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LAWRENCE LIVERMORE LABORATORY

University of California/Livermore, California

DT Fusion Neutron Irradiation of BPNL Molybdenum, ORNL Magnesium Oxide Crystal, SLL Glass Samples, UW/LLL High Purity Metallic Foils, LLL Optical Glass, and LLL Copper Tensile Specimens

Unclassified

Susan C. MacLean

January 16, 1975

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In order to utilize the LLL Rotating Target Neutron Source (RTNS) most efficiently, samples from several experimenters were combined for the run beginning December 2, 1974.

A fluence of 4×10^{17} neutrons/cm² was being accumulated on molybdenum foils for Dr. John L. Brimhall of Battelle Pacific Northwest Laboratories (BPNL). The samples were placed in a stainless steel washer for convenience in handling. The molybdenum foils had previously been irradiated January 14-16, 1974, September 11, 1974, October 7-9, 1974, October 25, 1974, and November 7-13, 1974.

Dr. Yok Chen of Oak Ridge National Laboratory (ORNL) requested that a fluence of 10^{18} neutrons/cm² be built up on magnesium oxide crystal, MgO-8. The crystal, wrapped in aluminum foil, had previously been irradiated January 14-16, 1974, May 29-31, 1974, July 16-18, 1974, September 11, 1974, October 7-9, 1974, October 25, 1974, and November 7-13, 1974.

Dr. Peter L. Mattern of Sandia Livermore Laboratory (SLL) provided eight glass samples of different sizes and different degrees of purity for irradiation. He requested a fluence of 5×10^{16} neutrons/cm² on all the glass samples. His glass assortment consisted of samples of Homosil (used for optical windows), synthetic SiO₂, commercial SiO₂ containing aluminum impurities, SiO₂ plus TiO₂, and K-2 having lead and boron impurities.

Dr. Heinz Barschall of both the University of Wisconsin (UW) and LLL is interested in long-lived isotopes. He requested frequent irradiation of 13 high purity metallic foils over a long period of time. The foils, aluminum, iron, tantalum, nickel, niobium, copper, tungsten, molybdenum, zirconium, tin, titanium, vanadium and chromium, were enclosed in a stainless steel holder with aluminum foil spacers. Niobium dosimetry foils of 12 mm diameter were in front and back of the stack of metallic foils. The foils had been irradiated November 7-13, 1974.

Four samples of BK-7 optical glass were supplied by Michael Moran of LLL. He requested a fluence of 3×10^{14} neutrons/cm² for sample BK7-13 and for each succeeding sample a decrease in the fluence by a factor of 10 from the preceding sample.

Drs. Jack B. Mitchell and Richard A. Van Konynenburg of LLL provided 16 copper tensile specimens cut from Cominco American sheet copper. The samples had been irradiated July 8-15, 1974, October 25, 1974, and November 7-13, 1974.

The copper tensile specimens were loaded into two epoxy-fiberglass laminate sample holders with niobium dosimetry foils of the same size and shape as the tensile specimens. The molybdenum foils and magnesium oxide crystal were stacked with niobium dosimetry foils and were taped to the back of sample holder A and sample holder B was made flush with them.

Dr. Mattern's glass samples were arranged in a single layer (with the exception of glass 7971 placed in front of the T0-8 sample measuring 10 by 20 by 1 mm and both in front of the Homosil specimen measuring 12.5 by 25 by 3 mm) on the third sample holder. Niobium foils of the same shape as each sample were placed on the front and back of each piece of glass.

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-232	3 mm
2		Cu-1417	
3		Nb-233	
4		Cu-1418	
5		Nb-234	
6		Cu-1419	
7		Nb-235	
8		Cu-1422	
9		Nb-236	
10		Cu-1423	
11		Nb-237	
12		Cu-1425	
13		Nb-238	
14		Cu-1427	
15		Nb-239	
16		Cu-1430	
17		Nb-240	

<u>Order</u>	<u>Sample holder</u>	<u>Sample</u>	<u>Distance from source</u>
18	A	Cu-1431	
19		Nb-241	
20		Molybdenum in stainless steel washer	
21		Nb-242	
22		MgO-8 wrapped in aluminum foil	
23		Nb-243	
24	B	Nb-251	
25		Cu-1434	
26		Nb-250	
27		Cu-1435	
28		Nb-249	
29		Cu-1436	
30		Nb-248	
31		Cu-1437	
32		Nb-247	
33		Cu-1438	
34		Nb-246	
35		Cu-1440	
36		Nb-245	
37		Cu-1441	
38		Nb-244	
39	C (bracketed groups arranged side by side)	Nb-211	37 mm
40		Homosil (12 x 13 x 25 mm)	
41		Nb-212	
42		Nb-213	
43		Glass Sup - W1-67425	
44		Nb-214	
45		Nb-215	
46		Glass 3524 Sup-1	
47		Nb-216	
48		Nb-217	
49		Glass T0-8 (10 x 10 x 20 mm)	
50		Nb-218	

<u>Order</u>	<u>Sample holder</u>	<u>Sample</u>	<u>Distance from source</u>
51	C	Nb-219	
52		Glass K-2	
53		Nb-220	
54		Nb-223	
55		Glass 7971	
56		Nb-224	
57		Glass T0-8 (10 x 20 x 1 mm)	
58		Nb-225	
59		Nb-221	
60		Homosil (12.5 x 25 x 3 mm)	
61		Nb-222	
62	D	Nb-230	
63		Barschall's foils	
64		Nb-231	
65	E	BK7-13	146 mm
66		Nb-226	
67	F	BK7-14	462 mm
68		Nb-227	
69	G	BK7-15	1.46 meters
70		Nb-228a and b	
71	H	BK7-16	2.04 meters
72		Nb-229a, b and c	

The irradiation was carried out by the LLL E Division Accelerator Staff during the period December 2 to 6, 1974. Beam centering was checked by an autoradiograph of the front sample holder after a few minutes of irradiation. The centering of the samples appeared to be within 3 mm of the center of the neutron source. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. Total beam-on time was 76.18 hours. Sample holder H was removed after 14.87 hours of irradiation.

The sample holder assembly was removed and stored for several days to allow for decay of short lived isotopes.

The glass samples were returned to Dr. Mattern and the BK7 samples to M. Moran. The copper tensile specimens, molybdenum foils, magnesium oxide crystal and 13 metallic foils were all retained for further irradiation.

The tensile specimen shaped dosimetry foils were cut so that only the sections corresponding to the tensile sample gauge portions were weighed. These along with the other niobium dosimetry foils were delivered to the LLL Radiochemistry Division. Ruth Anderson carried out 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 were as follows:

<u>Dosimetry Foil Number</u>	<u>Fluence (neutrons/cm²)</u>
Nb-232	7.09×10^{16}
Nb-233	5.95×10^{16}
Nb-234	5.12×10^{16}
Nb-235	4.47×10^{16}
Nb-236	3.98×10^{16}
Nb-237	3.59×10^{16}
Nb-238	3.16×10^{16}
Nb-239	2.83×10^{16}
Nb-240	2.62×10^{16}
Nb-241	2.34×10^{16}
Nb-242	2.07×10^{16}
Nb-243	1.78×10^{16}
Nb-251	1.65×10^{16}
Nb-250	1.50×10^{16}
Nb-249	1.38×10^{16}
Nb-248	1.31×10^{16}
Nb-247	1.19×10^{16}
Nb-246	1.11×10^{16}
Nb-245	1.03×10^{16}
Nb-244	9.63×10^{15}
Nb-211	3.37×10^{15}
Nb-212	1.80×10^{15}
Nb-213	3.31×10^{15}

<u>Dosimetry Foil Number</u>	<u>Fluence (neutrons/cm²)</u>
Nb-214	2.00×10^{15}
Nb-215	2.75×10^{15}
Nb-216	1.76×10^{15}
Nb-217	3.36×10^{15}
Nb-218	2.03×10^{15}
Nb-219	2.89×10^{15}
Nb-220	1.82×10^{15}
Nb-223	2.57×10^{15}
Nb-224	2.43×10^{15}
Nb-225	2.31×10^{15}
Nb-221	2.27×10^{15}
Nb-222	1.93×10^{15}
Nb-230	1.47×10^{15}
Nb-231	1.27×10^{15}
Nb-226	1.73×10^{14}
Nb-227	1.77×10^{13}
Nb-228a and b	1.98×10^{12}
Nb-229a, b and c	1.61×10^{11}

The estimated overall uncertainty of these 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.

Distribution:

Dr. John L. Brimhall, Battelle Pacific Northwest Labs.
Battelle Blvd., Richland, Wash. 99352

Dr. Yok Chen, Oak Ridge National Laboratory
P. O. Box X, Oak Ridge, Tenn. 37830

Dr. Marvin Abraham, Oak Ridge National Laboratory

Dr. Heinz Barschall, Physics Department, University of Wisconsin
500 Lincoln Drive, Madison, Wisconsin 53706

Dr. Peter L. Mattern, Sandia Livermore Laboratory
East Avenue, Livermore, CA 94550

Dr. Klaus Zwilsky, AEC-DCTR, Washington, D. C. 20545

Dr. C. Z. Serpan, Jr., Division of Reactor Safety Research
G-158, U. S. AEC, Wash., D. C. 20545

Dr. Robert Heinrich, Bldg. 205, Argonne National Lab.
9700 South Cass Avenue, Argonne, Illinois 60439

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