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Lawrence Livermore Laboratory

FISCAL YEAR 1976 DT FUSION NEUTRON IRRADIATIONS AND DOSIMETRY AT THE LLL
ROTATING TARGET NEUTRON SOURCE

S. C. MacLean

March 31, 1977

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ABSTRACT

The DT fusion neutron irradiation of 319 samples during 19 irradiation periods (beam-on time of more than 1026 hours) is described. Experiments from 24 individuals representing 11 institutions are summarized. The numbers of the UCID dosimetry reports detailing each of the irradiations are given.

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Fiscal Year 1976 DT Fusion Neutron
Irradiations and Dosimetry at the LLL
Rotating Target Neutron Source

Susan C. MacLean

In order to most efficiently utilize the LLL Rotating Target Neutron Source (RTNS) during the Fiscal Year 1976, 319 samples from 24 experimenters were combined during 19 irradiation periods. Beam-on time was more than 1,026 hours during FY 76.

The tables following list the dates, experimenters and their laboratory, and the samples for each irradiation. The temperature of the irradiation and the maximum fluence are also given.

Fourteen of the 19 irradiations were at room temperature. For ten of these room temperature runs, the average flux on the front dosimetry foil (12 mm in diameter and as close to the neutron source as possible) was 7.79×10^{11} neutrons/cm²-sec with the range being $4.66-9.31 \times 10^{11}$ n/cm²-sec. Three of the irradiations were at cryogenic temperatures and two were at 210°C.

The $\text{Nb}^{93}(n,2n)\text{Nb}^{92m}$ reaction was used to determine the 14.8 MeV neutron fluences (UCRL-51393, Rev. 1). The cross section used for the activation of the 10.16 day isomer of niobium by 14.8 MeV neutrons was 458 millibarns. The UCID number for each irradiation is given if more details of the irradiation history and individual sample dosimetry are required.

Positioning and aligning the samples with the neutron beam prior to the irradiations was handled by Ralph H. Condit and Curtis L. Rowe. The neutron irradiations were carried out by members of the LLL E Division Accelerator Staff, Lewis P. Mego, Richard M. Penpraze, and Sharon A. Snowden. The gamma ray counting of the niobium dosimetry foils was performed by Ruth N. Anderson or Austin L. Prindle.

DT Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	June 30 - July 1, 1975	July 15-16 1975	July 18-25, 1975		
UCID #	16874	16900	16941		
Beam-on time (hours)	28.35	10.75	96.47		
Experimenters	L. R. Fleischer	M. W. Guinan	L. R. Fleischer	J. B. Mitchell R. A. Van Konynenburg	M. J. Moran
Laboratory	Westinghouse Research & Development Center	LLL	Westinghouse Research & Development Center	LLL	LLL
Samples	One each, Ta, Nb, Mo and V, high purity foils, 12.7 mm diameter, 0.127 mm thick, seven 3 mm diameter microscope specimens partially pre-punched from each	One each, Nb, V, and Mo wires	One each Ta, Nb, Mo, and V high purity foils, 12.7 mm diameter 0.127 mm thick, seven 3 mm diameter microscope specimens partially pre-punched from each	Nine Al tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Two supracil samples, each approx. 3 x 3 x 10 mm
Temperature of experiment	Room temperature	4.2°K	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm ²)	6.87×10^{16}	2.69×10^{15}	2.05×10^{17}	5.94×10^{16}	2.58×10^{16}
Measured property or technique used for analysis	Electron microscopy	Electrical resistivity	Electron microscopy	Tensile testing	ESR

DT Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	July 31, 1975		August 1-8, 1975	August 18, 1975	
UCID #	16978		16942	16980	
Beam-on time (hours)	9.67		82.75	3.07	
Experimenters	D. M. Parkin C. L. Suead	J. Kinney	J. B. Mitchell R. A. Van Konynenburg	A. C. Damask C. E. Violet	M. J. Moran
Laboratory	IASL BNL	LLL - Whitman College	LLL	BNL and Queens College LLL	LLL
Samples	12 superconductor wires; two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, three V ₃ Ga single core, two NbTi Supercon 402, two NbTi cupronickel jacketed. 15 to 28 mm in length	Four annealed Al foils, 12.7 mm diameter, 0.025 mm thick	Five Cu tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Four Al-1% Cu wires, each wound in a double flat coil	Two supracil samples, each approximately 3 x 3 x 8 mm
Temperature of experiment	Room temperature	Room temperature	210°C	Room temperature	Room temperature
Average fluence on front of samples (n/cm ²)	3.08×10^{16}	5.99×10^{15}	9.25×10^{16}	7.51×10^{15}	8.13×10^{14}
Measured property or technique used for analysis	Critical current and temperature	Study dechanneling of the alphas in-subsequent α -irradiation	Tensile testing	Resistivity	ESR

DT Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	August 18-22, 1975				August 26-29, 1975	
UCID #	16979				17021	
Beam-on time (hours)	66.12				56.57	
Experimenters	D. M. Parkin C. L. Snead	L. R. Fleischer	J. L. Brimhall	J. B. Mitchell R. A. Van Konynenburg	D. M. Parkin C. L. Snead	J. B. Mitchell R. A. Van Konynenburg
Laboratory	LASL BNL	Westinghouse Research and Development Center	Battelle Pacific Northwest Laboratories	LLL	LASL BNL	LLL
Samples	12 superconductor wires; two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, two NbTi Supercon 402, two NbTi cupronickel jacketed, three V ₃ Ga single core. 19 to 28 mm in length	One each, Ta, Nb, Mo, and V, high purity foils 0.127 mm thick, 12.7 mm diameter, seven 3 mm diameter microscope specimens partially pre-punched from each	Mo and Ni foil samples enclosed in a brass envelope	Nine Al tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	12 superconductor wires; two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, two NbTi Supercon 402, two NbTi cupronickel jacketed, three V ₃ Ga single core. 19 to 28 mm in length	Nine Cu tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide
Temperature of experiment	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm ²)	2.14×10^{17}	1.68×10^{17}	4.77×10^{16}	4.17×10^{16}	1.70×10^{17}	1.33×10^{17}
Measured property or technique used for analysis	Critical current and temperature	Electron microscopy	Electrical resistivity and volume changes	Tensile testing	Critical current and temperature	Tensile testing

DT Fusion Neutron Irradiations - Fiscal Year 1976

Irradiation dates	August 26-29, 1975 (cont.)	September 16-19, 1976					
UCID #	17021	17078					
Beam-on time (hours)	56.57	58.03					
Experimenters	H. Barschall	D. M. Parkin C. E. Snead	R. H. Condit	J. L. Brimhall	J. B. Mitchell R. A. Van Konynenburg	M. J. Moran	H. Barschall
Laboratory	University of Wisconsin and LLL	LASL BNL	LLL	BNL	LLL	LLL	University of Wisconsin and LLL
Samples	13 high purity foils one each Al, Fe, Ta, Ni, Nb, Cu, W, Mo, Zr, Sn, Ti, V, Cr, 12 mm diameter, 0.025 to 0.127 mm thick	12 superconductor wires; two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, two NbTi Supercon 402, two NbTi cupronickel jacketed, three V ₃ Ga single core. 19 to 28 mm in length	Six high purity Nb foils, 12 mm diameter, 0.137 mm thick	Mo and Ni foil samples enclosed in a brass envelope	Seven Al tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Two supracil samples, each approximately 3 x 3 x 8 mm	13 high purity foils, one each Al, Fe, Ta, Ni, Nb, Cu, W, Mo, Zr, Sn, Ti, V, Cr; 12 mm diameter, 0.025 to 0.127 mm thick
Temperature of irradiation	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm ²)	3.51×10^{16}	1.69×10^{17}	1.33×10^{17}	1.13×10^{17}	8.93×10^{16}	2.59×10^{16}	1.55×10^{16}
Measured property or technique used for analysis	Long lived activity	Critical current and temperature	Helium generation	Electrical resistivity and volume changes	Tensile testing	ESR	Long lived activity

DT Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	October 3-13, 1975					October 20-30, 1975	
UCID #	17055					17075	
Beam-on time (hours)	102.53					117.05	
Experimenters	D. M. Parkin C. L. Snead	J. L. Bimhall	Y. Chen	J. B. Mitchell R. A. Van Konynenburg	H. Barschall	J. B. Mitchell R. A. Van Konynenburg	L. M. Watkins
Laboratory	LASL BNL	BNL	ORNL	LLL	University of Wisconsin and LLL	LLL	Sandia Livermore Laboratory
Samples	12 superconductor wires, two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, three V ₃ Ga single core, two NbTi cupronickel jacketed, two NbTi Supercon 402, 19 to 28 mm in length	Mo and Ni foil samples enclosed in a brass envelope	MgO crystal, 1.5 mm thick approximately	Seven Al tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	13 high purity foils, one each Al, Fe, Ta, Ni, Nb, Cu, W, Mo, Zr, Sn, Ti, V, Cr, 12 mm diameter 0.025 to 0.127 mm thick	Five Cu tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Two fiber optic bundles
Temperature of irradiation	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	210°C	Room temperature
Average fluence on front of samples (n/cm ²)	3.02×10^{17}	2.41×10^{17}	1.80×10^{17}	1.24×10^{17}	3.85×10^{16}	2.02×10^{17}	3.53×10^{12}
Measured property or technique used for analysis	Critical current and temperature	Electrical resistivity and volume changes	Optical absorbtion	Tensile testing	Long lived activity	Tensile testing	Optical absorbtion

DT Fusion Neutron Irradiation-- Fiscal Year 1976

Irradiation dates	December 15, 1975			January 19-23, 1976			
UCID #	17076			17062			
Beam-on time (hours)	5.42			74.13			
Experimenters	D. M. Parkin G. L. Snead	W. J. Gray W. C. Morgan	L. S. Penn	W. L. Barmore	R. G. Meisenheimer	R. H. Condit	R. L. Lyles
Laboratory	LASL BNL	Battelle Pacific Northwest Labs.	LLL	LLL	LLL	LLL	ANL
Samples	12 superconductor wires; two 19-core Nb ₃ Sn multifilament, three Nb ₃ Sn single core, three V ₃ Ga single core, two NbTi Supercon 402, two NbTi cupronickel jacketed. 19 to 28 mm long	A pure Al capsule (53 mm long, 12 mm diameter) containing graphite sample holders, graphite samples and Nb dosimetry foils	Twenty-four Kevlar 49 bundles	Five Nb foils, 0.025 mm thick, 12 mm diameter, three "tritium-tricked" to helium concentrations of 25, 50, and 100 ppm	Sputtering experiment	Three crystal samples; SiC, 120 grit; B ₄ C; Al ₂ O ₃	Copper capsule, 9 mm in diameter containing electron microscopy samples in a 33 mm long stack.
Temperature of experiment	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm ²)	1.72×10^{16}	1.37×10^{16}	2.88×10^{14}	1.73×10^{17}	9.31×10^{16}	1.70×10^{16}	1.22×10^{15}
Measured property or technique used for analysis	Critical current and temperature	Change in Young's modulus using ultrasonic technique	Optical absorption	Electron microscopy	Ion microprobe	Helium release	Electron microscopy

DT Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	January 28-30, 1976		April 12-16, 1976		May 17-24, 1976		
UCID #	17061		17142		17199		
Beam-on time (hours)	45.67		54.92		73.35		
Experimenters	R. H. Condit	W. J. Gray W. C. Morgan	M. W. Guinan	R. A. Meyer	R. W. Klaffky	Y. Chen	J. M. Bunch
Laboratory	LLL	BPNL	LLL	LLL	BNL	ORNL	LASL
Samples	Three high purity Nb foils, 12 mm diameter, 0.127 mm thick, plus two thin SiC crystals wrapped in Al foil.	A pure Al capsule (53 mm long, 12 mm diameter) containing graphite sample holders, graphite samples and Nb dosimetry foils.	One each, Nb, Mo, V wires	Powdered SrCl_2 enclosed in plastic capsule	Nine single crystal Al_2O_3 samples; seven were 16 mm diameter discs, 0.51 to 1.02 mm thick; five of these contained Pt electrodes. Two samples were Al foil packets with two or three Al_2O_3 crystals inside.	MgO crystal 10 x 19 x 2.8 mm	90° sapphire, 0° sapphire, spinal, and YAG, all 25-29 mm diameter, 0.4-0.5 mm thick
Temperature of experiment	Room temperature	Room temperature	4.2°K	Room temperature	Room temperature	Room temperature	Room temperature
Average fluence on front of samples (n/cm^2)	1.53×10^{17}	1.33×10^{17}	3.78×10^{16}	3.22×10^{15}	1.23×10^{17}	2.54×10^{16}	1.75×10^{16}
Measured property or technique used for analysis	Helium generation	Change in Young's modulus using ultrasonic technique	Initial damage rate	Activation	Conductivity during electron irradiation	Optical absorption and EPR	Optical absorption

DT Fusion Neutron Irradiation - Fiscal Year 1976

Irradiation dates	June 7-17, 1976			June 22-29, 1976		June 30, 1976
UCID #	17295			17311		17294
Beam-on time (hours)	137.15					4.0
Experimenters	J. B. Mitchell	R. H. Jones	R. M. Scanlan	S. R. Gunn	R. R. Vandervoort	R. M. Scanlan
Laboratory	LLL	BNL	LLL	LLL	LLL	LLL
Samples	Six ∇ tensile specimens, 28.6 mm long, 9.5 mm wide, 0.5 mm thick, with gauge sections 6.4 mm long and 1.6 mm wide	Wire-foil packet (33 wires and/or tensile specimens) Nb, Ni, stainless steel	Nb ₃ Sn tape approx. 7 x 13 x 0.09 mm. Also a carbon resistor about 4 mm long and 1 mm diameter	Two glass samples, 12.7-mm diameter. Six thermoelectric temperature sensors	Four 316 stainless steel tensile specimens with gauge sections 6.4 mm wide, 0.5 mm thick. 316 S.S. sample 10 x 10 x 0.5 mm. 316 S.S. sample 4 x 8 x 0.5 mm	One superconductor wire
Temperature of experiment	Room temperature	Room temperature	Room temperature	Room temperature	Room temperature	4.2°K
Average fluence on front of samples (n/cm ²)	2.13×10^{17}	6.15×10^{16}	5.63×10^{16}	5.17×10^{16}	4.11×10^{16}	2.27×10^{15}
Measured property or technique used for analysis	Tensile testing	Tensile testing	Critical current	Optical absorbtion	Tensile testing and temperature	Critical current

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