Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF LLL
STAINLESS STEEL, LASL MgO, YAG, SAPPHIRE
AND SPINEL, AND LLL CaF₂ AND SUPRASIL

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ABSTRACT

The DT fusion neutron irradiation of nine LLL stainless steel samples (including six tensile specimens), four LASL high purity single crystals (one each of MgO, YAG, Sapphire and Spinel), ten LLL silica samples, and seven LLL calcium fluoride samples is described. The sample position, beam - on time, and neutron dose record are given. The maximum neutron fluence on any sample was 1.39×10^{17} neutron/cm².

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In order to efficiently utilize the LLL Rotating Target Neutron Source (RTNS), samples from several experimenters were combined for the irradiation starting October 11, 1976.

Dr. Richard R. Vandervoort of LLL provided three additional stainless steel samples (G series) to be included with six stainless steel samples that had been irradiated previously (June 22-29, 1976 and July 8-21, 1976). Six of the stainless steel samples were tensile specimens with gauge sections of approximately $1.6 \times 6 \times 0.5$ mm. These were stacked in an epoxy-fiberglass laminate sample holder with niobium dosimetry foils of the same size and shape but 0.14 mm thick. The three remaining stainless steel samples were tabs of varying sizes:

S.S., P-3, $4 \times 8 \times 0.5$ mm

S.S., C-3, $10 \times 10 \times 0.5$ mm

S.S., G-1, $10 \times 10 \times 0.8$ mm

The tabs were sandwiched between niobium dosimetry foils and centered on the front of the sample holder containing the stainless steel tensile specimens.

Four high purity single crystal samples for RTNS irradiation were received from Dr. George F. Hurley of Los Alamos Scientific Laboratory (LASL) and Dr. Harold Weinstock of Illinois Institute of Technology (IIT). Three of the samples, YAG ($\text{Y}_3\text{Al}_5\text{O}_{12}$), Spinel (MgAl_2O_4), and Sapphire (Al_2O_3), measured approximately $4 \times 4 \times 3.5$ mm, and the fourth sample, MgO, was about $4 \times 4 \times 3.7$ mm. A fluence of 10^{17} neutron/cm² was requested with half the dose on one face of each sample, and half on the opposite face. Each sample was individually wrapped in aluminum foil, labeled on one side only, and was put between two niobium dosimetry foils ($4 \times 4 \times 0.14$ mm). The four samples were arranged in a single layer square with the labeled sides away from the direction of the neutron beam and were taped to the back of the sample holder containing the stainless steel tensile specimens.

Dr. Ralph H. Condit of LLL supplied ten silica - Suprasil-I samples and seven calcium fluoride samples. The Suprasil samples were approximately $10 \times 2 \times 2$ mm. Eight of the SiO₂ samples were loaded in the second sample holder, stacked with 12 mm diameter 0.14 mm thick niobium dosimetry foils.

The four SiO_2 closest to the neutron beam, were parallel to each other in a single layer and parallel to the floor. The second layer of four Suprasil samples was perpendicular to the floor. The last two Suprasil samples were put in the third sample holder to the side of the CaF_2 sample stack. The CaF_2 crystals of varying sizes and shapes were stacked with niobium dosimetry foils, 12 mm in diameter and 0.14 mm thick.

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

<u>Order</u>	<u>Sample</u>
First Sample Holder	
1	Nb-725 (12 mm diameter, 0.03 mm thick)
2	Nb-709
3	S.S., P-3 tab
4	Nb-708
5	Nb-710
6	S.S., C-3 tab
7	Nb-711
8	Nb-667
9	S.S., G-1 tab
10	Nb-668
11	mylar
12	Nb-716
13	S.S., P-1 tensile
14	Nb-706
15	S.S., C-1 tensile
16	Nb-707
17	S.S., P-2 tensile
18	Nb-712
19	S.S., C-2 tensile
20	Nb-713
21	S.S., G-1 tensile
22	Nb-714
23	S.S., G-2 tensile
24	Nb-715
25	mylar spacers

26		{ Nb-721
27		{ MgO
28	Bracketed groups were side by side.	{ Nb-717
29		{ Nb-722
30		{ YAG
31		{ Nb-718
32		{ Nb-723
33		{ Al ₂ O ₃
34		{ Nb-719
35		{ Nb-724
36		{ Spinel
37		{ Nb-720

Second Sample Holder

38	Nb-734
39	Four SiO ₂ samples
40	Nb-735
41	Four SiO ₂ samples
42	Nb-736

Third Sample Holder

43	Nb-669
44	CaF ₂ -0
45	Nb-726
46	CaF ₂ -1
47	Nb-727
48	CaF ₂ -2
49	Nb-728
50	CaF ₂ -3
51	Nb-729
52	CaF ₂ -4
53	Nb-730
54	CaF ₂ -5
55	Nb-731
56	CaF ₂ -6
57	Nb-732

To the side,
Two SiO₂ samples.

The samples were centered with the neutron beam using autoradiographs of the front sample holder made after a few minutes of irradiation. The LLL E Division Accelerator Staff carried out the neutron irradiation during the period October 11 to 15, 1976. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. Total beam - on time was 65.88 hours.

Following the irradiation, the sample holders were stored for a few days to allow for decay of short-lived isotopes. The LASL crystal samples were retained for further irradiation. The stainless steel samples were returned to R. R. Vandervoort and the SiO_2 and CaF_2 were returned to R. H. Condit.

The tensile specimen shaped dosimetry foils were cut and weighed so that only the portions corresponding to the sample gauge sections were used for gamma ray counting. These along with the other niobium dosimetry foils were delivered to Ruth Anderson in the LLL Radiochemistry Division for 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-725	1.30×10^{17}
Nb-709	1.39×10^{17}
Nb-708	1.17×10^{17}
Nb-710	9.81×10^{16}
Nb-711	8.49×10^{16}
Nb-667	7.77×10^{16}
Nb-668	6.65×10^{16}
Nb-716	6.44×10^{16}
Nb-706	5.74×10^{16}
Nb-707	4.67×10^{16}
Nb-712	4.09×10^{16}
Nb-713	3.54×10^{16}
Nb-714	2.97×10^{16}
Nb-715	2.50×10^{16}
Nb-721	1.56×10^{16}

Nb-717	1.08×10^{16}
Nb-722	2.02×10^{16}
Nb-718	1.36×10^{16}
Nb-723	1.66×10^{16}
Nb-719	1.15×10^{16}
Nb-724	2.22×10^{16}
Nb-720	1.43×10^{16}
Nb-734	1.21×10^{16}
Nb-735	9.19×10^{15}
Nb-736	6.99×10^{15}
Nb-669	6.52×10^{15}
Nb-726	5.99×10^{15}
Nb-727	5.01×10^{15}
Nb-728	4.44×10^{15}
Nb-729	3.99×10^{15}
Nb-730	3.49×10^{15}
Nb-731	3.12×10^{15}
Nb-732	2.72×10^{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 OCTOBER 11 TO 15, 1976

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