27
4-2-76
25 Jan 77

UCID-17078

Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF BNL-LASL SUPERCONDUCTOR WIRES,
BNL MOLYBDENUM AND NICKEL, UW-LLL HIGH PURITY METALLIC FOILS,
LLL NIOBIUM, LLL SUPRACIL, AND LLL ALUMINUM TENSILE SPECIMENS

Susan C. MacLean

January 28, 1976

Unclassified

MASIE

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the laboratory.

Prepared for U.S. Energy Research & Development Administration under contract No. W-7405-Eng-48.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DT FUSION NEUTRON IRRADIATION OF BNL-LASL SUPERCONDUCTOR WIRES,
BNL MOLYBDENUM AND NICKEL, UW-LLL HIGH PURITY METALLIC FOILS,
LLL NIOBIUM, LLL SUPRACIL, AND LLL ALUMINUM TENSILE SPECIMENS

Unclassified

Susan C. MacLean

January 28, 1976

Samples from several experimenters were combined for the LLL Rotating Target Neutron Source (RTNS) irradiation run beginning September 16, 1975.

A fluence of 1×10^{18} neutrons/cm² was being accumulated on twelve superconductor wires for Dr. C. L. Snead, Jr., of Brookhaven National Laboratory (BNL) and Dr. Don M. Parkin of Los Alamos Scientific Laboratory (LASL). The wires had been irradiated July 31, 1975, August 18-22, 1975, and August 26-29, 1975. Prior to these runs, two of the wires, 19-core Nb₃Sn multi-filament, had received 10^{18} neutrons/cm² from RTNS irradiations. The ten remaining wires consisted of three pieces Nb₃Sn single core, three pieces V₃Ga single core, two pieces NbTi Supercon 402, and two pieces NbTi cupronickel jacketed. The wires were wrapped together in aluminum foil. A 12 mm diameter, 0.03 mm thick niobium foil was put in front of the wires for dosimetry.

Dr. John L. Brimhall of Battelle Pacific Northwest Laboratories (BPNL) requested that a fluence of 4×10^{17} be accumulated on his molybdenum and nickel foils. The samples were enclosed in a brass envelope. They had been irradiated August 18-22, 1975. Some of the molybdenum foils had previously received irradiation from the RTNS. A 12 mm diameter, 0.03 mm thick, niobium foil was attached to the back of the brass envelope for dosimetry.

Dr. Henry Barschall, of the University of Wisconsin (UW) and LLL, is interested in looking for long lived isotopes. Therefore, thirteen high purity metallic foils are being irradiated frequently on the RTNS over a long period of time for him. The 12 mm diameter foils, aluminum, iron, tantalum, nickel, niobium, copper, tungsten, molybdenum, zirconium, tin, titanium, vanadium and chromium, were sealed in an aluminum capsule with aluminum foil spacers between the sample foils. The foils had been irradiated November 7-13, 1974, December 2-6, 1974, January 6-14, 1975, January 21-February 4, 1975, May 2-7, 1975, May 16, 1975, and August 26-29, 1975. Niobium dosimetry foils (0.127 mm thick, 12 mm in diameter) were fastened to the front and back of the capsule.

As samples to study helium generation, Dr. Ralph H. Condit of LLL requested the inclusion of six high purity niobium foils on the RTNS run. Six 12 mm diameter discs were punched from two pieces of approximately 0.127 mm thick niobium foil supplied by Dr. Richard Reed of Oak Ridge National Laboratory (ORNL). Niobium foils numbers 494, 496 and 498 were taken from Nb(C) 95 piece #5 with a residual resistance ratio of 7296. Foils numbers 495, 497, and 499 were punched from Nb(C) 95 piece #1 which had a residual resistance ratio of 6618.

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any legal warranty, express or implied, or assumes any liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

Michael J. Moran of LLL requested further irradiation of supracil samples 46 and 56. They had previously been irradiated during the period July 18-25, 1975. The two supracil pieces were placed side by side and sandwiched between two niobium dosimetry foils measuring approximately 10 x 7 x 0.127 mm.

Seven aluminum tensile specimens were included in the RTNS irradiation for Drs. Jack B. Mitchell and Richard A. Van Konynenburg of LLL. The samples measured approximately 28.6 mm in length, 9.5 mm wide, and 0.5 mm thick. The gauge sections were about 6 mm long and 1.6 mm wide. Previous irradiation of the tensile specimens had occurred May 2-7, 1975, July 18-25, 1975 and August 18-22, 1975. The aluminum tensile specimens were stacked with 0.127 mm thick niobium dosimetry foils of the same size and shape and put in an epoxy-fiberglass-laminate sample holder.

The order of stacking, beginning with the material nearest the neutron source, was as follows:

<u>Order</u>	<u>Sample</u>
1	Nb-502
2	Superconductor wires
3	Nb-494
4	Nb-495
5	Nb-496
6	Nb-497
7	Nb-498
8	Nb-499
9	Brass envelope containing Mo and Ni
10	Nb-503
11	Nb-486

<u>Order</u>	<u>Sample</u>
12	A1-5384
13	Nb-487
14	A1-5386
15	Nb-488
16	A1-5387
17	Nb-489
18	A1-5388
19	Nb-490
20	A1-5389
21	Nb-491
22	A1-5391
23	Nb-492
24	A1-5392
25	Nb-493
26	mylar spacers
27	Nb-500
28	Supracil 46 and 56
29	Nb-501
30	Nb-505
31	Barschall's foils
32	Nb-506

Centering of the samples with the neutron beam was accomplished with the use of an autoradiograph of the front sample following a few minutes of irradiation. Following the entire irradiation period, an autoradiograph of the front sample showed that the centering had been excellent. The

irradiation was carried out by the LLL E Division Accelerator Staff during the period September 16 to 19, 1975. The neutron production was monitored continuously with a proton recoil counter and recorded every hour. The dose record is attached. The total beam-on time was 58.03 hours.

The sample holder assembly was stored for a few days to allow for decay of short lived isotopes. The supracil samples were returned to M. Moran. Except for the six niobium sample foils, the remainder of the samples were retained for further irradiation.

The tensile shaped dosimetry foils were cut so that only the portions corresponding to the sample gauge sections were weighed. These along with the niobium sample foils and the other niobium dosimetry foils were delivered to Ruth Anderson in the LLL Radiochemistry Division for gamma ray counting.

The average fluence of each foil was calculated using the method described in UCRL-51393, Rev. 1. However, the cross section used for the 10.16 day niobium isomer activation by 14.8 MeV neutrons was changed to 458 m barns. The results were as follows:

<u>Foil Number</u>	<u>Fluence (neutrons/cm²)</u>
Nb-502	1.69×10^{17}
Nb-494	1.33×10^{17}
Nb-495	1.29×10^{17}
Nb-496	1.24×10^{17}
Nb-497	1.20×10^{17}
Nb-498	1.16×10^{17}
Nb-499	1.13×10^{17}
Nb-503	8.58×10^{16}
Nb-486	8.93×10^{16}

<u>Foil Number</u>	<u>Fluence (neutrons/cm²)</u>
Nb-487	7.76×10^{16}
Nb-488	6.73×10^{16}
Nb-489	5.84×10^{16}
Nb-490	5.21×10^{16}
Nb-491	4.63×10^{16}
Nb-492	4.17×10^{16}
Nb-493	3.72×10^{16}
Nb-500	2.59×10^{16}
Nb-501	1.64×10^{16}
Nb-505	1.55×10^{16}
Nb-506	1.06×10^{16}

The estimated overall uncertainty of these results is $\pm 7.5\%$. The relative uncertainty between any two values is about $\pm 2\%$. The values given here represent average fluences over the volume of each dosimetry foil.

RTNS IRRADIATION OF SEPTEMBER 16 TO 19, 1975

26 SEP 75

10:16:15

INTERNAL DISTRIBUTION

J. D. Anderson, L-312

R. Booth, L-330

C. M. Logan, L-141

J. C. Davis, L-313

C. Wong, L-313

J. W. Frazer, L-401

L. W. Roberts, L-401

R. J. Borg, L-231

C. Gatrousis, L-231

R. N. Anderson, L-231

L. G. Mann, L-540

R. R. Vandervoort, L-426

J. B. Mitchell, L-426

M. W. Guinan, L-233

R. A. Van Konynenburg, L-233

S. C. MacLean, L-233 (7)

R. H. Condit, L-503

M. J. Moran, L-503

TID, L-9 (15)

EXTERNAL DISTRIBUTION

Dr. Klaus Zwilsky, USERDA
Division of Controlled Thermonuclear
Research
Washington, D.C. 20545

Dr. Marvin Cohen, USERDA
Division of Controlled Thermonuclear
Research
Washington, D.C. 20545

EXTERNAL DISTRIBUTION (cont.)

Dr. Charles Finfgeld, USERDA
Division of Controlled Thermonuclear
Research
Washington, D.C. 20545

Dr. Louis Ianniello, USERDA
Division of Physical Research
Washington, D.C. 20545

Dr. Robert Heinrich,
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 205
Argonne, Illinois 60439

Dr. T. C. Reuther, USERDA
Division of Controlled Thermonuclear
Research
Washington, D.C. 20545

Dr. C. L. Snead, Jr.
Brookhaven National Laboratory
Upton, Long Island, New York 11973

Dr. Don M. Parkin
Los Alamos Scientific Laboratory
P.O. Box 1663
Los Alamos, New Mexico 87544

Dr. John L. Brimhall
Battelle Pacific Northwest Laboratories
Metallurgy
Battelle Blvd.
Richland, Washington 99352

Dr. Heinz Barschall,
University of Wisconsin
Physics Department
500 Lincoln Drive
Madison, Wisconsin 53706

TIC, Oak Ridge, TN, (27)

NOTICE

"This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research & Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights."

Printed in the United States of America
Available from
National Technical Information Service
U. S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy \$ ____*; Microfiche \$2.25

<u>* Pages</u>	<u>NTIS Selling Price</u>
1-50	\$4.00
51-150	\$5.45
151-325	\$7.60
326-500	\$10.60
501-1000	\$13.60

Technical Information Department
LAWRENCE LIVERMORE LABORATORY
University of California | Livermore, California | 94550