HEDL-6782

MASTER

RTNS-II IRRADIATION PROGRAM

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I. PROGRAM

Title: Irradiation Effects Analysis (AKJ)

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II. OBJECTIVE

The objective of this work is to determine the effects of high energy neutrons on damage production and evolution, and the relationships of these effects to effects produced by fission reactor neutrons. Specific objectives of current work are the planning and performance of an irradiation program at the Rotating Target Neutron Source (RTNS)-II at the Lawrence Livermore Laboratory (LLL) and postirradiation testing.

III. RELEVANT DAES PROGRAM TASK/SUBTASK

SUBTASK II.B.3.2 Experimental Characterization of Primary Damage State; Studies of Metals

II.C.6.3 Effects of Damage Rate and Cascade Structure on Microstructure; Low-Energy/High-Energy Neutron Correlations.

II.C.11.4 Effects of Cascades and Flux on Flow; High-Energy Neutron Irradiations.

II.C.18.1 Relating Low- and High-Exposure Microstructures; Nucleation Experiments

IV. SUMMARY

Two additional ferritic alloys have been obtained for the RTNS-II metal stockpile. Preparations for HEDL 5, a high dose elevated temperature experiment at RTNS-II, are continuing. HEDL 4, the irradiation of both microtensile and disk specimens, was completed. Hardening has been

observed for copper, nickel and an Fe-Ni-Cr ternary, irradiated at RTNS-II to a fluence of about 3×10^{17} n/cm².

V. ACCOMPLISHMENTS AND STATUS

A. RTNS-II Irradiation Program - N. F. Panayotou (HEDL)

1. Specimen Preparation

Specimen fabrication for future irradiations is continuing. Stock material for two ferritic alloys, D57-B and 9A-1Mo, has been obtained from the Breeder Reactor Program advanced alloy stockpile.

A supply of Nb and Fe dosimetry foils were received from LLL. These foils will be laser engraved and stored for use in future HEDL irradiations at RTNS-II.

2. Status of Irradiations

HEDL-4, a dual purpose irradiation containing both microtensile and disk specimens was initiated and completed during this reporting period. This experiment will permit the direct correlation of tensile strength with microhardness data on specimens fabricated from the same heat of material.

The HEDL-4 capsule was received on site, disassembled, and dosimetry foils returned to LLL for analysis. Preliminary microhardness testing is in progress.

3. Elevated Temperature Irradiation

HEDL-5, our first elevated temperature irradiation, is currently scheduled to begin in June. The objective is to accumulate exposure of at least 3×10^{19} (~ 0.1 dpa) at temperatures below 350°C on materials under consideration for the first wall of the ETF. Because of the long irradiation time required, the possibility of employing a dual-temperature zone furnace is currently being explored.

4. Microhardness Data

The results of microhardness testing of copper, nickel and an Fe-Ni-Cr ternary irradiated at RTNS-II are shown in Figures 1 to 3. The increase in diamond pyramid hardness is plotted as a function of fluence over the range of 2 to 12×10^{17} n/cm². $E \sim 14$ MeV. The composition

HEDL 8002-193.4

FIGURE 1. Normalized Diamond Pyramid Microhardness, 50 gm Load, for Copper TEM Disk Specimens, Irradiated with 14 MeV Neutrons at Ambient Temperature.

HEDL 8C02-193.5

FIGURE 2. Normalized Diamond Pyramid Microhardness, 50 gm Load, for Nickel TEM Disk Specimens, Irradiated with 14 MeV Neutrons at Ambient Temperature.

HEDL 8002-193.6

FIGURE 3. Normalized Diamond Pyramid Microhardness, 50 gm Load for Fe-Ni-Cr Ternary TEM Disk Specimens, Irradiated with 14 MeV Neutrons at Ambient Temperature.

of the metals tested is given in Table 1.

TABLE 1
METAL COMPOSITION⁺

<u>ELEMENT</u>	<u>COPPER (ppm)</u>	<u>NICKEL (ppm)</u>	<u>Fe-Ni-Cr (percent)</u>
Ni	<0.1	Balance	19.4
Cr	0.3	2.0	14.9
Mo	<0.1	0.25	--
Nb	<0.1	<0.1	--
Si	0.3	17	--
Mn	0.3	---	--
	<0.1	0.65	--
Ti	<0.1	<0.1	--
Al	1.0	0.9	--
C	<10	15	0.003
B	---	---	--
W	<0.1	<0.1	--
O	2.0	12	0.018
Cu	Balance	---	--
Fe	0.8	20	Balance

⁺Weight Units

The prior histories of the specimens used for this study are given in Table 2.

TABLE 2

PRIOR HISTORY

<u>METAL</u>	<u>AS RECEIVED CONDITION</u>	<u>HEAT TREATMENT</u>
Copper	Annealed	400°C/15 min/FC
Nickel	Cold Worked	500°C/10 min/FC
Fe-Ni-Cr	Cold Worked	975°C/10 min/FC

FC: Furnace Cool

The heat treatments used for the Fe-Ni-Cr alloy and the nickel were sufficient to recrystallize the materials. Since the copper stock was received in an annealed condition our heat treatment served only as a stress relieving treatment.

Each data point shown in Figures 1 to 3 represents the average and range of at least three indents made on TEM disk specimens. The minimum load employed for microhardness testing was 50 gms. Tests were at room temperature using a standard Tukon microhardness testing instrument. Fluence data was derived from niobium dosimeters which bracketed the positions of the specimens.

Over about the same range in fluence the Fe-Ni-Cr alloy has sustained a thirty percent increase in hardness while the nickel and copper have sustained forty and fifty percent increases, respectively.

No hardening has been observed over the same range in fluence for the Path A and Path B alloys.

VI. REFERENCES

None.

VII. FUTURE WORK

Microhardness testing on key disk specimens up to and including those irradiated in HEDL-4 will be completed. Irradiation experiments at Omega West Reactor at Los Alamos will be initiated. A high dose, elevated temperature experiment (HEDL-5) will be initiated at the RTNS-II.