DENSITY. MASSIVE, CARBON-STABILIZED PU₂ WAS SYNTHESIZED BY THE CARBON REDUCTION OF THE DIOXIDE. THE CARBON CONTENT OF THE PRODUCT WAS 0.14 WT. %. THE COEFFICIENTS OF EXPANSION OF (U SUB 0.95 PU SUB 0.05)C SUB 0.98 WITH AND WITHOUT NICKEL SINTERING AID WERE MEASURED TO 1400 DEG C, AND FOUND TO BE 12.2 TO 12.6*10⁻⁶/ DEG C. MEASUREMENTS OF MELTING POINT AND VAPOR PRESSURE OF MIXED MONOCARBIDES WERE STARTED BY TESTING STANDARDS. COMPATIBILITY TESTS AT 593 AND 816 DEG C WERE STARTED. EXAMINATION OF RESULTS TO DATE SHOW A REACTION BETWEEN (U SUB 0.95 PU SUB 0.05) C SUB 0.98 AND ZIRCALCY-2, AND NO REACTION WITH TYPE 316 STAINLESS STEEL AND NIOBIUM AFTER 1000 H AT 816 DEG C. THIS IS SIMILAR TO PREVIOUS RESULTS WITH JC. IRRADIATION TESTS. THE ASSEMBLY OF ALL THE IRRADIATION CAPSULES WAS COMPLETED. TEN OF THE 12 PLANNED SPECIMENS OF (U SUB 0.8 PU SUB 0.2) C SUB 0.95 ARE CURRENTLY OPERATING IN THE GETR. THE LONGEST BURNUP OBTAINED TO DATE IS 13000 MWD/TON (AVG).

ABSTRACT 657

STRASSER A

UNC-5065 (1963)

OUT-OF-PILE PROPERTIES OF MIXED URANIUM-PLUTONIUM CARBIDES

FABRICATION STUDIES TO PRODUCE HIGH DENSITY SOLID SOLUTIONS OF 80% UC-20% PUC, WITH REPRODUCIBLE STRUCTURE, COMPOSITION, AND DENSITY, WERE COMPLETED. TWO TYPES OF MATERIAL WERE PRODUCED: (U SUB 0.8 PU SUB 0.2) C SUB 0.95, SINGLE-PHASE MONOCARBIDE PELLETS WITH AVERAGE DENSITIES OF 12.8 G/CM³ (94% OF THEORETICAL), SINTERED AT 1950 DEG C; AND (U SUB 0.8 PU SUB 0.2) C SUB 0.95 + 0.1 WT.% NI SINTERING AID, MAJOR MONOCARBIDE AND MINOR AMOUNT OF SESQUICARBIDE PELLETS, WITH AVERAGE DENSITIES OF 13.1 G/CM³ (96.5% OF THEORETICAL) SINTERED AT 1550 DEG C. BAR-SHAPED THERMAL EXPANSION SPECIMENS WERE FABRICATED OF UC, PRIOR TO FABRICATION OF SIMILAR (U,PU)C SPECIMENS. UC PELLETS WERE FABRICATED FOR ELECTRO-POLISHING AND LIQUID-METAL BONDING STUDIES. CHEMICAL ANALYSIS PROCEDURES WERE ESTABLISHED AND CHECKED FOR PLUTONIUM, NITROGEN, AND OXYGEN. CHEMICAL ANALYSIS PROCEDURES FOR CARBON ARE BEING ESTABLISHED. THE EXPERIMENTAL SETUPS FOR THE MEASUREMENT OF COEFFICIENT OF THERMAL EXPANSION, THERMAL STABILITY, MELTING POINT, AND FUEL CLADDING COMPATIBILITY WERE COMPLETED. TESTING OF THERMAL EXPANSION, VAPOR PRESSURE, AND MELTING POINT STANDARDS WAS INITIATED. UC-LIQUID METAL-TANTALUM COMPATIBILITY TESTS WERE COMPLETED, AND (U,PU)C-LIQUID METAL-TANTALUM COMPATIBILITY SPECIMENS WERE PREPARED. THESE TESTS ARE TO HELP IN CHOOSING A LIQUID-METAL BOND FOR THE THERMAL CONDUCTIVITY TEST. THE PRE-INSTALLATION TESTS FOR THE SAFE PERFORMANCE OF THE HIGH TEMPERATURE

ABSTRACT 657 (CONT'D)
MEASUREMENTS GLOVE BOX WERE NEARLY COMPLETED.

ABSTRACT 658
STRASSER A
UNC-5094 (1964)
CARBIDE FUEL DEVELOPMENT

THE MELTING (LIQUIDUS) TEMPERATURE OF (U SUB 0.96 PU SUB 0.05)C SUB 0.98 WAS DETERMINED TO BE 2535 $\pm$ 20 DEG C; THE SOLIDUS TEMPERATURE WAS ESTIMATED TO BE 2500 $\pm$ 20 DEG C. THE VAPOR PRESSURES OF U AND PU OVER (U SUB 0.96 PU SUB 0.05)C SUB 0.98 WERE MEASURED BY THE KNUDSEN EFFUSION TECHNIQUE. PU VAPORIZED AT A HIGHER RATE THAN U. THE U VAPOR PRESSURE OVER (UPU)C WAS SIMILAR TO THAT OF U OVER UC. POST-IRRADIATION EXAMINATION OF THE NB CLADDING AND SPECIMEN PARTS WHICH HAD BEEN IN CONTACT WITH (U SUB 0.8 PU SUB 0.2)C SUB 0.96 FUEL REVEALED THAT NO REACTIONS HAD OCCURRED AFTER 3270 H AT 795 DEG C. NIOBIUM SPECIMEN PARTS DID NOT REACT AFTER 3270 H AT 1000 DEG C, HOWEVER, CARBURIZATION WAS NOTED AT SLIGHTLY HIGHER TEMPERATURES. A POST-IRRADIATION EXAMINATION OF FOUR CLAD (U SUB 0.8 PU SUB 0.2)C SUB 0.95 SPECIMENS IRRADIATED WITH A GREATER DOSAGE DISCLOSED THAT THE FUEL WAS STABLE, FISSION GAS RELEASE WAS LOW (1.5% MAX), DIMENSIONAL CHANGES RELATIVELY SMALL (UP TO 5% VOLUME INCREASE), AND THE MICROSTRUCTURE WAS ESSENTIALLY UNCHANGED. NO SIGNIFICANT DIFFERENCES WERE NOTED IN THE BEHAVIOR OF FUEL WITH OR WITHOUT A NI SINTERING AID. THE NB-CLAD SPECIMENS WERE SOUND, THEIR DIMENSIONS DID NOT CHANGE, AND NO INCOMPATIBILITY WAS DISCOVERED. STAINLESS STEEL-CLAD SPECIMENS WERE RUPTURED BY LONGITUDINAL BRITTLE CRACKS. THE RUPTURES ARE BELIEVED TO BE THE RESULT OF A DRASTIC, HIGH TEMPERATURE DECREASE IN THE STEELS DUCTILITY TO A LEVEL BELOW THAT REQUIRED TO ACCOMMODATE THE FUEL EXPANSION STRAINS. THE TYPE 316 STAINLESS STEEL CLADDING OPERATED AT 760 DEG C MAXIMUM FOR 3270 H. THE DECREASE IN DUCTILITY PROBABLY RESULTED FROM HIGH TEMPERATURE IRRADIATION IN A THERMAL NEUTRON FLUX. THE CLADDING DID NOT REACT WITH THE FUEL AT POINTS OF TIGHT CONTACT, HOWEVER, REACTIONS OCCURRED IN THE CLADDING OPPOSITE FUEL PELLET INTERFACES AND CRACKS. EVIDENCE TO DATE INDICATES THE REACTION TO BE A TRANSFER OF U AND PU TO THE CLADDING BY NA WHICH HAD ENTERED THE SPECIMENS AFTER THE RUPTURE. NO CORRELATION OF THE REACTED ZONES WITH THE RUPTURE WAS EVIDENT.

ABSTRACT 659
STRASSER A
UNC-5134 VOL I (1965)
CARBIDE FUEL DEVELOPMENT

HEAT TRANSFER, NUCLEAR, AND PRELIMINARY COST STUDIES WERE CONDUCTED TO EVALUATE THE POTENTIAL OF CARBIDE FUELS IN FAST BREEDER POWER REACTORS. A PROCESS DEVELOPED TO PRODUCE HIGH DENSITY (UPU)C PELLETS. THE STARTING MATERIALS UO SUB 2, AND C WERE BLENDED AND REACTED AT 1625 DEG C TO PRODUCE A (UPU)C CLINKER. THE CLINKER WAS CRUSHED TO A FINE POWDER, COLD PRESSED, AND SINTERED AT 1525 DEG C TO 95% MINIMUM THEORETICAL DENSITY WITH 0.1 WT% NI SINTERING AID, OR SINTERED AT 1925 DEG C TO 91 WT% THEORETICAL DENSITY WITHOUT SINTERING AID. THE PROCESS WAS USED TO PREPARE SAMPLES AT 5 AND 20 WT% PUC LEVELS. ESSENTIALLY STOICHIOMETRIC UC POWDER WAS PREPARED BY THE C REDUCTION OF UO SUB 2 IN A HE ATMOSPHERE. ATTEMPTS TO PREPARE STOICHIOMETRIC PUC BY THE C REDUCTION OF PUO SUB 2

ABSTRACT 659 (CONT'D)

FAILED. PU SUB 2 C SUB 3 AND (UPU)SUB 2 C SUB 3 WAS READILY OBTAINED BY REACTING STOICHIOMETRIC AMOUNTS OF PUO SUB 2, UO SUB 2, AND C. SINTERING (U SUB 0.8 PU SUB 0.2)C AT 1500 DEG C WITH 0.1 WT% NI SINTERING AID PRODUCED A STRUCTURE OF MONOCARBIDE WITH A SECOND PHASE OF SESQUICARBIDE. SINTERING WITHOUT SINTERING AID AT 1900 DEG C OF HIGHER PRODUCED MONOCARBIDE WITH A SECOND PHASE OF DICARBIDE. HIGH-TEMPERATURE HEAT TREATMENT (1750 TO 2200 DEG C) IN VACUUM CAUSED THE NI TO DIFFUSE TO THE GRAIN BOUNDARIES. IN VACUUM, THE NI COULD BE EVAPORATED. SOME OF THE RESIDUAL O SUB 2 IN PELLETS COULD BE REACTED BY VACUUM HEAT TREATMENT AND REMOVED AS CO, WITH AN ATTENDANT SLIGHT SWELLING AND DECREASE IN DENSITY. THE LATTICE PARAMETER OF (U SUB 0.8 PU SUB 0.2)C DID NOT CHANGE SIGNIFICANTLY IN SEVEN MONTHS. TESTS UP TO 820 DEG C FOR 4000 H SHOW THAT UC IS COMPATIBLE WITH TYPE 304 STAINLESS STEEL, 2 1/4 CR-1 MO STEEL, AND PURE NB. THE TESTS SHOW THAT UC REACTED WITH INCONEL-X, BE, AND ZIRCALOY-2. (U SUB 0.95 PU SUB 0.05)C WAS COMPATIBLE WITH TYPE 316 STAINLESS STEEL, 2 1/4 CR-1 MO STEEL, PURE NB, AND NB-1 ZR ALLOY. IT REACTED WITH ZIRCALOY-2. THE COEFFICIENT OF EXPANSION OF (U SUB 0.95 PU SUB 0.05)C SUB 0.98 AT 25 TO 1400 DEG C WAS MEASURED AS $12.6 \times 10^{-6}/\text{DEG C}$ AND THAT OF (U SUB 0.95 PU SUB 0.05)C SUB 0.98 +1 WT% NI AT 25 TO 1400 DEG C WAS MEASURED AS $12.2 \times 10^{-6}/\text{DEG C}$. THE EXPANSION CURVES WERE SMOOTH AND INDICATED THAT NO TRANSFORMATIONS OCCURRED. THE LIQUIDUS TEMPERATURE OF (U SUB 0.95 PU SUB 0.95)C SUB 0.98 WAS DETERMINED TO BE 2535 ± 20 DEG C. THE SOLIDUS TEMPERATURE WAS ESTIMATED TO BE 2500 ± 20 DEG C. THE VAPOR PRESSURES OF U AND PU OVER (U SUB 0.95 PU SUB 0.05)C SUB 0.98 WERE MEASURED BY THE KNUDSEN EFFUSION TECHNIQUE. THE PU VAPORIZED AT A HIGHER RATE THAN THE U. THE U VAPOR PRESSURE OVER (UPU)C WAS SIMILAR TO THAT OF U OVER UC. THE DIFFICULTY IN MAINTAINING CONSTANT SAMPLE COMPOSITION AT HIGH TEMPERATURES FOR RELATIVELY LONG TIMES INCREASED THE DIFFICULTY OF THE MEASUREMENTS.

ABSTRACT 660

STRASSER A

UNC-5134 VOL II (1965)

CARBIDE FUEL DEVELOPMENT

IRRADIATION TESTS OF 12 CLAD (U SUB 0.8 PU SUB 0.2)C SPECIMENS IN THE RANGE OF 20000 TO 113000 MWD/T AT 490 TO 570 W/CM (AVERAGE) DEMONSTRATED THE STRUCTURAL AND DIMENSIONAL STABILITY OF THE FUEL. THE MICROSTRUCTURE OF THE FUEL WAS ESSENTIALLY UNCHANGED BY IRRADIATION. THE FUEL O.D. INCREASED 0.5 TO 0.6% PER AT.% BURN-UP. THE FISSION GAS RELEASE INCREASED FROM LESS THAN 1% AT 7×10^{20} FISSIONS/CM³ AND 1% AT 13×10^{20} FISSIONS/CM³ TO 30% AT 38×10^{20} FISSIONS/CM³. THIS WAS ACCOMPANIED BY A SIGNIFICANT INCREASE IN FUEL POROSITY AT THE CENTRE. NO SIGNIFICANT DIFFERENCES WERE NOTED BETWEEN THE 91% DENSE FUEL WITHOUT SINTERING AID, AND THE 95% DENSE FUEL MADE WITH NI SINTERING AID. THE SIX NB-CLAD SPECIMENS WERE SOUND AND IN EXCELLENT CONDITION. THE CLAD O.D. WAS UNCHANGED UP TO 3500 MWD/T. AT 11400 MWD/T, THERE WAS AN AVERAGE 2.5% O.D. INCREASE. OF THE SIX STAINLESS STEEL-CLAD SPECIMENS, ONE WAS IN EXCELLENT CONDITION, ONE FAILED BECAUSE OF AN EXPERIMENT MALFUNCTION, AND FOUR WERE RUPTURED AS A RESULT OF THE DRASTIC DECREASE IN STEEL DUCTILITY TO A LEVEL BELOW THAT REQUIRED TO ACCOMMODATE STRAINS FROM FUEL EXPANSION AND THERMAL STRESSES.

ABSTRACT 661

STURIALE T J

PWAC 477 (1965)

SELF DIFFUSION OF NITROGEN IN URANIUM MONONITRIDE

A GAS-SOLID EXCHANGE TECHNIQUE WAS USED TO MEASURE N SUB 2 SELF-DIFFUSION RATES AND ACTIVATION ENERGY FOR DIFFUSION IN UN, USING (15N) AS THE TRACER ATOM. ABOVE 1500 DEG C $D = 2.6 \times 10^{-4} \exp (-55,000/RT)$ CM**2/SEC. BELOW 1500 DEG C THE APPARENT ACTIVATION ENERGY FOR GRAIN BOUNDARY DIFFUSION IS 29 KCALS/MOLE.

ABSTRACT 662

SUZUKI H

BULL TOKYO INST TECHNOL 69 (1965)

BEHAVIOR REFERRED TO THE TRANSFORMATION OF UC SUB 2 AT HIGH TEMPERATURES

THE THERMAL EXPANSION AND CONTRACTION FROM 700 TO 2300 DEG C OF THE SINTERED UC SUB 2 WAS MEASURED AND 2.1% OF EXTRAORDINARY VOLUME CHANGE WAS FOUND AT ABOUT 1800 DEG C. AFTER THE CHANGE WAS DISCUSSED ON THE BASIS OF THE RESULT OF X-RAY DIFFRACTION AND REFLECTING MICROSCOPIC OBSERVATION, THE HIGH-TEMPERATURE PHASE WAS FOUND TO BE THE CUBIC TYPE OF UC SUB 2-X. THIS TRANSFORMATION SHOULD BE NOTICED IN THE PRODUCTION AND USE OF REACTOR FUEL.

ABSTRACT 663

TACHIS A M

AECI-2521 (1966)

IN-REACTOR THERMAL CONDUCTIVITY OF URANIUM CARBIDE.

SIX PLAIN NATURAL UC FUEL ELEMENTS AND ONE WITH FOUR THERMOCOUPLES WERE IRRADIATED IN THE X-7 LOOP OF THE NRX REACTOR. THE SHEATHING MATERIAL WAS SAP. THE PRINCIPAL AIM OF THE EXPERIMENT WAS TO DETERMINE THE IN-REACTOR THERMAL CONDUCTIVITY OF UC WHICH WAS FOUND TO BE REPRESENTED BY THE EQUATION: $K = 0.113 (1 + 3.67 \times 10^{-4} T)$, WHERE K IS THE THERMAL CONDUCTIVITY IN W/CM DEG C AND T IS THE TEMPERATURE IN DEG C. AFTER THE IRRADIATION, THE THERMOCOUPLE ELEMENT WAS DESTRUCTIVELY EXAMINED IN THE METALLURGY CAVES. THE RESULTS OF THE IRRADIATION AND OF THE EXAMINATION OF THE FUEL ARE GIVEN.

ABSTRACT 664

TAGAWA H

J ATOMIC ENERGY (JAPAN) 13, 267 (1971)

PHASE BEHAVIORS AND CRYSTAL STRUCTURES OF THE ACTINIDE NITRIDES.

THE INFORMATION AVAILABLE TO DATE ON THE PHASE BEHAVIORS AND THE LATTICE PARAMETERS OF U-N, U-C, PU-C AND PU-N SYSTEMS IS REVIEWED.

ABSTRACT 665

TAGAWA H

J NUCL MATER 34, 116 (1970)

THE VARIATION OF LATTICE PARAMETER WITH CARBON CONTENT OF NON-STOICHIOMETRIC URANIUM DICARBIDE

THE STRUCTURE OF α -UC SUB 2 HAS BEEN DETERMINED TO BE THE CAC SUB 2-TYPE BODY CENTERED TETRAGONAL BELOW 1765 DEG C BY X-RAY AND NEUTRON DIFFRACTION. NUMEROUS LATTICE PARAMETERS HAVE BEEN REPORTED FOR α -UC SUB 2, BUT THEY ARE NOT IN AGREEMENT. THE ROOM TEMPERATURE LATTICE PARAMETERS ARE SCATTERED BETWEEN A SUB 0=3.515 Å AND C SUB 0=5.98 Å, AND A SUB 0=3.526 Å AND C SUB 0=6.00 Å, ALSO THE COMPOSITION RANGES FROM UC SUB 1.86 TO UC SUB 1.96. HOWEVER, NO EXACT KNOWLEDGE IS YET OBTAINED ON THE RELATION BETWEEN THE LATTICE PARAMETER AND THE UC SUB 2 COMPOSITION. FROM THE DATA IN THE LITERATURE, IT SEEMS THAT THE SCATTERING IS DUE TO THE NON-STOICHIOMETRIC PROPERTY AND DISTORTED STRUCTURE. THIS LETTER REPORTS THE RELATIONSHIP BETWEEN THE LATTICE PARAMETER AND THE COMPOSITION FOR NON-STOICHIOMETRIC URANIUM DICARBIDE COEXISTING WITH CARBON AS THE SECOND PHASE.

ABSTRACT 666

TAGAWA H

J NUCL MATER 41, 313 (1971)

EQUILIBRIUM NITROGEN PRESSURES AND THERMODYNAMIC PROPERTIES OF URANIUM SESQUINITRIDE

EQUILIBRIUM NITROGEN PRESSURES OVER THE TWO-PHASE REGION UN- U SUB 2 N SUB 3 WERE MEASURED BETWEEN 750 DEG AND 1050 DEG C. NITROGEN PRESSURES WERE ALSO DETERMINED IN THE SINGLE-PHASE REGION OF U SUB 2 N SUB 3. THE U-RICH PHASE BOUNDARY WAS OBTAINED AS 1.542 OF THE N/U ATOM RATIO FROM THE TENSIMETRIC MEASUREMENT. THE DECOMPOSITION PRESSURE OF U SUB 2 N SUB 3 WAS GIVEN BY $\log P_{\text{SUB } N_2}(\text{ATM}) = 7.201 - 11736/T$. THE STANDARD HEAT OF THE DECOMPOSITION, UN SUB 1.54=UN-0.27 N SUB 2, WAS CALCULATED TO BE $\Delta H_{\text{SUB } 298} = 16.74 \text{ KCAL/MOLE}$.

ABSTRACT 667

TAGAWA H

J NUCL MATER 51, 78 (1974)

PHASE RELATIONS AND THERMODYNAMIC PROPERTIES OF THE URANIUM-NITROGEN SYSTEM

THE PRESENT STATE OF KNOWLEDGE OF THE PHASE RELATIONS AND THERMODYNAMIC PROPERTIES OF THE URANIUM-NITROGEN SYSTEM IS GIVEN. EMPHASIS IS PLACED ON THE NONSTOICHIOMETRIC AND THERMODYNAMIC PROPERTIES OF URANIUM SESQUINITRIDE. THE PRESENT PAPER CONSISTS OF TWO PARTS. THE FIRST PART IS ON THE PHASE RELATIONS; AN EQUILIBRIUM PHASE DIAGRAM IS PROPOSED, AND THE RELATIONSHIP BETWEEN STRUCTURE AND LATTICE PARAMETER FOR THE α -U SUB 2 N SUB 3-UN SUB 2 SYSTEM IS SHOWN. THE SECOND PART DEALS WITH THERMODYNAMIC PROPERTIES OF UN AND α -U SUB 2 N SUB 3; THE DATA ON DECOMPOSITION PRESSURES, SPECIFIC HEATS, AND HEATS AND FREE ENERGIES OF FORMATION ARE SUMMARIZED AND EVALUATED.

ABSTRACT 668

TAGAWA H

JAERI-13650 (1969)

REVIEW OF THE PHASE RELATIONS AND THE STRUCTURE OF THE NaCl TYPE COMPOUNDS IN THE SYSTEM U-PU-C-N

THE PRESENT STATE OF KNOWLEDGE OF THE PHASE RELATIONS AND THE STRUCTURES OF THE NaCl TYPE COMPOUNDS IN THE SYSTEM U-PU-C-N ARE REVIEWED, AND FURTHER WORKS IN THESE AREAS ARE POINTED OUT. THE SYSTEMS CONSIDERED ARE U-C, U-C-O, PU-C, PU-C-O, U-PU-C, U-N, PU-N, U-PU-N, U-C-N, PU-C-N AND U-PU-C-N. HAS ALSO REVIEWED VARIATION IN LATTICE PARAMETERS FOR THE ABOVE SYSTEMS.

ABSTRACT 669

TAGAWA H

JAERI-4042 (1968)

STRUCTURE AND FORMATION OF THE CARBIDES OF URANIUM

THE LITERATURE ON THE CARBIDES OF URANIUM IS REVIEWED, INCLUDING THE CRYSTAL STRUCTURES, THERMODYNAMICS AND FORMATION OF THE CARBIDES. MONO- AND DI-CARBIDE OF URANIUM AS NONSTOICHIOMETRIC COMPOUNDS ARE DESCRIBED, WITH EMPHASIS ON THE PHASE DIAGRAM, AND THE EFFECT OF IMPURITIES (OXYGEN AND NITROGEN ETC.,) ON THE LATTICE DIMENSIONS. THE CONDITIONS FOR THE FORMATION AND STABILITY OF THE CARBIDES ARE ALSO DISCUSSED IN THEIR THERMODYNAMICS. THE MECHANISM OF FORMATION OF URANIUM CARBIDES ARE CONSIDERED FROM THE ASPECT OF SELF-DIFFUSION IN THE CARBIDES.

ABSTRACT 670

TAGAWA H

NUCL SCI TECH 8, 244 (1971)

STUDIES ON THE URANIUM DICARBIDE PHASE

THE LATTICE PARAMETERS OF UC SUB 2 ARE EXAMINED AS A FUNCTION OF CARBON CONTENT AND ANNEALING CONDITIONS ON SINTERED CARBIDES BETWEEN UC SUB 1.5 AND UC SUB 2.2 (7.0 TO 10.0 W/O OF CARBON). THE VALUES OF UC SUB 2 OBTAINED UNDER EQUILIBRIUM STATE ARE AROUND A SUB 0 = 3.5253 Å AND C SUB 0 = 5.9994 Å. THE LATTICE PARAMETER MEASUREMENTS WERE MADE ALSO ON UC SUB 2 OBTAINED UNDER NON-EQUILIBRIUM CONDITIONS BY ARC-MELTING AND CARBOTHERMIC REACTION OF UO SUB 2. THE LATTICE PARAMETERS WERE APPRECIABLY SMALLER THAN ON THE SPECIMENS OBTAINED UNDER EQUILIBRIUM. WITH ANNEALING, BOTH THE LATTICE PARAMETER AND THE COMBINED CARBON CONTENT SHOWED A TENDENCY TO INCREASE.

ABSTRACT 671

TAKAHASHI Y

J NUCL MATER 38, 303 (1971)

URANIUM MONONITRIDE: HEAT CAPACITY AND THERMAL CONDUCTIVITY FROM 298 TO 1000 K

THE HEAT CAPACITY AND THE THERMAL DIFFUSIVITY OF URANIUM MONONITRIDE WERE MEASURED BY A LASER FLASH METHOD AT TEMPERATURES RANGING FROM 298 TO 1000 DEG K. THE SAMPLES WERE ARC-MELTED UN HAVING NEARLY ZERO POROSITY AND SINTERED UN HAVING POROSITY OF 10.1%. THE HEAT CAPACITY OF UN WAS REPRESENTED BY $C_{SUB} P = 12.08 + 2.548 \times 10^{-5} T - 1.252 \times 10^{-5} T^2$ CAL/MOL.DEG K (298-1000 DEG K). FROM THE HEAT CAPACITY DATA, ENTROPY, ENTHALPY AND THE GIBBS ENERGY FUNCTION OF UN WERE CALCULATED. THE THERMAL CONDUCTIVITIES

ABSTRACT 671 (CONT'D)

OF ARC-MELTED UN, CALCULATED FROM THE HEAT CAPACITY AND THE THERMAL DIFFUSIVITY DATA, AT 350 AND 1000 DEG K WERE 0.031 AND 0.045 CAL/CM.SEC.DEG K, RESPECTIVELY. THE RESULTS AGREED REASONABLY WELL WITH THOSE OF MOORE ET AL. OBTAINED AT LOWER TEMPERATURES.

ABSTRACT 672

TAKAHASHI Y

JAERI, JAPAN/US RESEARCH NEWLETTER, 7-19 (1970)

THERMAL DIFFUSIVITY OF URANIUM CARBONITRIDE

TEMPERATURE DEPENDENCE AND COMPOSITION DEPENDENCE OF THERMAL DIFFUSIVITIES OF URANIUM CARBONITRIDES ARE GIVEN WITH SIMILAR RESULTS OF NITRIDE AND CARBIDE IN THE TEMPERATURE RANGE OF 300 TO 1500 DEG C.

ABSTRACT 673

TAKEUCHI S

TRANS JAPAN INST OF METALS 5, 111 (1964)

THE REACTION OF URANIUM WITH GRAPHITE AT HIGH TEMPERATURES

THE REACTION OF URANIUM METAL WITH GRAPHITE WAS STUDIED IN THE TEMPERATURE RANGE OF 800 TO 1100 DEG C. IT WAS FOUND THAT THE REACTION RATE IS PARABOLIC AND THAT THE ACTIVATION ENERGY FOR THE REACTION IS 59 KCAL/MOLE. MARKER EXPERIMENTS SHOWED THAT THE GROWTH OF THE CARBIDE FILM WAS DUE MAINLY TO THE MIGRATION OF CARBON. FROM THESE RESULTS THE RATE DETERMINING PROCESS OF THE REACTION SEEMS TO BE THE DIFFUSION OF CARBON THROUGH THE CARBIDE FILM FORMED ON THE METAL SURFACE. HYDROCARBON, YIELDED BY HYDROLYSIS OF THE CARBIDE FILM, WAS ANALYSED BY THE GAS-CHROMATOGRAPHIC METHOD. FROM THESE RESULTS IT WAS CONFIRMED THAT THE FILM FORMED IN THIS TEMPERATURE RANGE WAS COMPOSED OF UC ONLY. THESE RESULTS WERE CONFIRMED BY THE X-RAY DIFFRACTION TECHNIQUE. FROM THESE PARABOLIC RATE CONSTANTS, THE SELF-DIFFUSION COEFFICIENTS OF CARBON IN UC WERE CALCULATED. THESE VALUES WERE EXTRAPOLATED AND FOUND TO AGREE WELL WITH CHUBB'S RESULTS BY TRACER TECHNIQUE.

ABSTRACT 674

TAYLOR K M

AM CER SOC 50, 321 (1967)

MONOXIDE-TYPE COMPOUNDS OF U AND PU: I. OXYCARBIDES

OXYCARBIDES HAVING THE FACE-CENTERED CUBIC MO-TYPE STRUCTURE WERE FORMED BY THE CONTROLLED REDUCTION OF MIXTURES OF PU_{0.2} SUB 2 AND UO₂ SUB 2 IN HELIUM AND IN VACUUM. CARBON, UC, AND U WERE USED AS REDUCING AGENTS. CARBON APPEARED TO BE NECESSARY TO STABILIZE THE MONOXIDE STRUCTURE. THE MAXIMUM OXYGEN CONTENT FOR ESSENTIALLY SINGLE-PHASE (U SUB 0.9 PU SUB 0.1) (O SUB X C SUB 1-X) IS X = 0.4. OXYCARBIDE COMPOSITIONS WITH HIGHER OXYGEN CONTENTS (APPROACHING X = 0.6) CAN BE PRODUCED BUT THESE PRODUCTS ARE MULTIPHASE CONTAINING APPRECIABLE QUANTITIES OF A DIOXIDE, MO SUB 2-X IN CARBON REDUCTION, AND MO SUB 2-X PLUS METAL IN U PLUS UC REDUCTION. THE SINGLE-PHASE OXYCARBIDES LACK SUFFICIENT WATER-CORROSION RESISTANCE TO BE USED AS FUELS IN WATER-COOLED REACTORS; HOWEVER, THEIR THERMAL CONDUCTIVITY APPEARS TO BE HIGHER THAN THAT OF THE DIOXIDE FUELS.

ABSTRACT 675

TAYLOR K M

ORO 400 (1961)

SYNTHESIS AND FABRICATION OF REFRACTORY U COMPOUNDS

UC OF 97 TO 99% PURITY, 92-96% TO, UN OF 85-95% TO, AND U SUB 3 SI SUB 2 OF 96-98% TO WERE PREPARED IN PELLET AND BAR FORM AND CHARACTERIZED WITH RESPECT TO THERMAL EXPANSION, FRACTURE STRENGTH AND THERMAL CONDUCTIVITY.

ABSTRACT 676

TENNERY V J

J AM CERAM SOC 54, 247 (1971)

LATTICE PARAMETER OF (U,Pu)N SOLID SOLUTIONS

THE LATTICE PARAMETERS OF THE CUBIC SOLID SOLUTIONS FROM THE SYSTEM (USUB 1-X PU SUB X)N WERE MEASURED AT 25 DEG C. THE LATTICE CONSTANT, A SUB 0, OF UN WAS 4.88918 ± 0.00017 Å AND THAT OF PUN WAS 4.90476 ± 0.00008 Å. THE PARAMETER OF THE SOLID SOLUTION DOES NOT DEPEND LINEARLY ON THE COMPOSITION PARAMETER, X. THE X-RAY SPECIMENS CONTAINED FROM 600 TO 1200 PPM TOTAL O+C AS IMPURITIES; THUS, THESE SAMPLES HAD MUCH LOWER IMPURITY LEVELS THAN THOSE OF PREVIOUS INVESTIGATORS. THE COMPOSITIONS OF THE X-RAY SPECIMENS WERE CORROBORATED BY QUANTITATIVE CHEMICAL ANALYSIS. THE SIGNIFICANT DEVIATION FROM VEGARD'S RELATION AND THE SMALL VARIATION OBSERVED FOR A SUB 0 IN THIS SYSTEM ARE DISCUSSED IN TERMS OF THE STRONGLY HYBRIDIZED ELECTRON F-D BANDS THAT HAVE BEEN CALCULATED FOR THESE COMPOUNDS.

ABSTRACT 677

TENNERY V J

J AM CERAM SOC 54, 327 (1971)

SINTERING OF UN AS A FUNCTION OF TEMPERATURE AND N SUB 2 PRESSURE

THE SINTERING OF URANIUM MONONITRIDE (UN) DEPENDS ON TEMPERATURE AND THE N PRESSURE MAINTAINED OVER THE NITRIDE DURING HEAT TREATMENT. AT A GIVEN TEMPERATURE, AN N PRESSURE THAT MAINTAINED THE UN IN THE SINGLE-PHASE REGION SLIGHTLY ABOVE THE PHASE BOUNDARY WHERE THE REACTION $UN=U+1/2N$ SUB 2 (G) OCCURRED WAS MOST EFFECTIVE IN ACCELERATING THE SINTERING OF SINGLE-PHASE UN. FOR EXAMPLE, SPECIMENS SINTERED AT 1600 DEG C UNDER N SUB 2 PRESSURES OF EITHER 1140 OR 1.7×10^{-4} TORR HAS ESSENTIALLY IDENTICAL COMPOSITIONS, BUT THE DENSITY OF THE FORMER WAS 10.78 G/CM^3 (75% OF THEORETICAL), WHEREAS THAT OF THE LATTER WAS 12.2 G/CM^3 (85% OF THEORETICAL). RESULTS WERE SIMILAR AT TEMPERATURES UP TO 2100 DEG C. THE X-RAY LATTICE CONSTANT OF UN SINTERED AT REDUCED N SUB 2 PRESSURES WAS SLIGHTLY LARGER THAN THAT OF UN SINTERED IN 1140 TORR OF N SUB 2. THE OBSERVED CONSTANTS RANGED FROM 4.88904 TO 4.88991 Å; THE COMBINED O+C CONTENT VARIED FROM 400 TO 900 PPM.

ABSTRACT 678

TENNERY V J

NUCL TECH 13, 264 (1972)

THE CHEMICAL CHARACTERIZATION OF URANIUM NITRIDES

CHEMICAL ANALYSIS TECHNIQUES WERE DEMONSTRATED FOR THREE URANIUM NITRIDE SPECIMENS. SINTERED URANIUM MONONITRIDE (UN), UNSINTERED UN POWDER, AND UN SUB 1.572 POWDER WERE ANALYZED FOR THE MAJOR CONSTITUENTS, AND A MASS BALANCE OF 100.00±0.03% WAS REALIZED IN EVERY CASE. THE GRAVIMETRIC DETERMINATION OF URANIUM IN THESE MATERIALS BY AN OXIDATION-REDUCTION-OXIDATION METHOD GAVE GOOD PRECISION AND ACCURACY. RESULTS FROM THE DIRECT OXIDATION METHOD WERE STRONGLY DEPENDENT ON THE OXYGEN CONTENT OF THE GAS USED TO OXIDIZE THE SAMPLE. THE CONTROLLED-POTENTIAL COULOMETRIC METHOD WAS USED TO CONFIRM THE GRAVIMETRIC URANIUM RESULTS. THE DUMAS METHOD FOR NITROGEN DETERMINATIONS WAS SHOWN TO BE SUPERIOR TO THE KJELDAHL FOR BOTH UN AND UN SUB 1.572. INERT GAS FUSION IS SUITABLE FOR THE DETERMINATION OF OXYGEN AND A CONVENTIONAL COMBUSTION METHOD IS SUITABLE FOR CARBON DETERMINATIONS. SINTERED UN PROVIDED A MASS BALANCE OF 99.989% WITH A MOLE RATIO $N+O+C/U = 0.997$ AND A CRYSTAL LATTICE PARAMETER $A = 4.8896 \pm 0.0001$ Å. THE MICROSTRUCTURE OF THIS SAMPLE CONSISTED OF SINGLE PHASE MONONITRIDE.

ABSTRACT 679

TENNERY V J

ORNL-4608 (1970)

SYNTHESIS, CHARACTERIZATION AND FABRICATION OF UN- AND THERMAL STABILITY

WE DEVELOPED PROCEDURES FOR SYNTHESIZING FINE URANIUM NITRIDE POWDERS THAT CONTAIN LESS THAN 200 PPM O FROM URANIUM METAL BY THE HYDRIDE-DEHYDRIDE-NITRIDE PROCESS. WE ESTABLISHED A METHOD BASED ON THE PRINCIPLE OF GAS SEDIMENTATION AS SUITABLE FOR MEASURING THE DISTRIBUTION OF PARTICLE SIZES AND FOUND THAT 80% OF THE PARTICLES WERE BETWEEN 1 AND 7 μ M IN DIAMETER. SCANNING ELECTRON MICROSCOPY SHOWED THAT THE PARTICLES WERE VERY IRREGULARLY SHAPED AND THAT EACH PARTICLE HAD SEVERAL PROTRUSIONS FROM THE SURFACE, WHICH EXPLAINS THE DIFFICULTY IN FABRICATING THESE POWDERS. WE FABRICATED URANIUM MONONITRIDE (UN) CYLINDERS BY BOTH UNIAXIAL AND ISOSTATIC PRESSING. UNIAXIAL PRESSING REQUIRED ADDITIVES SUCH AS CAMPHOR TO ACT AS A BINDER AND DIE LUBRICANT, BUT THE ADDITION OF CAMPHOR RESULTED IN ABOUT 1000 PPM O IN THE SINTERED PRODUCT. ISOSTATIC PRESSING REQUIRED NO ADDITIVES AND TYPICALLY RESULTED IN A SINTERED PRODUCT WITH LESS THAN 300 PPM O. WE FOUND THAT THE PRECISION AND ACCURACY POSSIBLE IN THE ANALYSES FOR URANIUM AND NITROGEN WERE THE LIMITING FACTORS FOR ADEQUATE QUANTITATIVE CHEMICAL ANALYSIS OF UN. WE FOUND THAT THE MICROSTRUCTURE OF UN BODIES OF ABOUT 85% THEORETICAL DENSITY WAS VERY STABLE WHEN SUBJECTED TO 1400 DEG C (1673 K) FOR 100 HR IN VACUUM; VERY SMALL SHRINKAGES OF ABOUT 1/2 TO 1% WERE ACCOMPANIED BY VERY SMALL INCREASES IN GRAIN SIZE. CONVENTIONAL GRINDING OF UN PRODUCED MINUTE CRACKS IN THE MACHINED SURFACE, BUT ELECTRODISCHARGE MACHINING PRODUCED VERY SMOOTH SURFACES WITH A THIN COATING OF AN UNIDENTIFIED PHASE.

ABSTRACT 680

TETENBAUM M

ETUDE DES TRANSFORMATIONS CRISTALLINES A HAUTE TEMPERATURE AU-DESSUS DE 2000 K, PAPER NO 205 (1971)

PHASE TRANSFORMATIONS IN THE U-C AND U-O-C SYSTEMS VIA CONTROLLED OXYGEN AND CARBON POTENTIALS

PHASE TRANSFORMATIONS IN THE URANIUM-CARBIDE AND URANIUM-OXYCARBIDE SYSTEMS CAN BE EFFECTED BY CONTROLLING THE CARBON AND OXYGEN POTENTIAL IN THE EQUILIBRATING GAS. WITH THE BINARY UC SUB X SYSTEM, UNIVARIANT AND BIVARIANT COMPOSITIONS HAVE BEEN OBTAINED IN THE TEMPERATURE RANGE 2155 TO 2455 K BY MEANS OF A FLOWING-GAS TECHNIQUE WITH HYDROGEN-METHANE MIXTURES TO FIX THE CARBON POTENTIAL IN THE GAS STREAM. FOR THE SPECIAL CASE OF CONGRUENT EVAPORATION THE CONGRUENT-VAPORIZATION COMPOSITION WAS ESTABLISHED BY FLOWING AND INERT GAS OVER URANIUM CARBIDE AT HIGH TEMPERATURE. WITH THE TERNARY U-C-O SYSTEM SINGLE AND MULTIPHASE URANIUM-OXYCARBIDE COMPOSITIONS WERE OBTAINED BY APPROPRIATE CHOICE OF TEMPERATURE CO PARTIAL PRESSURE, AND CO/CO SUB 2 RATIO IN THE EQUILIBRATING GAS STREAM. DISSOLUTION OF OXYGEN APPEARS TO DECREASE TO A SIGNIFICANT EXTENT THE ACTIVITY OF CARBON IN URANIUM CARBIDE.

ABSTRACT 681

TETENBAUM M

J NUCL MATER 40, 104 (1971)

HIGH-TEMPERATURE THERMODYNAMIC PROPERTIES OF HYPO - AND HYPER - STOICHIOMETRIC URANIUM CARBIDES

MEASUREMENTS OF CARBON ACTIVITY OVER UNIVARIANT AND BIVARIANT UC SUB X COMPOSITIONS, INCLUDING THE DIFFICULT REGION NEAR STOICHIOMETRY, HAVE BEEN MADE IN THE TEMPERATURE RANGE 2155-2455 DEG K. A FLOWING-GAS TECHNIQUE WAS USED WITH H SUB 2- CH SUB 4 MIXTURES IN ORDER TO FIX THE CARBON POTENTIAL IN THE GAS STREAM. THE SHAPE OF THE ISOTHERMS SHOWED A SHARP DECREASE IN CARBON ACTIVITY NEAR THE STOICHIOMETRIC COMPOSITION AS THE COMPOSITION OF THE CONDENSED PHASE WAS REDUCED TOWARD THE LOWER PHASE BOUNDARY IN THE HYPOSTOICHIOMETRIC REGION. WITH ARGON AS THE CARRIER GAS, A CONGRUENT VAPORIZATION COMPOSITION OF C/U APPROX = 1.05 WAS OBTAINED. VALUES FOR THE FREE ENERGY AND HEATS OF FORMATION, RELATIVE PARTIAL MOLAR ENTHALPIES AND ENTROPIES OF SOLUTION, ENTHALPY OF VAPORIZATION AND URANIUM ACTIVITY ARE PRESENTED.

ABSTRACT 682

TETENBAUM M

U S PATENT 3,714,060; (1973)

NUCLEAR REACTOR FUEL AND FUEL ELEMENT AND PREPARATION THEREOF

A NUCLEAR REACTOR FUEL AND FUEL ELEMENT THEREFROM COMPRISING URANIUM OXYCARBIDE CONTAINING 500-2500 PARTS PER MILLION OF OXYGEN HAVING THE EMPIRICAL FORMULA UC SUB 1.00 O SUB .01-.05 PREPARED BY HEATING SINGLE PHASE UC AT A TEMPERATURE IN THE RANGE OF ABOUT 2000 DEG K.-2400 DEG K., PASSING HELIUM CARRIER GAS CONTAINING CO AND CO SUB 2 OVER SAID HEATED UC AT A SUFFICIENTLY HIGH RATIO OF CO TO CO SUB 2 TO PREVENT FORMATION OF UC SUB 2, SUCH AS AT 10,000:1, AND FOR A TIME TO PRODUCE SAID PRODUCT.

ABSTRACT 683

THAMER R J

LA-3646 (1967)

THE USE OF (U,PU)N FUEL WITH A SODIUM BOND: A SUMMARY OF EXISTING DATA

THE PERTINENT LITERATURE IS REVIEWED FOR AN EXPERIMENTAL STUDY OF THE NUCLEAR FUEL (UN-PUN) BONDED WITH NA TO A SUITABLE CLAD. SECTIONS ON THE FUELS PHYSICAL PROPERTIES, MECHANICAL PROPERTIES, COMPATIBILITY, AND RESISTANCE TO REACTOR RADIATION ARE FOLLOWED BY A DISCUSSION ON OUTSTANDING PROBLEMS THAT STILL EXIST.

ABSTRACT 684

THURBER W C

ORNL-3670 (1964)

METALS AND CERAMICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30 1964

URANIUM MONONITRIDE IS BEING EVALUATED AS A FUEL FOR HIGH-TEMPERATURE REACTORS WITH HIGH POWER DENSITIES. SEVERAL PERTINENT PHYSICAL PROPERTIES, INCLUDING COEFFICIENT OF THERMAL EXPANSION, ELECTRIC RESISTIVITY, THERMAL CONDUCTIVITY, AND FISSION-GAS RELEASE AFTER NEUTRON ACTIVATION, HAVE BEEN MEASURED AND ARE REPORTED. PRELIMINARY MEASUREMENTS OF THE PRESSURE-TEMPERATURE-COMPOSITION RELATIONSHIPS IN THE URANIUM-NITROGEN BINARY SYSTEM ARE DESCRIBED.

ABSTRACT 685

TOKAR M

J AM CERAM SOC 56,173 (1973)

COMPRESSIVE CREEP AND HOT HARDNESS OF U-PU CARBIDES

THE COMPRESSIVE CREEP OF CARBIDES HAVING THE COMPOSITION $U_{0.79}Pu_{0.21}C_{1.02}$ AND SINTERED DENSITY OF 11.8 g/cm^3 WAS STUDIED AT 1300 DEG, 1400 DEG, AND 1500 DEG C AND STRESSES OF 2000, 4000, AND 6000 PSI. THE EQUATION WHICH BEST FITTED THE DATA WAS $\dot{\epsilon} = 7.96 \times 10^{-14} \exp(-126.4/RT)$. THE DOMINANT CREEP MECHANISM WAS PROBABLY GRAIN-BOUNDARY SLIDING. THE HARDNESS OF MONOCARBIDES WITH VARIOUS U/PU RATIOS WAS MEASURED FROM ROOM TEMPERATURE TO 1200 DEG C. PROBABLY MECHANISMS OF DEFORMATION ARE DISCUSSED.

ABSTRACT 686

TOKAR M

LA 4452 (1970)

MECHANICAL PROPERTIES OF CARBIDE AND NITRIDE REACTOR FUELS

MECHANICAL-PROPERTY EVALUATIONS OF PLUTONIUM-BEARING CARBIDES AND NITRIDES CONDUCTED AT THE LOS ALAMOS SCIENTIFIC LABORATORY IN A STUDY OF FAST REACTOR FUELS ARE PRESENTED, ALONG WITH A REVIEW OF THE LITERATURE ON THE MECHANICAL PROPERTIES OF URANIUM AND PLUTONIUM CARBIDES AND NITRIDES.

ABSTRACT 687

TOKAR M

LA-4704 (1971)

HIGH TEMPERATURE COMPRESSIVE CREEP AND HOT HARDNESS OF URANIUM-PLUTONIUM CARBIDES

THE COMPRESSIVE CREEP OF URANIUM-PLUTONIUM CARBIDES HAVING THE COMPOSITION U SUB 0.79 PU SUB 0.21 C SUB 1.02 AND A SINTERED DENSITY OF 11.8 G/CM**3 WAS STUDIED AT 1300, 1400, AND 1500 DEG C AND STRESSES OF 2000, 4000 AND 6000 PSI. THE EQUATION WHICH BEST FITTED THE DATA WAS: $\dot{\epsilon} = 7.96 \times 10^{-4} \exp(-126.4/RT, \text{KCAL/MOLE})$ THE DOMINANT CREEP MECHANISM WAS PROBABLY GRAIN BOUNDARY SLIDING. THE HARDNESS OF SOME MONOCARBIDES WITH VARIOUS U/PU RATIOS WAS MEASURED FROM ROOM TEMPERATURE TO 1200 DEG C. PROBABLE MECHANISMS OF DEFORMATION ARE DISCUSSED.

ABSTRACT 688

TOKAR M

LA-4887 (1972)

HOT HARDNESS TESTING OF URANIUM-PLUTONIUM CERAMICS

THE MICROINDENTATION HARDNESSES OF SOME URANIUM-PLUTONIUM CARBIDES AND OF PLUTONIUM MONONITRIDE HAVE BEEN DETERMINED AS A FUNCTION OF TEMPERATURE. THE HOT-HARDNESS BEHAVIOR IS DISCUSSED IN TERMS OF POSSIBLE DEFORMATION MECHANISMS.

ABSTRACT 689

TOKAR M

LADC-12173 (1971)

COMPRESSIVE CREEP AND HOT HARDNESS OF URANIUM-PLUTONIUM CARBIDE

THE COMPRESSIVE CREEP OF URANIUM-PLUTONIUM CARBIDES HAVING THE COMPOSITION U SUB 0.79 PU SUB 0.21 C SUB 1.02 AND SINTERED DENSITY OF 11.8 G/CM**3 WAS STUDIED AT 1300, 1400, AND 1500 DEG C AND STRESSES OF 2000, 4000 AND 6000 PSI. THE EQUATION WHICH BEST FITTED THE DATA WAS: $\dot{\epsilon} = 7.96 \times 10^{-4} \exp(-126.4/RT, \text{KCAL/MOLE})$ THE DOMINANT CREEP MECHANISM WAS PROBABLY GRAIN BOUNDARY SLIDING. THE HARDNESS OF SOME MONOCARBIDES WITH VARIOUS U/PU RATIOS WAS MEASURED FROM ROOM TEMPERATURE TO 1200 DEG C. PROBABLE MECHANISMS OF DEFORMATION ARE DISCUSSED.

ABSTRACT 690

TOKAR M

TRANS AM NUCL SOC 12,592 (1969)

MECHANICAL PROPERTIES OF CARBIDE AND NITRIDE REACTOR FUELS

A PROGRAM FOR THE MECHANICAL PROPERTY EVALUATION OF THE CARBIDES AND NITRIDES OF PLUTONIUM AND OF THE MIXED (U,PU) CARBIDES AND NITRIDES HAS BEEN INITIATED. THE PROPERTIES CONSIDERED ARE HOT HARDNESS, COMPRESSIVE CREEP, ELASTIC MODULI, INTERNAL FRICTION ETC. HAS GIVEN SMALL REVIEW OF WORK DONE IN THE LITERATURE ON VARIOUS MECHANICAL PROPERTIES OF ADVANCED FUEL.

ABSTRACT 691

TOKAR M

6TH US/JAPAN CERAM FUELS INFORMATION EXCHANGE, SEATTLE, I-8 (1970)
THE HOT HARDNESS OF (U,PU)C AND PUN AND THE COMPRESSIVE CREEP OF (U,PU)C

THE MEAN HARDNESS NUMBERS FOR PUC SUB 0.93, PUC SUB 1.454, U SUB 0.79 PU SUB 0.21 C SUB 0.95, AND U SUB 0.47 PU SUB 0.53 C SUB 1.03 ARE COMPARED IN THE TEMPERATURE RANGE OF 20 TO 1000 DEG C. THE HOT HARDNESS OF PUN, UN, AND U SUB 0.7 PU SUB 0.3 N IS COMPARED IN THE TEMPERATURE RANGE OF 20 TO 1000 DEG C. COMPRESSIVE CREEP RATES OF U SUB 0.79 PU SUB 0.21 C SUB 1.02 WERE MEASURED IN THE TEMPERATURE RANGE OF 1300 TO 1500 DEG C AND PRESSURES OF 2000 TO 4000 PSI.

ABSTRACT 692

TOTH L M

J INORG NUCL CHEM 35, 1509 (1973)

EQUILIBRIA OF URANIUM CARBIDES IN THE MOLTEN FLUORIDE SOLUTIONS OF UF SUB 3 AND UF SUB 4 CONTAINED IN GRAPHITE AT 850 DEG K

THE EQUILIBRATION OF DILUTE MOLTEN FLUORIDE SOLUTIONS OF UF SUB 4 WITH UC, U SUB 2 C SUB 3 AND UC SUB 2 AT 850 DEG K HAS BEEN INVESTIGATED TO ESTABLISH THAT A UC SUB 2 PHASE, POSSIBLY OXYGEN STABILIZED, IS THE STABLE CARBIDE PHASE IN CONTACT WITH DILUTE UF SUB 3-UF SUB 4 SOLUTIONS CONTAINED IN GRAPHITE. THE CARBIDES WERE IDENTIFIED BY X-RAY POWDER PATTERNS. LATTICE PARAMETERS FOR THESE CARBIDES ARE INCLUDED. UF SUB 3 AND UF SUB 4 CONCENTRATIONS IN SOLUTION WERE MEASURED BY NEAR I.R.-VISIBLE ADSORPTION SPECTROPHOTOMETRY. EQUILIBRIUM QUOTIENTS, $Q = (UF SUB 3)^{4/3} / (UF SUB 4)^{1/3}$ WERE CALCULATED FOR EACH OF THE CARBIDES IN CONTACT WITH THE MOLTEN FLUORIDE SOLUTION BASED ON THE REACTION: $UC SUB 2 + 3UF SUB 4 = 4UF SUB 3 + XC$

ABSTRACT 693

TRIPLER A B JR

BMI-1313 (1959)

FURTHER STUDIES OF SINTERED REFRACTORY URANIUM COMPOUNDS.

THE REFRACTORY URANIUM COMPOUNDS UC AND UC SUB 2 WERE PREPARED BY ARC-MELTING METHODS, UN BY GAS-SOLID REACTIONS, AND UB SUB 2 AND UBE SUB 13 BY SOLID-SOLID REACTIONS. TECHNIQUES FOR SINTERING POWDER COMPACTS OF THESE COMPOUNDS TO DENSITIES 90% OF THEORETICAL OR GREATER WERE DEVELOPED. MEAN LINEAR THERMAL-EXPANSION COEFFICIENTS OF 7.9×10^{-6} PER DEG F FOR UC AND 9.3×10^{-6} PER DEG F FOR UBE SUB 13 WERE OBTAINED IN THE RANGE 68 TO 1800 DEG F. THE THERMAL CONDUCTIVITY OF SINTERED UBE SUB 13 INCREASED FROM 0.050 CAL/(SEC)(CM)(C) AT 100 DEG C TO 0.064 CAL/(SEC)(CM)(C) AT 650 DEG C. THE ELECTRICAL RESISTIVITY OF SINTERED UBE SUB 13 WAS 113 MICROHM-CM AT 27.6 DEG C. KNOOP MICROHARDNESS VALUES VARIED FROM 500 FOR SINTERED UC SUB 2 TO 1155 FOR SINTERED UBE SUB 13. SINTERED UC AND UC SUB 2 DECOMPOSE RAPIDLY IN BOILING (ATMOSPHERIC PRESSURE) WATER. A SINTERED UBE SUB 13 COMPACT LOST 2.2 MG PER CM² (AVERAGE), AFTER 72 HR IN BOILING WATER (ATMOSPHERIC PRESSURE). UC SUB 2 REACTS MORE RAPIDLY WITH NITROGEN AND OXYGEN THAN DOES PURE URANIUM. UB SUB 2 AND UBE SUB 13 WERE LESS REACTIVE WITH OXYGEN AND NITROGEN THAN IS PURE URANIUM. THE HEAT OF FORMATION OF UC WAS -20.5 KCAL PER MOLE AT 25 DEG C. STANDARD FREE-ENERGY-OF-FORMATION EQUATIONS WERE ESTIMATED FOR UN, USI SUB 2, US, UB SUB 2, UC SUB 2, AND UC.

ABSTRACT 694

TYE R P

CARBON 4, 167 (1966)

THE THERMAL CONDUCTIVITY OF COMPACTED POWDER CARBONS AND MIXTURES OF CARBON POWDERS WITH URANIUM CARBIDE PARTICLES.

MEASUREMENTS OF THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY WERE UNDERTAKEN OVER THE TEMPERATURE RANGE 20-200 DEG C FOR A SERIES OF COMPACTED GRAPHITE POWDER MATRICES AND A SERIES OF MATRIX MATERIALS MIXED WITH DIFFERENT VOLUMES OF COATED URANIUM CARBIDE PARTICLES. THE TEMPERATURE RANGE WAS EXTENDED TO 1000 DEG C FOR PARTICULAR SAMPLES. RESULTS INDICATE THAT THE MANUFACTURING PROCESS PRODUCES HOMOGENEOUS MATERIALS WHOSE MEASURED TRANSPORT PROPERTIES ARE AFFECTED MARKEDLY BY VARIATIONS OF SEVERAL PARAMETERS INCLUDING THE INITIAL COMPACTING PRESSURE, THE VOLUME OF ADDED PARTICLES, AND THE AMOUNT OF PYROLYTIC CARBON DEPOSITED IN THE PORES. LARGE VARIATIONS IN BOTH PHYSICAL PROPERTIES ARE OBTAINED AT THE LOWER TEMPERATURES FOR CHANGES IN EACH OF THESE PARAMETERS. FOR THE PRESSURE VARIABLE THE THERMAL CONDUCTIVITY IS FOUND TO CHANGE LINEARLY WITH INCREASE OF PRESSURE OVER THE RANGE 6-1000 LB/IN** 2. AT HIGHER TEMPERATURES THE DIFFERENCES ARE MUCH REDUCED AND THE MATERIALS BEHAVE IN A MANNER SIMILAR TO OTHER CARBONS AND GRAPHITES HAVING SIMILAR PROPERTIES AT THE LOWER TEMPERATURES.

ABSTRACT 695

UCHIDA M

J NUCL MATER 49,91 (1973/74)

COMPRESSIVE CREEP OF SINTERED UC-UN SOLID SOLUTIONS

COMPRESSIVE CREEP OF SLIGHTLY HYPO-STOICHIOMETRIC URANIUM CARBONITRIDES SINTERED FROM UC AND UN POWDER MIXTURE WAS STUDIED AT TEMPERATURES OF 1310 AND 1500 DEG C. THE CREEP RATE AS A FUNCTION OF C/N MOLE FRACTION SHOWED A MAXIMUM NEAR THE COMPOSITION $N/(C+N) = 1/4$ (IN MOLES) AND A MINIMUM NEAR $N/(C+N) = 3/4$. THIS BEHAVIOR WAS CORRELATED WITH THE RECENT EXPERIMENTAL EVIDENCE OF THE ANOMALIES IN THE ELASTIC CONSTANT AND MELTING POINT, AND THERMODYNAMIC DISCUSSIONS ON THE DEVIATION OF URANIUM CARBONITRIDES FROM THE IDEAL SOLUTION OF UC AND UN.

ABSTRACT 696

UGAGIN M

J NUCL MATER 49, 151 (1973/74)

THERMODYNAMIC ESTIMATIONS FOR THE SYSTEM U-PU-W-C

THE STANDARD FREE ENERGIES OF FORMATION FOR UWC SUB 1.75, UWC SUB 2 AND PUWC SUB 2 ARE ESTIMATED BASED ON PHASE-DIAGRAM DATA: AT 2000 K, -41.2 # 3.0, -45.4 # 5.0 AND -37 # 10 KCAL/MOLE, RESPECTIVELY. IN VIEW OF THE FUEL-CLADDING COMPATIBILITY, THE CARBON ACTIVITY WITHIN A THREE-PHASE REGION (UC + UWC SUB 1.75 + W) IS CALCULATED USING ESTIMATES OF SUB F (UWC SUB 1.75). IT IS SHOWN THAT THE CARBON ACTIVITY IN THE TUNGSTEN-BUFFERED UC IS CONSIDERABLY LOWER THAN IN TYPE 304 STAINLESS STEEL AT 1000 K. DISTRIBUTIONS OF TIE LINES IN THE 2000 K TWO-PHASE EQUILIBRIUM (U, PU)(C+(U,PU)WC SUB 2 WITH A TOTAL PU/(U+PU) RATIO OF 0.2 ARE CALCULATED, PREDICTING AN ENRICHMENT OF PLUTONIUM IN THE (U,PU)WC SUB 2 PHASE. THE MAGNITUDE OF THE SEGREGATION (DIFFERENCES IN U:PU RATIOS) BETWEEN THE PHASES SEEMS SIMILAR TO THAT IN THE TWO-PHASE EQUILIBRIA (U,PU)(C+(U,PU) SUB 2 C SUB 3, ASSUMING THE THREE SOLUTIONS BEHAVE ALMOST IDEALLY.

ABSTRACT 697

VAN CRAEYNEST J C

CEA-COFE-1248

THERMAL CONDUCTIVITY OF MIXED U AND PU CARBIDES, NITRIDES AND CARBONITRIDES

THE THERMAL DIFFUSIVITY OF MIXED URANIUM AND PLUTONIUM 20/80, 35/65, 50/50 65/35, 85/15, AND PU/U RATIO OF 15% HAS BEEN MEASURED. TWO THERMAL DIFFUSIVITY METHODS HAVE BEEN USED IN THE TEMPERATURE RANGE 50 DEG C TO 2000 DEG C, THE ANGSTROM'S METHOD BETWEEN 100 DEG C AND 900 DEG C AND THE COWAN'S METHOD FOR THE TEMPERATURES ABOVE 1000 DEG C. AT EVERY TEMPERATURE THE THERMAL DIFFUSIVITY IS HIGHER FOR CARBIDES THAN FOR NITRIDES, AND THE THERMAL DIFFUSIVITY OF THE CARBONITRIDES IS INTERMEDIATE BETWEEN THE MC AND MN VALUES. THE THERMAL DIFFUSIVITY, EXPRESSED AS A FUNCTION OF CARBON PERCENT SHOWS A MAXIMUM FOR (U,PU) CN 35/65 AND A MINIMUM FOR (U, PU) CN 65/35. THIS ANOMALY IS MORE IMPORTANT AT LOW TEMPERATURE 100 DEG C THAN AT HIGH TEMPERATURE 1500 DEG C. IN ALL CASES THE THERMAL CONDUCTIVITY γ HAS BEEN CALCULATED BY THE RELATION: $\gamma = L \cdot CP \cdot D$ WHERE CP IS THE SPECIFIC HEAT AND D THE THEROTICAL DENSITY.

ABSTRACT 698

VANDERVOORT R P

TRANS AIME 242,1466 (1968)

COMPRESSIVE CREEP OF POLYCRYSTALLINE URANIUM MONONITRIDE IN NITROGEN

THE CREEP OF STOICHIOMETRIC UN WAS INVESTIGATED FROM 1500 DEG TO 1800 DEG C AT STRESSES FROM 2000 TO 5000 PSI IN A PARTIAL PRESSURE OF 200 MM OF NITROGEN. THE ACTIVATION ENERGY FOR CREEP FOUND IN THIS INVESTIGATION WAS 75 KCAL PER MOLE, AND SO DIFFUSION OF THE URANIUM ION APPARENTLY IS THE RATE CONTROLLING DIFFUSION PROCESS DURING CREEP.

ABSTRACT 699

VAUGHAN D A

J METALS 8,78 (1956)

X-RAY DIFFRACTION STUDY OF THE NITRIDES OF URANIUM

THE INVESTIGATION HAS SHOWN THE EXISTENCE OF A NEW NITRIDE PHASE IN THE U-N SYSTEM. THE OCCURRENCE OF THIS PHASE INDICATES A N COMPOSITION LESS THAN UN SUB 2 AND GREATER THAN UN. THE ISOSTRUCTURAL RELATIONSHIP BETWEEN THIS PHASE AND TH SUB 2 N SUB 3 SUGGESTS A COMPOSITION OF U SUB 2 N SUB 3 FOR THE NEW NITRIDE PHASE.

ABSTRACT 700

VILLAIN P

CEA-R-3436

URANIUM SELF-DIFFUSION IN URANIUM MONOCARBIDE

URANIUM SELF DIFFUSION IN NEAR-STOICHIOMETRIC STABILIZED URANIUM MONOCARBIDE HAS BEEN INVESTIGATED IN THE TEMPERATURE RANGE 1450-2000 DEG C. A THIN LAYER OF ²³⁵UC WAS DEPOSITED ONTO THE SAMPLES AND THE DIFFUSION PROFILES WERE ANALYZED BY BOTH SECTIONING AND ALPHA-SPECTROMETRY TECHNIQUES. THE VARIATION WITH TEMPERATURE OF THE SELF-DIFFUSION COEFFICIENT CAN BE EXPRESSED BY THE EQUATION: $D = 7.5 \cdot 10^{-5} \exp(- (81 \pm 10) / RT) \text{ CM}^2/\text{SEC}$ THE COEFFICIENT D DECREASES WITH INCREASING CARBON CONTENT. AUTORADIOGRAPHS AND PROFILE ANALYSIS HAVE EVIDENCED A PREFERENTIAL GRAIN-BOUNDARY DIFFUSION AT ALL TEMPERATURES AND

ABSTRACT 700 (CONT'D)

COMPOSITIONS INVESTIGATED. THIS PHENOMENON WAS USED FOR A STUDY OF GRAIN-BOUNDARY MIGRATION AND FOR THE EVALUATION OF GRAIN-BOUNDARY DIFFUSION COEFFICIENTS. THE ACTIVATION ENERGY THUS DERIVED IS CLOSE TO THE VOLUME DIFFUSION ACTIVATION ENERGY.

ABSTRACT 701

VILLAIN P

COMPT REND ACAD SC PARIS 264, 2015 (1967)

SELF-DIFFUSION COEFFICIENT OF URANIUM IN URANIUM MONOCARBIDE

THE STUDY OF URANIUM DIFFUSION PROFILES IN THE MONOCARBIDE WAS DONE BY A TRACER METHOD FOR TEMPERATURES RANGING FROM 1450 TO 1980 DEG. THE STOICHIOMETRIC COEFFICIENT OF SELF-DIFFUSION FOR THE CARBIDE IS EXPRESSED BY $D = 7 \cdot 10^{-5} \exp 80,000/RT$, THE ACTIVATION ENERGY BEING 80 KCAL/MOLE $\pm$ 10 KCAL. THIS COEFFICIENT IS CONSIDERABLY LARGER FOR THE SUBSTOICHIOMETRIC CARBIDES, SMALLER FOR THE SUPERSTOICHIOMETRIC CARBIDES.

ABSTRACT 702

VOZZELLA P A

CNLM-5066 (1962)

THE THERMAL DECOMPOSITION OF URANIUM NITRIDE

FROM AMERICAN NUCLEAR SOCIETY MEETING, CINCINNATI, APRIL 1963. A STUDY WAS MADE TO PROVIDE A QUANTITATIVE MEASURE OF THE THERMAL STABILITY OF UN AND TO ESTABLISH ITS THERMODYNAMIC PROPERTIES. PRELIMINARY LANGMUIR EXPERIMENTS INDICATED THAT UN DECOMPOSES TO NITROGEN AND URANIUM, LOSING NITROGEN AT A MUCH FASTER RATE THAN URANIUM. THE SURFACE OF A UN SPECIMEN WAS ALMOST COMPLETELY COVERED WITH URANIUM AFTER BEING HEATED FOR 30 MIN AT 3400 DEG F IN VACUUM. KNUDSEN EXPERIMENTS WERE ALSO CARRIED OUT. IT WAS ESTIMATED THAT THE ACCOMMODATION COEFFICIENT FOR N SUB 2 OVER UN IS APPROXIMATELY 0.01 TO 0.04 IN THE TEMPERATURE RANGE 2900 TO 3150 DEG F.

ABSTRACT 703

VOZZELLA P A

CNLM-5619 (1964)

THE THERMAL DECOMPOSITION OF URANIUM MONOCARBIDE

THE VAPORIZATION OF SINTERED UC WAS STUDIED BY THE LANGMUIR EVAPORATION TECHNIQUE AT 2190 - 2525 DEG K. UC WAS FOUND TO LOSE U PREFERENTIALLY UNTIL A CONGRUENTLY VAPORIZING COMPOSITION NEAR UC SUB 1.1 WAS REACHED. THE TEMPERATURE DEPENDENCE OF THE EVAPORATION RATE OF UC SUB 1.1 WAS STUDIED, AND THE PARTIAL PRESSURES (ATM) OF U(G) AND C SUB 3(G) WERE FOUND TO OBEY THE EQUATIONS $\log \text{SUB } 10 P(U) = 8.191 - 3.624 \cdot 10^4/T$ AND $\log \text{SUB } 10 P(C \text{ SUB } 3) = 7.345 - 3.624 \cdot 10^4/T$. THE STANDARD HEAT OF VAPORIZATION OF UC SUB 1.1 WAS CALCULATED TO BE 223 KCAL/GFW, IN FAIR AGREEMENT WITH OTHER VALUES FOR UC.

ABSTRACT 704

VOZZELLA P A

CNLM-5620 (1964)

THE THERMAL DECOMPOSITION OF URANIUM MONONITRIDE

NITROGEN PRESSURE OVER UN VARIES FROM 1.5×10^{-7} TO 5×10^{-5} ATM OVER THE TEMPERATURE RANGE 1910-2265 DEG K. URANIUM NITRIDE DECOMPOSES BY THE REACTION $UN(S) = U(l) + N_2(g)$ IN WHICH THE $U(l)$ ACTIVITY MAY BE LOWERED BY SOLUTION OF NITROGEN. THE STANDARD HEAT OF FORMATION OF UN AT 298 DEG K WAS FOUND TO BE -74.5#1 KCAL/GFW. THE CONDENSATION COEFFICIENT FOR NITROGEN ON URANIUM NITRIDE IS ESTIMATED TO BE 0.01.

ABSTRACT 705

VOZZELLA P A

J CHEM PHYS 49, 876 (1968)

DISSOCIATION BEHAVIOR OF UC

URANIUM MONOCARBIDE WAS FOUND TO LOSE URANIUM PREFERENTIALLY IN THE TEMPERATURE RANGE 2250 DEG-2525 DEG K UNTIL A CONSTANT VAPORIZING, NONSTOICHIOMETRIC COMPOSITION APPROACHING UC SUB 1.1 WAS FORMED. RATES OF EVAPORATION OF THIS COMPOSITION, MEASURED FROM 2190 DEG TO 2525 DEG K BY THE LANGMUIR METHOD, ARE DESCRIBED BY $\log_{10} \text{SUB } 10(\text{UC SUB } 1.1(S)) = 9.148 - 3.574 \times 10^4/T$ (G/CM**2-SEC). BASED ON THE DECOMPOSITION PROCESS, UC SUB 1.1(S) = U SUB (G) + N SUB 1 C SUB 1(G) + N SUB 2 C SUB 2(G) + N SUB 3 C SUB 3(G). THE PARTIAL PRESSURE OF URANIUM IS GIVEN BY $\log_{10} \text{PU SUB (G) (ATM)} = 8.191 - 3.624 \times 10^4/T$. THE PARTIAL PRESSURE OF CARBON, EXPRESSED AS EFFECTIVE MONATOMIC PRESSURE, IS $\log_{10} \text{SUB } 10 \text{ P SUB } 0 = 8.341 - 3.608 \times 10^4/T$. THESE DATA YIELD A HEAT OF VAPORIZATION AT 298 DEG K OF 235.1#2.7 KCAL/MOLE FOR THE ABOVE VAPORIZATION PROCESS. THE RESULTANT STANDARD HEAT OF FORMATION OF UC SUB 1.1(S) AT 298 DEG K IS -21.2#4.1 KCAL/MOLE IF 125#3 KCAL/MOLE IS TAKEN AS THE HEAT OF SUBLIMATION OF URANIUM.

ABSTRACT 706

VOZZELLA P A

PWAC-378 (1962)

THE THERMAL DECOMPOSITION OF URANIUM MONOCARBIDE

THE THERMAL STABILITY OF UC WAS INVESTIGATED USING A MODIFIED LANGMUIR VAPOR PRESSURE TECHNIQUE. URANIUM MONOCARBIDE VAPORIZED CONGRUENTLY OVER THE RANGE 2010 TO 2230 DEG C. AT 2175 DEG C, THE CONGRUENTLY VAPORIZING COMPOSITION WAS UC SUB 1.1. THE DOMINANT MODE OF VAPORIZATION IN THE TEMPERATURE RANGE STUDIED WAS UC SUB 1.1 = U(G) + 1.1 C(G). THE VAPORIZATION RATE IN A HIGH VACUUM ENVIRONMENT RANGED FROM 2.0×10^{-6} G/CM**2-SEC AT 2010 DEG C TO 38.3×10^{-6} G/CM**2-SEC AT 2230 DEG C. THE PRESSURE OF U OVER UC VARIED APPROX LINEARLY FROM 1.3×10^{-7} ATM AT 2010 DEG C TO 26×10^{-7} ATM AT 2230 DEG C, WHILE THE CARBON PRESSURE VARIED FROM 0.3×10^{-7} TO 6.4×10^{-7} OVER THE SAME RANGE. THE FREE ENERGY CHANGE FOR VAPORIZATION IN THE RANGE 2010 TO 2230 DEG C MAY BE EXPRESSED AS $\Delta F = 306000 - 65T$ (#35 KCAL/GFW). THE HEAT OF VAPORIZATION OF UC AT 298 DEG K IS 324.6#2 KCAL/GFW. THE STANDARD HEAT OF FORMATION OF UC SUB 1.1 AT 298 DEG K IS - 19.4#2.0 KCAL/GFW.

ABSTRACT 707

VOZZELLA P A

PWAC-478 (1965)

THERMODYNAMIC PROPERTIES OF URANIUM MONOCARBIDE

URANIUM MONOCARBIDE WAS FOUND TO LOSE URANIUM PREFERENTIALLY IN THE TEMPERATURE RANGE 2250 TO 2525 DEG K UNTIL A CONSTANT VAPORIZING, NON-STOICHIOMETRIC COMPOSITION APPROACHING UC SUB 1.1 WAS FORMED. RATES OF EVAPORATION OF THIS COMPOSITION, MEASURED FROM 2190 TO 2525 DEG K BY THE LANGMUIR METHOD, ARE DESCRIBED BY $\log_{10} P(\text{UC SUB 1.1(S)}) = 9.148 - 3.574 \times 10^4 / T$ (G/CM**2-SEC). BASED ON THE DECOMPOSITION PROCESS $\text{UC SUB 1.1(S)} = \text{U SUB (G)} + \text{N SUB 1 C SUB 1(G)} + \text{N SUB 2 C SUB 2(G)} + \text{N SUB 3 C SUB 3(G)}$. THE PARTIAL PRESSURE OF URANIUM IS GIVEN BY $\log_{10} P_{\text{U}}(\text{G}) (\text{ATM}) = 8.191 - 3.624 \times 10^4 / T$. THE RATE OF EVAPORATION AND CONSEQUENTLY THE VAPOR PRESSURE OF CARBON WAS FOUND TO BE EQUIVALENT TO THAT OVER GRAPHITE. A THIRD-LAW ANALYSIS YIELDS A HEAT OF VAPORIZATION AT 298 DEG K OF 235.1 ± 2.7 KCAL/MOLE FOR THE ABOVE VAPORIZATION PROCESS. THE RESULTANT STANDARD HEAT OF FORMATION OF UC SUB 1.1(S) AT 298 DEG K IS -21.2 ± 4.1 KCAL/MOLE IF 125 ± 3 KCAL/MOLE IS TAKEN AS THE HEAT OF SUBLIMATION OF URANIUM.

ABSTRACT 708

VOZZELLA P A

PWAC-479 (1965)

THERMODYNAMIC PROPERTIES OF URANIUM MONONITRIDE

THE PARTIAL PRESSURE OF NITROGEN OVER URANIUM MONONITRIDE WAS MEASURED BY KNUDSEN EFFUSION EXPERIMENTS OVER THE TEMPERATURE INTERVAL 1910 TO 2265 DEG K. A LINEAR LEAST-SQUARES FIT OF THESE DATA IS GIVEN BY: $\log_{10} P_{\text{N}}(\text{ATM}) = 8.279 - 2.874 \times 10^4 / T - 1$, WHERE T IS IN DEG K. BASED ON THE DECOMPOSITION MECHANISM $\text{UN SUB (S)} = \text{U SUB (L)} + 1/2 \text{N SUB 2(G)}$, THE SECOND-LAW ENTHALPY AND ENTROPY CHANGES ARE GIVEN BY $\Delta H_{\text{UN}}(2100) = 65.9$ KCAL/MOLE AND $\Delta S_{\text{UN}}(2100) = 19.0$ EU. A THIRD-LAW ANALYSIS RESULTS IN A STANDARD HEAT OF FORMATION AT 298 DEG OF $\Delta H_{\text{UN}}(298) = -74.4 \pm 2.0$ KCAL/MOLE.

ABSTRACT 709

VOZZELLA P A

TID-7676, P154 (1964)

THERMAL DECOMPOSITION OF URANIUM CARBIDE

THIS PAPER PRESENTS DATA ON THE HIGH TEMPERATURE VAPORIZATION BEHAVIOR OF URANIUM MONOCARBIDE IN VACUUM AND IS PART OF A CONTINUING PROGRAMME AIMED AT PROVIDING MUCH NEEDED THERMAL DATA ON REFRACTORY MATERIALS AT ELEVATED TEMPERATURES.

ABSTRACT 710

WALLACE T C

J ELECTROCHEM SOC 111, 1404 (1964)

THE HIGH CARBON PORTION OF THE URANIUM-GADOLINIUM-CARBON SYSTEM

THE HIGH CARBON PORTION OF THE URANIUM-GADOLINIUM-CARBON SYSTEM WAS INVESTIGATED USING X-RAY, THERMAL ANALYSIS, AND CHEMICAL TECHNIQUES. IT WAS FOUND THAT UC SUB 2 AND GDC SUB 2 FORM A CONTINUOUS SERIES OF SOLID SOLUTIONS ABOVE 1525 ± 25 DEG C WITH THE EXCEPTION OF A NARROW TWO-PHASE REGION TETRAGONAL-(U,GD)C SUB 2 + CUBIC-(U,GD)C SUB 2 LYING ALONG A LINE

ABSTRACT 710 (CONT'D)

CONNECTING UC SUB 2 AT 1785 DEG C AND APPROXIMATELY (U SUB 0.8 GD SUB 0.2) C SUB 2 AT 1510 DEG C. THE (U,GD) C SUB 2 DECOMPOSITION CURVE AND THE EQUILIBRIUM ASSOCIATED WITH IT WERE DETERMINED FOR THE 1300 TO 1525 DEG C TEMPERATURE RANGE. THE RESULTS AT 1300 DEG C SHOW THAT THE SOLID SOLUTION IS STILL STABLE OVER THE REGION FROM (U SUB 0.12 GD SUB 0.88) C SUB 2 TO GDC SUB 2. A LATTICE PARAMETER CURVE IS GIVEN FOR THE QUENCHED TETRAGONAL-(U,GD) C SUB 2 SOLID SOLUTION PHASE THAT VARIES CONTINUOUSLY FROM A SUB 0 = 3.5224, AND C SUB 0 = 5.982A AT UC SUB 2 TO A SUB 0 = 3.717A AND C SUB 0 = 6.264A AT GDC SUB 2. THE SOLIDUS TEMPERATURE DECREASED FROM 2475 # 30 DEG C FOR UC SUB 2 TO 2370 # 30 DEG C FOR GDC SUB 2, WHEREAS THE EUTECTIC TEMPERATURE DECREASED FROM 2450 # 30 DEG C FOR UC SUB 2 + C TO 2310 # 30 DEG C FOR GDC SUB 2 + C. THE TETRAGONAL TO CUBIC TRANSFORMATION TEMPERATURE OF 1785 # 20 DEG C FOR UC SUB 2 WAS FOUND TO DECREASE WITH THE ADDITION OF GDC SUB 2, LIKEWISE THE TETRAGONAL TO CUBIC TRANSFORMATION TEMPERATURE OF 1275 # 20 DEG C FOR GDC SUB 2 WAS FOUND TO DECREASE WITH THE ADDITION OF UC SUB 2. BECAUSE OF THE SLOW RATE OF DECOMPOSITION OF THE SOLID SOLUTION COMPARED TO THE TIME REQUIRED TO DETERMINE THE TETRAGONAL TO CUBIC TRANSFORMATION TEMPERATURE OF SINGLE PHASED (U,GD) C SUB 2 SAMPLES, IT WAS POSSIBLE TO DETERMINE THE TOTAL TRANSFORMATION CURVE. A MINIMUM WAS FOUND AT 1155 # 20 DEG C AND A COMPOSITION OF (U SUB 0.34 GD SUB 0.66) C SUB 2. THE COURSE OF THE TRANSFORMATION CURVE WAS USED TO ESTIMATE THE HEAT OF TRANSFORMATION OF TETRAGONAL TO CUBIC GDC SUB 2 AT 1275 DEG C AS 3.1 # 0.5 KCAL/MOLE AND THE CHANGE IN THE FREE ENERGY OF MIXING IN TRANSFORMING FROM TETRAGONAL-(U,GD)C SUB 2 TO CUBIC-(U,GD)C SUB 2 SOLID SOLUTION AS $\Delta F_{SUB M} = -X(1-X)(5,330 \# 960) - (2.29 \# 0.62)T$ CAL/MOLE, WHERE X IS THE MOLE FRACTION OF GDC SUB 2 IN THE SOLID SOLUTION.

ABSTRACT 711

WALLACE T C

LA-DC-8940

CARBON DIFFUSION IN THE CARRIDES OF URANIUM

THE CHEMICAL DIFFUSION COEFFICIENT OF CARBON IN UC SUB Y (FACE CENTERED CUBIC, R_1 STRUCTURE TYPE) HAS BEEN DETERMINED AS A FUNCTION OF COMPOSITION AND TEMPERATURE. THE HEAT OF CHEMICAL DIFFUSION HAS A MAXIMUM VALUE OF 142.5 # 21.3 KCAL/MOLE AT APPROXIMATELY UC SUB 1.3. U SUB 2 C SUB 3 (BODY CENTERED CUBIC, SPACE GROUP 143D) AND α -UC SUB 2 (BODY CENTERED TETRAGONAL, SPACE GROUP 14/MM) LAYER GROWTHS WERE STUDIED OVER THE TEMPERATURE RANGES 1185 TO 1780 DEG C AND 1525 TO 1780 DEG C, RESPECTIVELY. CARBON SELF DIFFUSION COEFFICIENTS WERE CALCULATED FROM THE EXPERIMENTAL DATA AND KNOWN THERMODYNAMIC DATA. THE RESULTS ARE GIVEN BY THE EXPRESSIONS: $D^{**}(UC SUB 1.0) = 0.30 \cdot \exp(-63.5/RT)$ FROM 1185 TO 2347 DEG C; $D^{**}(U SUB 2 C SUB 3) = 228 \cdot \exp(-98.3/RT)$ FROM 1185 TO 1780 DEG C; $D^{**}(\alpha-UC SUB 1.83) = 156 \cdot \exp(-90.2/RT)$ FROM 1525 TO 1780 DEG C; $D^{**}(R-UC SUB 1.80) = 9.5 \cdot \exp(-77.2/RT)$ FROM 1830 TO 2347 DEG C. FROM THERMAL DIFFUSION EXPERIMENTS IT IS SHOWN THAT THE APPARENT HEAT OF TRANSPORT IS POSITIVE FOR THE SINGLE AND TWO PHASE REGIONS STUDIED IN THE COMPOSITION RANGE UC SUB 1.0 TO UC SUB 1.85.

ABSTRACT 712

WARREN I H

CAN METALL Q 3 183, (1964)

THERMOELECTRIC PROPERTIES OF CUBIC URANIUM MONOCOMPOUNDS

SODIUM CHLORIDE TYPE MONOCOMPOUNDS OF U WITH C, N, P, AS, SB, S AND SE WERE PREPARED. THEIR THERMOELECTRIC POWERS (A) AND ELECTRICAL CONDUCTIVITIES (D) WERE MEASURED UP TO APPROXIMATELY 1000 DEG C. ROOM-TEMPERATURE THERMAL-CONDUCTIVITY (K) DATA WERE ALSO OBTAINED.

ABSTRACT 713

WARREN I H

CANAD MIN METALL BULL 56,288 (1963)

URANIUM COMPOUNDS AS THERMOELECTRIC MATERIALS

THE PROPERTIES REQUIRED FOR A COMPOUND TO FORM USEFUL THERMOELECTRIC MATERIALS ARE DESCRIBED. URANIUM COMPOUNDS THAT MIGHT HAVE THE PROPERTIES ARE REVIEWED. SEVERAL OF THE COMPOUNDS WERE PREPARED AND THESE FABRICATED INTO COMPACTS. THE APPARATUS USED FOR HOT PRESSING, AND FOR MEASUREMENT OF THERMOELECTRIC POWER, ELECTRIC CONDUCTIVITY, AND THERMAL CONDUCTIVITY, IS DESCRIBED. DETAILED ATTENTION WAS GIVEN TO THE PROPERTIES OF NITRIDES. PRELIMINARY STUDIES ON A NUMBER OF OTHER U COMPOUNDS ARE REPORTED. THE FIGURES OF MERIT OF THE BEST MATERIALS SO FAR EXAMINED ARE ONE-TENTH OF THOSE NECESSARY FOR A USEFUL THERMOELECTRIC MATERIAL.

ABSTRACT 714

WASHBURN T N

PROC ON THE CONF ON FAST REACTOR FUEL ELEMENT TECH P741 (1971)

PERFORMANCE CAPABILITIES OF ADVANCED FUELS AND FAST BREEDER REACTORS

THE BOUNDARY LIMITS OF FUEL PERFORMANCE ARE SHOWN ON PLOTS OF SPECIFIC POWER (W/G) AGAINST LINEAR POWER (K W/FT). FOR (U,PU)O SUB 2 FUELS, THESE BOUNDARIES FORM A TRIANGLE WITH BORDERS OF ABOUT 100 W/G MINIMUM SPECIFIC POWER, ABOUT 0.200-IN. MINIMUM FUEL DIAMETER, AND A MAXIMUM LINEAR POWER OF ABOUT 12 KW/FT FOR THE CORE AVERAGE OR ABOUT 19 KW/FT FOR THE HIGHEST RATED FUEL PIN. FOR (U,PU)C AND (U,PU)N FUELS, THE MINIMUM SPECIFIC POWER AND MINIMUM FUEL DIAMETER ARE THE SAME AS FOR THE OXIDES. HOWEVER, THE HIGHER THERMAL CONDUCTIVITY OF THESE ADVANCED FUELS PERMITS LINEAR POWERS TO ABOUT 30 KW/FT CORE AVERAGE AND ABOUT 45 KW/FT FOR THE HIGHEST RATED PIN, WHEN A SODIUM BOND IS USED BETWEEN THE FUEL AND CLADDING TO PREVENT EXCESSIVE FUEL TEMPERATURES AND TO PROVIDE SPACE TO ACCOMMODATE FUEL SWELLING. THERE IS SUBSTANTIAL ECONOMIC ADVANTAGE IN OPERATING FUEL AT THESE HIGHLY RATED CONDITIONS, BUT A LARGE AMOUNT OF DEVELOPMENT WORK AND IRRADIATION TESTING MUST BE PERFORMED WITH BOTH THE CARBIDES AND NITRIDES TO PERMIT AN ABSOLUTE COMPARISON OF THEIR WORTH RELATIVE TO OXIDES.

ABSTRACT 715

WASHINGTON A B

TRG-REPORT-2236

PREFERRED VALUES FOR THE THERMAL CONDUCTIVITY OF SINTERED CERAMIC FUEL FOR THE FAST REACTOR USE

FOR ADVANCED FUELS SUCH AS UC, MIXED CARBIDES, NITRIDES, CARBONITRIDES, MIXED NITRIDES AND OXYCARBIDES, THE ESTIMATES OF THE UNCERTAINTIES ASSOCIATED WITH THE RECOMMENDED THERMAL CONDUCTIVITIES AND CONDUCTANCES ARE GIVEN. OF THE VARIOUS FACTORS CONSIDERED, STOICHIOMETRY, POROSITY,

ABSTRACT 715 (CONT'D)

AND OXYGEN-NITRIGEN AS IMPURITIES ARE MAJOR ONES. SOME 131 REFERENCES ARE LISTED.

ABSTRACT 716

WEBB B A

NAA-SR-6246 (1963)

CARBURIZATION OF AUSTENITIC STAINLESS STEEL BY URANIUM CARBIDES IN SODIUM SYSTEMS

THE STABILITY OF URANIUM CARBIDES IN SODIUM-BONDED STAINLESS STEEL CLADDING WAS STUDIED IN LONG-TERM COMPATIBILITY TESTS AT 1000, 1200, AND 1600 DEG F, OUT OF PILE. NO APPARENT CARBURIZATION OF THE CLADDING OCCURS WHEN THE C CONTENT OF THE UC IS 4.8 WT. % OR BELOW. EXTENSIVE CARBURIZATION OF TYPE 304 AND TYPE 347 STAINLESS STEELS OCCURS AT 1000 DEG F AND ABOVE, WHEN THE C CONTENT OF THE UC EXCEEDS 4.8 WT. %. THE DEGREE OF CLADDING CARBURIZATION INCREASES WITH THE C CONTENT OF THE UC COMPOSITION. FROM THE RESULTS, IT WAS CALCULATED THAT STAINLESS STEEL CLADDING (0.010 IN WALL THICKNESS) WITH SODIUM-BONDED, 0.500-IN DIAM. U-4.9 WT. % C FUEL COULD BE CARBURIZED TO AN AVERAGE C CONTENT OF 0.5 TO APPROX 2.0 WT. % IN THREE YEARS OF REACTOR OPERATION AT A 1000 DEG F FUEL SURFACE TEMPERATURE. AT A 1200 DEG F SURFACE TEMPERATURE, THE C LEVEL IN THE CLADDING COULD RANGE FROM APPROX 1.2 TO APPROX 2.0 WT. %. AS THE FUEL DIAMETER INCREASES, THE UPPER CARBURIZATION LIMIT INCREASES, SINCE THE RATIO OF FUEL VOLUME TO CLADDING VOLUME INCREASES. THEREFORE, 0.800-IN DIAM. U-4.9 WT. % C FUEL COULD CARBURIZE THE CLADDING TO A MAXIMUM 3% LEVEL. RESULTS OF 300-H, 1600 DEG F TESTS, USING TRANSFORMED AND AS-CAST SPECIMENS, INDICATE C TRANSFER FROM TRANSFORMED FUEL TO THE CLADDING AT 1600 DEG F PROCEEDS AT A VERY SLOW RATE, COMPARED TO AS-CAST FUEL.

ABSTRACT 717

WEBB B A

TRANS AM NUCL SOC 4, 349 (1961)

COMPATIBILITY OF URANIUM CARBIDES WITH 304 STAINLESS STEEL

ISOTHERMAL COMPATIBILITY TESTS OF U-C ALLOYS SODIUM BONDED IN 304 STAINLESS STEEL CAPSULES WERE RUN AT TEMPERATURES OF 1000, 1200 AND 1600 DEG F FOR 800-12000 H. IRRADIATION TESTS WERE ALSO CONDUCTED IN WHICH U-C ALLOY FUEL SLUGS WERE SODIUM BONDED IN THINWALLED 304 STAINLESS STEEL CLADDING. THE FUEL OPERATED AT AVERAGE CENTRE AND SURFACE TEMPERATURES OF 1600 AND 1000 DEG F, RESPECTIVELY, FOR APPROXIMATELY 4000 AND 8000 H. THE RESULTS OF THESE TESTS SHOW THAT CARBON IS TRANSFERRED FROM THE FUEL TO THE CLADDING WHEN THE U-C CONTAINS THE DISPERSED UC SUB 2 PHASE.

ABSTRACT 718

WEBER E T

BNWL-SA-1666 (1968)

DEVELOPMENT OF MIXED-NITRIDE FUEL MATERIALS OBTAINED BY CARBOTHERMIC REDUCTION OF OXIDES

THE REACTIONS FOR THE SYNTHESIS OF NITRIDES ARE DISCUSSED. THE PARTICLE-BED REACTOR FOR CARBOTHERMIC SYNTHESIS OF UN-PUN IS DESCRIBED, AND CHEMICAL ANALYSES OF U SUB 0.8 PU SUB 0.2 N PRODUCTS ARE GIVEN. SINTERING STUDIES INDICATE THAT DENSITIES OF 85 TO 94% TD MAY BE OBTAINED

ABSTRACT 718 (CONT'D)

BY SINTERING FOR 3 TO 6 HR AT 1700 TO 1900 DEG C, AND THE RESULTING MICROSTRUCTURES ARE SHOWN. THERMAL DIFFUSIVITY OF U SUB 0.8 PU SUB 0.2 N WAS MEASURED AT 200 TO 1600 DEG C AND THERMAL CONDUCTIVITY VALUES CALCULATED. RESULTS OF PRELIMINARY MELTING STUDIES ARE GIVEN. NO EVIDENCE WAS FOUND FOR INCOMPATIBILITY BETWEEN MIXED NITRIDES AND 304 STAINLESS STEEL AT 650 AND 1000 DEG C.

ABSTRACT 719

WEBER E T

BNWL-SA-414 (1965)

UN-PUN SOLID SOLUTION STUDIES

X-RAY DIFFRACTION PATTERNS OF HEAT TREATED UN-PUN DISPLAYED A SINGLE PHASE. LATTICE PARAMETERS WERE DETERMINED. COMPOSITIONS BETWEEN 30 AND 60 MOLE % PUN HAD SLIGHTLY BETTER DEFINITION OF HIGH ANGLE REFLECTIONS THAN SAMPLES OF HIGHER OR LOWER PUN CONTENT, INDICATING BETTER HOMOGENEITY IN THAT RANGE. DENSITY CHANGES OF THE PELLETS FROM THE GREEN TO THE FIRED STATE DISPLAYED AN ANOMALOUS EFFECT. A SHARP INCREASE IN VOLUME WAS NOTED FOR COMPOSITIONS IN THE MIDDLE TO HIGH PUN PORTION OF THE SYSTEM. A CARBOTHERMIC OXIDE REDUCTION SCHEME FOR SYNTHESIS OF MIXED NITRIDES WAS ATTEMPTED, USING MECHANICALLY MIXED AND COMPACTED POWDERS OF UO SUB 2, PUO SUB 2, AND C. X-RAY DIFFRACTION PATTERNS OF THE PRODUCT INDICATED A TWO-PHASE MIXTURE OF A SOMEWHAT INHOMOGENEOUS UN-PUN SOLUTION PHASE AND A UO SUB 2 PHASE.

ABSTRACT 720

WEBER E T

BNWL-435 P4 3 (1967)

MELTING STUDIES ON PLUTONIUM AND URANIUM-PLUTONIUM NITRIDES

THE RELATIVE STABILITY OF COMPOSITIONS IN THE UN-PUN PSEUDOBINARY ARE BEING STUDIED BY DETERMINATION OF DISSOCIATION PRESSURES AND CONGRUENT MELTING POINTS. SAMPLES OF PUN WERE MELTED UNDER NITROGEN PRESSURES FROM 1 TO 70 ATM. IN THE TEMPERATURE RANGE 2500 TO 2800 DEG C. DISSOCIATION BEHAVIOR OF UN, PUN AND (U SUB 0.8 PU SUB 0.2)N SAMPLES WAS DETERMINED IN THE TEMPERATURE RANGE OF 2500 TO 2800 DEG C.

ABSTRACT 721

WEINBERG A

GA-3124 (1962)

INTERDIFFUSION BETWEEN URANIUM BEARING REACTOR FUELS AND REFRACTORY METAL THERMIONIC EMITTERS.

MATERIAL COMPATIBILITY AS RELATED TO THE "MARRIAGE" OF REACTOR FUELS TO REFRACTORY-METAL THERMIONIC EMITTERS IS UNDER INVESTIGATION. FUEL MATERIALS SUCH AS UC, UC SUB 2, UZRC, AND UO SUB 2 ARE BEING STUDIED IN COMBINATION WITH W, MO, TA, AND NB AT 1200 TO 2000 DEG C. A TECHNIQUE WAS DEVELOPED FOR SIMULTANEOUSLY STUDYING THE INTERDIFFUSION BETWEEN A SPECIFIED U-BEARING MATERIAL AND EACH OF THE REFRACTORY METALS. UC IN CONTACT WITH NB AND TA AT 1875 # 20 DEG C AND 1925 # 30 DEG C, RESPECTIVELY, REACTED TO FORM A LIQUID PHASE IDENTIFIED AS ALMOST PURE METAL. MO ALSO REACTED WITH UC AT 1800 # 20 DEG C. WHILE AT THE SAME TEMPERATURE W APPEARED RELATIVELY UNAFFECTED. HOWEVER, AFTER BEING IN

ABSTRACT 721 (CONT'D)

CONTACT WITH UC AT 2000 # 20 DEG C FOR 30 HR, W EXHIBITED A MILD REACTION. THE REACTION MECHANISM FOR ALL OF THESE METALS APPEARS TO BE $UC + M = MC + U$. FORMATION OF THIS LIQUID PHASE WAS SUPPRESSED AT 1800 DEG C WHEN UC-UC SUB 2 MIXTURES WERE SUBSTITUTED FOR THE UC. THE KINETICS OF UNIFORM METAL-CARBIDE-LAYER FORMATION WERE STUDIED FOR UC-UC SUB 2 MIXTURES IN CONTACT WITH THE REFRACTORY METALS AT 1800 DEG C. IN ADDITION TO THE UNIFORM CARBIDE LAYERS FORMED, SEVERE CARBIDE PENETRATION OF THE GRAIN BOUNDARIES WAS OBSERVED IN NP, TA, AND MO. INVESTIGATION OF THE INTERACTION BETWEEN UZRC (6.0 MOLE % U-45.8 MOLE % ZR-48.2 MOLE % C) AND THE SAME FOUR REFRACTORY METALS AT 1800 DEG C FOR 50 HR SHOWED THAT THE STABILIZATION OF THE CARBIDE PHASE BY THE ADDITION OF ZR IMPROVES THE DIFFUSION CHARACTERISTICS. ELECTRON-MICROPROBE ANALYSES OF THESE DIFFUSION COUPLES WERE MADE, THE RESULTS OF WHICH ARE DISCUSSED. PRELIMINARY INVESTIGATIONS OF UO SUB 2-REFRACTORY METAL COMPATIBILITY WERE COMPLETED AT 1200, 1800, AND 2000 DEG C INDICATIONS OF TRANSPORT OF ONE OR MORE OF THE FUEL COMPONENTS THROUGH GRAIN BOUNDARIES WERE OBSERVED.

ABSTRACT 722

WEINBERG A F

ADV ENERGY CONVERSION 3, 101 (1963)

INTERDIFFUSION BETWEEN URANIUM-BEARING REACTOR FUELS AND REFRACTORY-METAL THERMIONIC EMITTERS

MATERIAL COMPATIBILITY AS RELATED TO THE MARRIAGE OF REACTOR FUELS TO REFRACTORY METAL THERMIONIC EMITTERS IS UNDER INVESTIGATION. FOUR FUEL MATERIALS, UC, UC SUB 2, UC-ZRC, AND UC SUB 2, ARE STUDIED IN COMBINATION WITH TUNGSTEN, MOLYBDENUM, TANTALUM, AND NIOBIUM OVER THE TEMPERATURE RANGE 1200-2000 DEG C. A TECHNIQUE HAS BEEN DEVELOPED FOR SIMULTANEOUSLY STUDYING THE INTERDIFFUSION BETWEEN A GIVEN URANIUM-BEARING MATERIAL AND EACH OF THE FOUR REFRACTORY METALS. URANIUM MONOCARBIDE IN CONTACT WITH NIOBIUM AND TANTALUM AT 1875#20 DEG C AND 1925#30 DEG C RESPECTIVELY REACTED TO FORM A LIQUID PHASE IDENTIFIED AS ALMOST PURE URANIUM METAL. MOLYBDENUM ALSO REACTED WITH UC AT 1800#20 DEG C WHILE AT THE SAME TEMPERATURE TUNGSTEN APPEARED RELATIVELY UNAFFECTED. HOWEVER, AFTER BEING CONTACTED WITH UC AT 2000#20 DEG C FOR 30 HR TUNGSTEN EXHIBITED A MILD REACTION. THE REACTION MECHANISM FOR ALL THESE METALS APPEARS TO BE $UC + M = MC + U$. FORMATION OF THIS LIQUID PHASE WAS SUPPRESSED AT 1800 DEG C WHEN UC-UC SUB 2 MIXTURES WERE SUBSTITUTED FOR THE UC. THE KINETICS OF UNIFORM METAL CARBIDE LAYER FORMATION WERE STUDIED FOR UC-UC SUB 2 MIXTURES IN CONTACT WITH THE FOUR REFRACTORY METALS AT 1800 DEG C. IN ADDITION TO THE UNIFORM CARBIDE LAYERS FORMED, SEVERE CARBIDE PENETRATION OF THE GRAIN BOUNDARIES WAS OBSERVED IN NIOBIUM, TANTALUM, AND MOLYBDENUM. INVESTIGATION OF THE INTERACTION BETWEEN UZRC (6.0 MOL% U; 45.8 MOL% ZR; 48.2 MOL% C) AND THE SAME FOUR REFRACTORY METALS AT 1800 DEG C FOR 50 HR SHOWED THAT THE STABILIZATION OF THE CARBIDE PHASE BY THE ADDITION OF ZIRCONIUM DRAMATICALLY IMPROVES THE DIFFUSION CHARACTERISTICS. ELECTRON MICRO-PROBE ANALYSES OF THESE DIFFUSION COUPLES HAVE BEEN MADE AND THE RESULTS ARE DISCUSSED. PRELIMINARY INVESTIGATIONS OF UO SUB 2-REFRACTORY METAL COMPATIBILITY HAVE BEEN COMPLETED FOR THREE TEMPERATURES 1200, 1800 AND 2000 DEG C. INDICATIONS OF TRANSPORT OF ONE OR MORE OF THE FUEL COMPONENTS THROUGH GRAIN BOUNDARIES HAVE BEEN OBSERVED.

ABSTRACT 723

WESTRUM E F JR
ADVANCES IN THERMOPHYSICAL PROPERTIES AT EXTREME TEMPERATURES AND PRESSURES P156 (1965); CDO-1149-28
URANIUM MONOCARBIDE AND HYPOSTOICHIOMETRIC DICARBIDE. HEAT CAPACITIES AND THERMODYNAMIC PROPERTIES FROM 5 TO 350 DEG K

HEAT CAPACITIES WERE DETERMINED BY ADIABATIC CALORIMETRY ON CHARACTERIZED MASSIVE SAMPLES OF UC AND UC SUB 1.90. NO THERMAL ANOMALIES WERE OBSERVED. THE DATA WERE COMPARED BY MEANS OF A SHOMATE PLOT WITH VALUES TAKEN AT HIGHER TEMPERATURES BY VARIOUS TECHNIQUES. VALUES OF THE HEAT CAPACITY (C_P), THE ENTROPY (S), ENTHALPY FUNCTION ($(H - H_{SUB\ 0})/T$), AND FREE ENERGY FUNCTION ($-(G - H_{SUB\ 0})/T$) AT 298.15 DEG K ARE: 12.11, 14.28, 7.36, 6.93, AND 14.46, 16.30, 8.43, 7.87, FOR UC AND UC SUB 1.90, RESPECTIVELY, IN CAL/(GFM DEG K).

ABSTRACT 724

WESTRUM E F JR
J CHEM PHYS 45,635 (1966)
URANIUM MONONITRIDE HEAT CAPACITY AND THERMODYNAMIC PROPERTIES FROM 5 DEG TO 350 DEG K

THE LOW-TEMPERATURE HEAT CAPACITY OF UN WAS DETERMINED BY ADIABATIC CALORIMETRY AND FOUND TO HAVE A NORMAL SIGMATE TEMPERATURE DEPENDENCE, EXCEPT FOR THE PRESENCE OF AN ANOMALY NEAR 52 DEG K ASSOCIATED WITH ANTIFERROMAGNETIC ORDERING OF THE ELECTRON SPINS. AT 298.15 DEG K THE HEAT CAPACITY (C_P), ENTROPY (S), ENTHALPY FUNCTION ($(H - H_{SUB\ 0})/T$), AND GIBBS ENERGY FUNCTION ($-(G - H_{SUB\ 0})/T$) ARE, RESPECTIVELY, 11.43, 14.97, 7.309, AND 7.664 CAL/GRAM-FORMULA MASS * DEG K) (GFM* DEG K).

ABSTRACT 725

WESTRUM E F JR
NUCL MET AIME 10,255 (1964)
CRYOTHERMAL PROPERTIES OF URANIUM NITRIDE, CARBIDES AND CHALCOGENIDES

HEAT CAPACITIES AND DERIVED THERMODYNAMIC PROPERTIES (E.G., S , $H - H_{SUB\ 0}$, AND $G - H_{SUB\ 0}$) HAVE BEEN OBTAINED FROM 5 TO 350 DEG K BY PRECISE ADIABATIC CALORIMETRY FOR A NUMBER OF MATERIALS OF ACTIVE OR POTENTIAL INTEREST FOR NUCLEAR REACTOR TECHNOLOGY, I.E., CN UN, UC, UC SUB 2, U SUB 2 C SUB 3, THC SUB 2, JS, US SUB 1.9, US SUB 2, US SUB 3, AND USE SUB 2. IN SEVERAL INSTANCES ENTIRELY INDEPENDENT WELL-CHARACTERIZED, DUPLICATE SAMPLES HAVE BEEN MEASURED TO INSURE THE RELIABILITY OF THE DATA. FOR EXAMPLE, HYPOSTOICHIOMETRIC URANIUM DICARBIDE SAMPLES WERE OBTAINED FROM GENERAL ATOMICS AND FROM LOS ALAMOS SCIENTIFIC LABORATORY. LIKEWISE THORIUM DICARBIDE SAMPLES WERE PROVIDED BY MICHIGAN STATE UNIVERSITY AND THE UNIVERSITY OF CALIFORNIA RADIATION LABORATORY. THE FINAL ENTROPIES FOR THE URANIUM CARBIDES, UC, U SUB 2 C SUB 3, AND UC SUB 2 AT 298.15 DEG K ARE 14.28, 32.95, AND 16.33 CAL/(MOLE DEG K) IN EXCELLENT ACCORD WITH THE PRELIMINARY AND/OR "AGREED" VALUES OF THE 1962 VIENNA CARBIDE THERMODYNAMICS PANEL VALUES EXCEPT FOR U SUB 2 C SUB 3 AND WITH RECENT UNPUBLISHED DATA FROM THE NATIONAL CHEMICAL LABORATORY AT TEDDINGTON. THE URANIUM MONONITRIDE SAMPLE CONTAINED SEVERAL MOLE PERCENT OF COMBINED OXYGEN; HOWEVER, THE COMPLETE ABSENCE OF THE URANIUM DIOXIDE ANTIFERRO-PARAMAGNETIC TRANSITION AT 30.4 DEG K ESTABLISHED THE ABSENCE OF THIS PHASE IN FAVOR OF THE MONOXIDE SOLID SOLUTION IN THE NITRIDE. ONLY US AND USE SUB 2 HAVE LAMBDA ANOMALIES ABOVE 5 DEG K. THAT IN US WITH A TRANSITIONAL ENTROPY INCREMENT OF 1.17 CAL/MOLE-DEG K AT 180 DEG K

ABSTRACT 725 (CONT'D)

CORRESPONDS TO THE DISORDERING OF THE FERROMAGNETIC STATE WHEREAS THAT IN URE SUB 2 OCCURS AT 13.1 DEG K WITH A ΔS SUB T OF ABOUT 0.61 CAL/MOLE-DEG K) AND IS ALSO ASSOCIATED WITH MAGNETIC DISORDERING. SOME SUCCESS HAS BEEN ACHIEVED IN THE PREDICTION OF ENTROPIES FOR THESE CARBIDES, Pnictides, AND CHALCOGENIDES. FURTHER STUDIES ON THEIR MAGNETIC PROPERTIES CONSTITUTE REAL DESIDERATA. CORRELATION OF THE THERMODYNAMIC VALUES FOUND IN THIS STUDY WITH THERMAL THERMODYNAMIC AND EQUILIBRIUM DATA AT HIGHER TEMPERATURES WILL BE DISCUSSED.

ABSTRACT 726

WESTRUM E F JR

TID-16987 (1962)

THERMODYNAMIC PROPERTIES OF ACTINIDE CARBIDES WITH SPECIAL REFERENCE TO THE ENTROPIES OF URANIUM MONO- AND DI-CARBIDE

THE THERMODYNAMIC PROPERTIES OF URANIUM MONO- AND DICARBIDE WERE INVESTIGATED. SPECIAL EMPHASIS IS GIVEN TO THE ENTROPIES AND HEAT CAPACITIES FROM 10 TO 350 DEG K. THE HEAT CAPACITY OF THE DICARBIDE IS GREATER THAN THAT OF THE MONOCARBIDE.

ABSTRACT 727

WHALEY H L

J NUCL MATER 31, 345 (1969)

ELASTIC MODULI AND DEBYE TEMPERATURE OF POLYCRYSTALLINE URANIUM NITRIDE BY ULTRASONIC VELOCITY MEASUREMENTS

THE EFFECT OF SPECIMEN DENSITY ON ELASTIC MODULI WAS DETERMINED AT ROOM TEMPERATURE, AND THE DATA WAS COMPARED WITH OTHER STUDIES. A LEAST SQUARES FIT OF THE DATA GAVE YOUNGS MODULUS (DYNES/CM**2*10**12) E = 2.620 (1-2.265 P) AND SHEAR MODULUS (DYNES/CM**2 * 10**12) G = 1.037(1-2.217 P), WHERE P IS THE FRACTION POROSITY.

ABSTRACT 728

WHEELER M J

AERE-R-6499 (1970)

THERMAL DIFFUSIVITY OF U, (U,PU) CARBIDES AND U OXIDE

THE DIFFUSIVITIES HAVE BEEN DETERMINED USING A MODULATED ELECTRON BEAM TECHNIQUE. RESULTS ARE GIVEN FOR SINTERED UC ALLOYS WITH AND WITHOUT ADDITIONS OF OXYGEN OR NICKEL, BETWEEN 500 AND 2200 DEG K, ARC-CAST UC SUB 1-X AND ARC-CAST (U,PU)C ALLOYS. ADDITIONS OF 2 WT% OXYGEN DECREASE THE DIFFUSIVITY BY ABOUT 20% AT 1200 DEG K, WHEREAS ADDITIONS OF 0.25 WT% NICKEL INCREASE THE DIFFUSIVITY BY ABOUT 20%. AN INFLECTION IN THE DIFFUSIVITY TEMPERATURE CURVE HAS BEEN FOUND FOR UC SUB 1-X AT APPROXIMATELY 1900 DEG K, WHICH MAY BE ATTRIBUTED TO A CHANGE IN THE VACANCY DISTRIBUTION. THE DIFFUSIVITY OF HYPERSTOICHIOMETRIC (U SUB 0.9 PU SUB 0.1) C IS CLOSE TO THAT OF UC SUB 1-X. HIGHER PUC CONTENTS REDUCE THE CONDUCTIVITY TO APPROX 70% OF THAT OF UC SUB 1-X AT 40% PUC.