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UCID - 16661

LAWRENCE LIVERMORE LABORATORY

University of California/Livermore, California

DT Fusion Neutron Irradiation of BPNL Molybdenum, ORNL Magnesium
Oxide Crystal, LLL Optical Glass, and LLL Copper Tensile Specimens

Unclassified

Susan C. MacLean

December 9, 1974

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DT Fusion Neutron Irradiation of BPNL Molybdenum,
ORNL Magnesium Oxide Crystal, LLL Optical Glass,
and LLL Copper Tensile Specimens

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For efficient use of the LLL Rotating Target Neutron Source (RTNS), samples from several experimenters were included during one irradiation period on October 25, 1974.

Dr. John L. Brimhall of Battelle Pacific Northwest Laboratories (BPNL) requested a fluence of 5×10^{17} neutrons/cm² be accumulated on molybdenum samples he provided. The molybdenum foils, which had been placed in a stainless steel washer for ease of handling, had previously been irradiated January 14-16, 1974, September 11, 1974, and October 7-9, 1974.

Dr. Yok Chen of Oak Ridge National Laboratory (ORNL) asked that a fluence of 10^{18} neutrons/cm² be accumulated on his magnesium oxide crystal designated MgO-8. This crystal, wrapped in aluminum foil, had been irradiated January 14-16, 1974, May 29-31, 1974, July 16-18, 1974, September 11, 1974, and October 7-9, 1974.

Clyde Layne and Michael Moran of LLL furnished two pieces of BK7 optical glass for irradiation. The approximate measurements of both BK7-11 and BK7-12 were 19 mm by 20 mm by 1 mm thick.

Drs. Jack B. Mitchell and Richard A. Van Konynenburg of LLL supplied 16 tensile specimens cut from Cominco American sheet copper for irradiation. The samples had previously been irradiated during the period July 8-15, 1974.

A niobium profile dosimetry foil was also included in this irradiation run in order to measure the lateral variation in the neutron flux. The foil was 24 mm square and 0.140 mm thick. It was scribed into 36 squares, each measuring 4 mm by 4 mm. Each square was numbered with a two digit figure. The first number indicated the horizontal row, top to bottom, 1 to 6. The second number designated the vertical rows, left to right, 1 to 6, facing the neutron beam. The profile foil was fastened to the front of the first sample holder.

The copper tensile specimens were stacked with niobium dosimetry foils of the same size and shape in two epoxy-fiberglass laminate sample holders. The other dosimetry foils were discs of 12.1 mm diameter except Nb-81 which measured 7 mm by 10 mm. These were stacked with the remaining samples and attached to the backs of the sample holders. The order of stacking, beginning with the material nearest the neutron source, was as follows:

<u>Order</u>	<u>Sample holder</u>	<u>Sample</u>	<u>Distance from Source</u>
1	A	Nb profile foil	3 mm
2		Mylar	
3		Nb-167	
4		Cu-1417	
5		Nb-168	
6		Cu-1418	
7		Nb-169	
8		Cu-1419	
9		Nb-170	
10		Cu-1422	
11		Nb-171	
12		Cu-1423	
13		Nb-172	
14		Cu-1425	
15		Nb-173	
16		Cu-1427	
17		Nb-174	
18		Cu-1430	
19		Nb-175	
20		Cu-1431	
21		Nb-176	
22		Mylar	
23		Molybdenum samples in a stainless steel washer	
24		Nb-177	
25		Glass BK7-11	
26		Nb-178	
27		MgO-8 wrapped in aluminum foil	
28		Nb-81	

<u>Order</u>	<u>Sample holder</u>	<u>Sample</u>	<u>Distance from Source</u>
29		Mylar	13 mm
30		Nb-179	
31		Cu-1434	
32		Nb-180	
33		Cu-1435	
34		Nb-181	
35		Cu-1436	
36		Nb-182	
37		Cu-1437	
38	B	Nb-183	
39		Cu-1438	
40		Nb-184	
41		Cu-1440	
42		Nb-185	
43		Cu-1441	
44		Nb-186	
45		Mylar	
46		Nb-187	
47		Glass BK7-12	
48		Nb-188	

The irradiation was carried out by the LLL E Division Accelerator Staff on October 25, 1974. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached as Figure I. Total beam-on time was 6.38 hours.

The sample holder assembly was removed and stored for a few days to allow for decay of short-lived isotopes. Browning of the front mylar sheet on sample holder A indicated that the samples had been centered to within 2 mm of the center of the neutron source.

The samples were removed from the holders. The copper tensile specimens, the packet of molybdenum samples, and MgO-8 were retained for further irradiation. The two optical glass specimens were returned to M. Moran.

The niobium profile foil was cut along the scribed lines and each of the 36 sections weighed. The tensile specimen-shaped dosimetry foils were cut so that only the sections corresponding to the tensile sample gauge sections were weighed. These, along with the other niobium dosimetry foils, were delivered to the LLL Radiochemistry Division. Ruth Anderson performed the gamma ray counting of the dosimetry foils. The average fluence of each foil was calculated as described in UCRL-51393, Rev. 1. The results for the profile foil are given in Figures II and III. These indicate that the samples were centered to within 3 mm of the center of the neutron source. The remaining results were as follows:

<u>Dosimetry Foil Number</u>	<u>Fluence (neutrons/cm²)</u>
Nb-167	1.18×10^{16}
Nb-168	9.76×10^{15}
Nb-169	8.25×10^{15}
Nb-170	7.08×10^{15}
Nb-171	5.96×10^{15}
Nb-172	5.30×10^{15}
Nb-173	4.58×10^{15}
Nb-174	4.14×10^{15}
Nb-175	3.73×10^{15}
Nb-176	3.30×10^{15}
Nb-177	2.75×10^{15}
Nb-178	2.26×10^{15}
Nb-81	1.94×10^{15}
Nb-179	1.90×10^{15}
Nb-180	1.76×10^{15}
Nb-181	1.62×10^{15}
Nb-182	1.54×10^{15}
Nb-183	1.42×10^{15}
Nb-184	1.30×10^{15}
Nb-185	1.21×10^{15}
Nb-186	1.13×10^{15}
Nb-187	9.03×10^{14}
Nb-188	8.23×10^{14}

The estimated overall uncertainty of the 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.

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IRRADIATION OF 10/25/74. EXPERIMETER: VAN K. MORAN BRIMHALL & CHEN

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11	12	13	14	15	16
2.42×10^{15}	4.05×10^{15}	6.11×10^{15}	6.94×10^{15}	5.96×10^{15}	3.67×10^{15}
21	22	23	24	25	26
3.22×10^{15}	5.95×10^{15}	9.66×10^{15}	1.14×10^{16}	9.29×10^{15}	5.31×10^{15}
31	32	33	34	35	36
3.72×10^{15}	7.28×10^{15}	1.22×10^{16}	1.32×10^{16}	1.05×10^{16}	5.66×10^{15}
41	42	43	44	45	46
3.71×10^{15}	7.08×10^{15}	1.08×10^{16}	1.18×10^{16}	8.70×10^{15}	4.79×10^{15}
51	52	53	54	55	56
2.91×10^{15}	5.08×10^{15}	7.42×10^{15}	7.60×10^{15}	5.63×10^{15}	3.24×10^{15}
61	62	63	64	65	66
2.02×10^{15}	2.98×10^{15}	3.81×10^{15}	3.86×10^{15}	3.07×10^{15}	2.14×10^{15}

Figure II. - Fluence Results for Niobium Profile Foil (n/cm^2)

Figure III. Fluence Results for Niobium Profile Foil