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DT FUSION NEUTRON IRRADIATION OF LLL 316 STAINLESS STEEL,
LLL VANADIUM TENSILE SPECIMENS, AND ORNL MAGNESIUM OXIDE CRYSTAL

Unclassified

September 9, 1976

Susan C. MacLean

MASTER

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In order to most efficiently utilize the LLL Rotating Target Neutron Source (RTNS) during the run beginning July 8, 1976, samples from three researchers were stacked together for the irradiation.

Dr. Richard R. Vandervoort of LLL had six 316 stainless steel samples which had been irradiated at the RTNS during the period June 22 to 29, 1976. Four of the samples were tensile specimens with gauge sections measuring approximately 1.6 x 6.4 x 0.5 mm. These were designated P-1, P-2, C-1, and C-2 and were stacked with 0.13 mm thick niobium dosimetry foils of the same size and shape.

Sample P-3 measured approximately 4 x 8 x 0.5 mm and was fitted into a hole in a piece of 0.25 mm thick mylar in order to be held in place, centered behind the gauge sections of the tensile specimens. Niobium dosimetry foils were placed on both sides of the sample and were held in place by mylar spacers. The P-3 sample, dosimetry foils and mylar spacers were all taped together.

Sample C-3 measured approximately 10 x 10 x 0.5 mm. Cardboard spacers were used to keep it centered. Niobium dosimetry foils of the same size were held on each side of the sample by cardboard spacers and

the packet was taped together. The samples and dosimetry foils were loaded in an epoxy-fiberglass laminate sample holder.

The 316 stainless steel sample package was still too radioactive from its previous irradiation to unload and re-load with new niobium dosimetry foils. Therefore, a niobium tensile specimen shaped foil was centered over the samples on the front and back of the sample holder for this second irradiation.

Six MRC VP grade vanadium tensile specimens had been irradiated June 7 to 17, 1976 for Dr. Jack B. Mitchell of LLL. The vanadium tensile specimens were stacked with 0.14 mm thick niobium dosimetry foils of the same size and shape as the samples. These were loaded into an epoxy-fiberglass laminate sample holder. The stainless steel package was centered on the front and taped in place.

Dr. Yok Chen of Oak Ridge National Laboratory (ORNL) requested a fluence of $4-5 \times 10^{16}$ neutrons/cm² for a magnesium oxide crystal. MgO-19 measured approximately 10 x 19 x 2.8 mm and had been irradiated May 17 to 24, 1976. The MgO crystal was wrapped in aluminum foil and sandwiched between two 12 mm diameter by 0.14 mm thick niobium foils. The MgO crystal and dosimetry foils were taped to a third sample holder and positioned so that the crystal was about 23 mm from the target.

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

<u>Order</u>	<u>Sample</u>
1	Nb-614
2	mylar
3	Nb-604

<u>Order</u>	<u>Sample</u>	
4	316 S.S., P-1	} First sample holder, taped on to second sample holder
5	Nb-605	
6	316 S.S., C-1	
7	Nb-606	
8	Nb-607	
9	316 S.S., P-3	
10	Nb-608	
11	Nb-609	
12	316 S.S., C-3	
13	Nb-610	
14	Nb-611	
15	316 S.S., P-2	
16	Nb-612	
17	316 S.S., C-2	
18	Nb-613	
19	mylar	}
20	Nb-615	
21	mylar	
22	Nb-616	
23	V-5951	
24	Nb-617	
25	V-5959	
26	Nb-618	
27	V-5970	
28	Nb-619	
29	V-5974	

<u>Order</u>	<u>Sample</u>	
30	Nb-620	} Second sample holder
31	V-5983	
32	Nb-621	
33	V-5984	
34	Nb-622	
35	Mylar spacers	} Third sample holder
36	Nb-623	
37	MgO-19 wrapped in Al foil	
38	Nb-624	

An autoradiograph of the front of the sample holder, made after a few minutes of irradiation, was used to center the samples with the center of the neutron beam. The neutron irradiation was carried out by the LLL E Division Accelerator Staff during the period July 8 to 21, 1976. It was necessary to change the target on both July 13 and July 20, 1976. Because the samples were moved to change the target, the realignment with the beam may not have been exactly as it had been before. Therefore, dosimetry foils were added to the outside center front and back of the sample holders. The neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose records are attached. The total beam-on time was 111.45 hours.

Following the irradiation, the sample holders were stored for several days to allow short-lived isotopes to decay. An autoradiograph of the front of the first sample holder indicated that the centering had been to within 1 mm of the center of the neutron beam.

The vanadium tensile specimens were returned to J. B. Mitchell. The stainless steel samples were retained for further irradiation as was the MgO-19 crystal.

The tensile specimen shaped dosimetry foils were cut and weighed so that only the portions corresponding to the gauge sections were delivered with the other dosimetry foils to Austin L. Prindle in the LLL Radiochemistry Division for gamma ray counting.

The fluence on each niobium dosimetry foil was calculated for each of the three portions of the irradiation and then the three numbers were added together to get the average fluence for each foil. The fluence on each of the exterior dosimetry foils 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.

To calculate the fluence on the interior intermediate foils for the July 21, 1976 irradiation, the measured ^{92m}Nb dpm/gm for the interior intermediate foils were plotted as a function of distance. The exterior front and back foils' locations were measured and the values for dpm/gm were taken where their locations intersected the curve. The fluence on an interior intermediate dosimetry foil was calculated by multiplying the fluence on the back exterior foil by a ratio of the dpm/gm for the interior foil to dpm/gm for the back exterior foil. Both dpm/gm values were taken from the graph.

The fluences from the irradiation period of July 13 to 20, 1976 were calculated similarly. After the dpm/gm due to the July 21, 1976 irradiation were subtracted from the measured dpm/gm value for each foil, the dpm/gm were corrected to a time corresponding to the end of the irradiation on July 20, 1976.

The fluences for the July 8 to 13, 1976 period of irradiation were calculated from dpm/gm values corrected by subtracting dpm/gm due to the July 21, 1976 and July 13 to 20, 1976 irradiations and then projecting the values back to the end of the first portion of the irradiation.

This same process was repeated once more for the dosimetry foils stacked with the 316 stainless steel samples to determine the fluence from the July 8 to 21, 1976 irradiation and the dpm/gm from a previous irradiation in June 1976.

The three fluence values for the three portions of the irradiation period were added together for each dosimetry foil and the results were as follows:

<u>Dosimetry Foil</u>	<u>Fluence(n/cm²)</u>
Nb-614	2.47×10^{17}
Nb-604	2.19×10^{17}
Nb-605	1.84×10^{17}
Nb-606	1.58×10^{17}
Nb-607	1.46×10^{17}
Nb-608	1.23×10^{17}
Nb-609	1.09×10^{17}
Nb-610	9.57×10^{16}
Nb-611	9.59×10^{16}
Nb-612	8.28×10^{16}
Nb-613	7.44×10^{16}
Nb-615	6.41×10^{16}
Nb-616	6.12×10^{16}
Nb-617	5.32×10^{16}

<u>Dosimetry Foil</u>	<u>Fluence(n/cm²)</u>
Nb-618	4.82×10^{16}
Nb-619	4.38×10^{16}
Nb-620	3.97×10^{16}
Nb-621	3.64×10^{16}
Nb-622	3.30×10^{16}
Nb-623	1.60×10^{16}
Nb-624	1.20×10^{16}

The estimated overall uncertainty of these results is $\pm 10\%$. 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 JULY 8 TO 13, 1976

16 JUL 76
08:34:29

RTNS IRRADIATION OF JULY 13 TO 20, 1976

29 JUL 76

12:48:03

RTNS IRRADIATION OF JULY 21, 1976

29 JUL 76

12:14:55

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