Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF LLL Nb-1 Zr TENSILE SPECIMENS, BNL-LASL SUPERCONDUCTOR WIRES, BPNL WIRE-FOIL PACKET, ORNL MAGNESIUM OXIDE CRYSTALS, LASL SPINEL, YAG, Al_2O_3 AND MgO , and LLL LiF AND GLASS MICROSCOPE COVER SLIDES

S. C. MacLean

March 4, 1977

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Abstract

The DT fusion neutron irradiation of eight LLL Nb-1Zr tensile specimens, eleven BNL-LASL superconductor wires, one BPNL wire-foil packet, two ORNL magnesium oxide crystals, four LASL high purity single crystals, one each of spinel, YAG, Al_2O_3 and MgO, one LLL bicrystal of LiF and several LLL glass microscope cover slides is described. The sample position, beam-on time and dose record are given. The maximum neutron fluence on any sample was 2.51×10^{17} neutrons/cm².

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DT Fusion Neutron Irradiation of LLL Nb-1Zr Tensile Specimens, BNL-LASL Superconductor Wires, BPNL Wire-Foil Packet, ORNL Magnesium Oxide Crystals, LASL Spinel, YAG, Al_2O_3 and MgO , and LLL LiF and Glass Microscope Cover Slides

March 4, 1977

Susan C. MacLean

Samples from several experimenters were stacked together in order to most efficiently utilize the LLL Rotating Target Neutron Source (RTNS) irradiation beginning January 17, 1977.

Dr. Jack B. Mitchell of LLL had supplied eight Nb-1Zr tensile specimens (28.6 mm long, 9.5 mm wide, 0.4 mm thick with gauge sections about 6 mm long and 1.6 mm wide). These samples had been irradiated during the period November 17 to December 2, 1976. The tensile specimens were stacked in an epoxy-fiberglass laminate sample holder with niobium dosimetry foils of the same size and shape but only 0.14 mm thick.

A fluence of 10^{18} neutrons/cm² was being accumulated on eleven 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, 19 to 28 mm long, were wrapped in aluminum foil and had been irradiated during the periods July 26-29, 1976, September 27 - October 1, 1976, November 17 - December 2, 1976, and January 3-7, 1977. Prior to the current fluence accumulation, nine of the wires (3 Nb₃Sn single core, 3 V₃Ga single core, 2 NbTi Supercon 402, and 1 NbTi cupronickel jacketed) had received 8×10^{17} neutrons/cm² from RTNS irradiation and the other two wires (19-core Nb₃Sn multifilament wires) 1.8×10^{18} neutrons/cm².

Drs. Russell H. Jones and David L. Styris of Battelle Pacific Northwest Laboratories (BPNL) requested a fluence of $5-7 \times 10^{17}$ neutrons/cm² for their wire-foil packet, No. 4. The packet had previously been irradiated September 27 - October 1, 1976, November 17 - December 2, 1976, and January 3-7, 1977. The sample packet was positioned so that the wires were toward the neutron source and the beam center was approximately 26 mm from the reference corner of the supporting foil, as requested.

Two thin MgO crystals were being irradiated to 10^{18} neutrons/cm² for Dr. Yok Chen of Oak Ridge National Laboratory (ORNL). The crystals were

wrapped together, with a 0.03 mm thick piece of mylar between them, in aluminum foil. They were designated MgO-20 and MgO-21 and had been irradiated at the RTNS during January 3-7, 1977.

Four high purity single crystal samples were received from Dr. George F. Hurley of LASL and Dr. Harold Weinstock of Illinois Institute of Technology (IIT). The samples, YAG, Spinel, Al_2O_3 and MgO, all measured approximately $4 \times 4 \times 4$ mm. Each was individually wrapped in aluminum foil and labeled on one side. The desired dose of 10^{17} neutrons/cm² was to be given half on the labeled faces of the crystals and half on the opposite faces. The samples had been irradiated October 11-15, 1976 and November 17-24, 1976. The crystals were stacked with niobium dosimetry foils measuring approximately $4 \times 4 \times 0.14$ mm. The labeled sides of the crystals were away from the neutron beam.

Dr. Ralph H. Condit of LLL supplied for RTNS irradiation a small stack of glass microscope cover slides which had been irradiated previously, during the period November 17 - December 2, 1976. He also provided two halves of a broken bicrystal of LiF measuring about $25 \times 25 \times 15$ mm thick.

The samples were all stacked with niobium dosimetry foils. The foils not already described were all 12 mm in diameter and 0.14 mm thick. The order of stacking was as follows:

<u>Order</u>	<u>Sample</u>
1	Nb-763
2	Nb-1Zr-2
3	Nb-764
4	Nb-1Zr-4
5	Nb-793
6	Nb-1Zr-5
7	Nb-794
8	Nb-1Zr-12
9	Nb-795
10	Nb-1Zr-15
11	Nb-796
12	Nb-1Zr-20
13	Nb-797
14	Nb-1Zr-33
15	Nb-798

16		Nb-1Zr-35
17		Nb-799
18		Mylar spacers
19		Nb-765
20		Superconductor wires
21		Nb-766
22		Wire-foil product, No. 4
23		Nb-767
24		MgO-20 and MgO-21
25		Nb-768
26		{ Nb-801
27	(Bracketed)	{ YAG
28	groups were	{ Nb-800
29	side by	{ Nb-803
30	side)	{ Spinel
31		{ Nb-802
32		{ Nb-805
33		{ Al ₂ O ₃
34		{ Nb-804
35		{ Nb-807
36		{ MgO
37		{ Nb-808
38		Nb-771
39		Glass cover slides
40		Nb-772
41		Nb-769
42		LiF
43		Nb-770

A copper foil with a 6 mm diameter hole was centered on cross hairs on the back of the target and irradiated briefly. An autoradiograph of the copper foil showed the position of the neutron source so that the samples could be aligned with it. The neutron irradiation was carried out by the LLL E Division Accelerator Staff during the period January 17 to 21, 1977. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. The total beam-on time was 77.11 hours.

Following the irradiation, an autoradiograph of the front sample holder showed that the centering of the samples had been within 2 mm of the center of the neutron beam. The sample assembly was stored for several days to allow short lived isotopes to decay. The Nb-1Zr tensile specimens were returned to J. B. Mitchell and the LiF and microscope cover slides were returned to R. H. Condit. The remaining samples were retained for further irradiation.

The tensile specimen shaped dosimetry foils were cut and weighed so that only the gauge sections would be used. These along with the other niobium dosimetry foils were delivered to Ruth Anderson in the LLL Radiochemistry Division. She carried out the gamma ray counting.

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

<u>Dosimetry Foil</u>	<u>Fluence (neutrons/cm²)</u>
Nb-763	2.51×10^{17}
Nb-764	2.03×10^{17}
Nb-793	1.69×10^{17}
Nb-794	1.42×10^{17}
Nb-795	1.23×10^{17}
Nb-796	1.04×10^{17}
Nb-797	9.08×10^{16}
Nb-798	8.00×10^{16}
Nb-799	7.17×10^{16}
Nb-765	5.18×10^{16}
Nb-766	4.69×10^{16}
Nb-767	4.18×10^{16}
Nb-768	3.37×10^{16}
Nb-801	3.15×10^{16}
Nb-800	2.15×10^{16}
Nb-803	3.29×10^{16}
Nb-802	2.23×10^{16}
Nb-805	3.38×10^{16}
Nb-804	2.17×10^{16}
Nb-807	3.56×10^{16}
Nb-806	2.24×10^{16}

Nb-771	1.86×10^{16}
Nb-772	1.35×10^{16}
Nb-769	8.28×10^{15}
Nb-770	3.46×10^{15}

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

RTNS IRRADIATION OF JANUARY 17 TO 21, 1977

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University of California | Livermore, California | 94550