Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF LLL Nb-1 Zr TENSILE SPECIMENS,
BNL WIRE-FOIL PACKETS, BNL-LASL SUPERCONDUCTOR WIRES, LASL SPINEL,
YAG, MgO, AND Al_2O_3 , AND LLL SILICA-SUPRASIL AND MICRO-COVER GLASSES.

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May 18, 1977

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ABSTRACT

The DT fusion neutron irradiation of eight LLL Nb-1Zr tensile specimens, two BPNL wire-foil packets, eleven BNL-LASL superconductor wires, four LASL high purity single crystals (one each of YAG, Spinel, Al_2O_3 and MgO), seven LLL Suprasil and several LLL micro cover glasses. The sample position, beam — on time, and neutron dose record are given. The maximum neutron fluence on any sample was 4.68×10^{17} neutrons/cm².

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DT FUSION NEUTRON IRRADIATION OF LLL Nb-1Zr
TENSILE SPECIMENS, BPNL WIRE-FOIL PACKETS,
BNL-LASL SUPERCONDUCTOR WIRES, LASL SPINEL,
YAG, MgO, AND Al_2O_3 , AND LLL SILICA-SUPRASIL
AND MICRO-COVER GLASSES

For most efficient use of the LLL Rotating Target Neutron Source (RTNS), samples from several experimenters were stacked together during the irradiation beginning November 17, 1976.

Dr. Jack B. Mitchell of LLL provided eight Nb-1Zr tensile specimens which had been annealed one hour at 1550°C . The samples measured approximately 28.6 mm long, 9.5 mm wide, 0.45 mm thick and had gauge sections 6 mm in length and 1.6 mm wide. The samples were loaded into an epoxy-fiberglass-laminate sample holder with niobium dosimetry foils of the same size and shape but 0.14 mm thick.

Two wire-foil packets from Drs. Russell H. Jones and David L. Styris of Battelle Pacific Northwest Laboratories (BPNL) had been irradiated at the LLL RTNS during the period September 27 to October 1, 1976. A fluence of 10^{17} neutrons/cm² was requested for wire-foil packet #3 and $5-7 \times 10^{17}$ neutrons/cm² was desired on wire-foil packet #4. Niobium dosimetry foils, 12 mm in diameter and 0.14 mm thick, were taped to the front and back of each packet over the point requested for the beam center on each packet. This was on one side of the arrangement of parallel sample wires, or approximately 26 mm from the sample foil reference corner on #3 and 27 mm from the reference corner on #4. Packet #3 was mounted so that it could be removed following six days of irradiation without disturbing the other samples.

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, arranged in a single layer and wrapped in aluminum foil, had been previously irradiated during the periods of July 26-29, 1976 and September 27-October 1, 1976. Prior to the current fluence accumulation, two of the wires, 19-core Nb_3Sn multifilament, had received 1.86×10^{18} neutrons/cm². The remaining wires had received 8.06×10^{17} neutrons/cm². They were three pieces of Nb_3Sn single core, three pieces of V_3Ga single core, two pieces NbTi Supercon 402 and one piece NbTi cupronickel jacketed wires. The aluminum foil packet of wires was sandwiched between two 12 mm diameter, 0.14 mm thick niobium dosimetry foils.

Four high purity single crystal samples were supplied by Drs. George F. Hurley of LASL and Dr. Harold Weinstock of Illinois Institute of Technology (IIT). The samples, YAG, Spinel, Al_2O_3 and MgO , were individually wrapped in aluminum foil and labeled on one side. The samples had been irradiated during the period of October 11-15, 1976. During that irradiation, the sample side opposite the label had been toward the neutron beam for all the samples. For the present irradiation, each sample was sandwiched between two niobium dosimetry foils ($4 \times 4 \times 0.14$ mm) and the labeled side was closest to the neutron source. The crystal samples were removed after six days of irradiation.

Dr. Ralph H. Condit of LLL requested irradiation of seven Suprasil samples and a stack of micro cover glasses. Four of the Suprasil samples had been irradiated during the period October 11-15, 1976. The Suprasil measured approximately $2.5 \times 2.5 \times 9$ mm. The four previously irradiated samples were arranged parallel to one another and perpendicular to the floor between two 12 mm diameter, 0.14 mm thick niobium dosimetry foils. The three new Suprasil samples were parallel to each other, parallel to the floor and behind the other four samples. A stack of approximately 35 micro cover glasses, 25 mm in diameter, were taped together and centered between 12 mm diameter, 0.14 mm thick niobium foils.

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

<u>Order</u>	<u>Sample</u>
First sample holder	
1	Nb-737
2	Nb-1Zr-2
3	Nb-738
4	Nb-1Zr-4
5	Nb-739
6	Nb-1Zr-5
7	Nb-740
8	Nb-1Zr-12

9	Nb-741
10	Nb-1Zr-15
11	Nb-742
12	Nb-1Zr-20
13	Nb-743
14	Nb-1Zr-33
15	Nb-744
16	Nb-1Zr-35
17	Nb-745
18	mylar spacers
19	Nb-733
20	Wire-foil packet #4
21	Nb-746
22	Superconductor wires
23	Nb-747

Second sample holder

24	Nb-756
25	Wire-foil packet #3
26	Nb-757
27	Bracketed
28	groups were
29	arranged side
30	by side.
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	

	{ Nb-748
	{ Al ₂ O ₃
	{ Nb-752
	{ Nb-749
	{ Spinel
	{ Nb-753
	{ Nb-750
	{ YAG
	{ Nb-754
	{ Nb-751
	{ MgO
	{ Nb-755
	{ Mylar
	{ Nb-758
	{ Four Suprasil
	{ Nb-759

43	Three Suprasil
44	Nb-760
	Third sample holder
45	Nb-761
46	Stack of micro cover glasses
47	Nb-762

The neutron irradiation was carried out by the LLL E Division Accelerator Staff during the period November 17 to December 2, 1976. Before the irradiation started on November 29, 1976, the LASL crystal samples and one BPNL wire-foil packet were removed from the sample assembly.

Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. Total beam — on time was 148.71 hours. Following the irradiation, the sample assembly was stored for several days to allow short-lived isotopes to decay.

The No. 3 wire-foil packet was removed early and returned to Dr. Jones at BPNL. The Suprasil samples and the micro cover glasses were given to R. Condit. The remaining samples were retained for further irradiation.

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

The average fluence on each 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-737	4.68×10^{17}
Nb-738	3.91×10^{17}
Nb-739	3.27×10^{17}
Nb-740	2.69×10^{17}
Nb-741	2.18×10^{17}
Nb-742	1.90×10^{17}
Nb-743	1.64×10^{17}

Nb-744	1.45×10^{17}
Nb-745	1.27×10^{17}
Nb-733	8.43×10^{16}
Nb-746	7.69×10^{16}
Nb-747	7.00×10^{16}
Nb-756	4.57×10^{16}
Nb-757	4.11×10^{16}
Nb-748	3.67×10^{16}
Nb-752	2.41×10^{16}
Nb-749	4.17×10^{16}
Nb-753	2.67×10^{16}
Nb-750	3.63×10^{16}
Nb-754	2.40×10^{16}
Nb-751	4.19×10^{16}
Nb-755	2.62×10^{16}
Nb-758	3.80×10^{16}
Nb-759	2.78×10^{16}
Nb-760	2.14×10^{16}
Nb-761	2.00×10^{16}
Nb-762	1.32×10^{16}

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

RTNS IRRADIATION OF NOVEMBER 17 TO DECEMBER 2, 1976

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