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Lawrence Livermore Laboratory

DT FUSION NEUTRON IRRADIATION OF ORNL
COPPER, NIOBIUM, GOLD, AND MAGNESIUM OXIDE CRYSTAL,
AND BPNL VACUUM CHAMBER

Susan C. MacLean

September 24, 1976

Unclassified

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Samples from several experimenters were stacked together for most efficient use of the LLL Rotating Target Neutron Source (RTNS) during the irradiation beginning August 23, 1976.

Three sample capsules were received from Drs. Jagdish Narayan, James Roberto, and Michael Saltmarsh of Oak Ridge National Laboratory (ORNL). The aluminum capsules measured 25.4 mm in diameter and the "front capsule" was 5.8 mm thick. This capsule contained copper and niobium samples and a dose of 2×10^{17} neutrons/cm² was requested for it. The remaining two capsules (designated capsule I and capsule II) were 2.5 mm thick and both contained copper and gold samples. A fluence of 4×10^{16} neutrons/cm² was desired for capsule I and 7×10^{15} neutrons/cm² for capsule II.

A magnesium oxide crystal, approximately 10 x 19 x 2.8 mm, from Dr. Yok Chen of ORNL had been previously irradiated at the RTNS during the period May 17 to 24, 1976. The crystal, MgO-19, was included during the present irradiation to complete the accumulation of $4-5 \times 10^{16}$ neutrons/cm².

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Dr. M. T. Thomas of Battelle Pacific Northwest Laboratories (BPNL) supplied a vacuum chamber containing his samples for irradiation. He requested a fluence of 10^{15} neutrons/cm² on the front of the chamber.

Niobium dosimetry foils (12 mm in diameter) were centered on both sides of the three ORNL capsules and MgO-19. All foils were 0.14 mm thick except the two on the front capsule, which were 0.03 mm thick. A single niobium foil, approximately 25.4 mm square and 0.14 mm thick, was fastened to the front of the vacuum chamber.

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

<u>Order</u>	<u>Sample holder</u>	<u>Sample</u>	<u>Distance from source</u>
1	A	Nb-641	3 mm
2		Front capsule	
3		Nb-642	
4	B	Nb-653	8 mm
5		Capsule I	
6		Nb-654	
7	C	Nb-655	27 mm
8		MgO-19	
9		Nb-656	
10		Nb-657	
11		Capsule II	
12		Nb-658	
13		Nb-659	78 mm
14		Vacuum chamber	

The samples were centered with the neutron beam with the use of 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 August 23 to 27, 1976. A new type target with internal water cooling was used for this irradiation. August 25, 1976, after 27.62 hours of beam-on time, the tripod holding the BPNL vacuum capsule (having an initial clearance of about 0.5 mm) "walked" forward causing contact of the front ORNL capsule with the target. The tripod was moved back to the original position and the clearance was returned to about 0.5 mm. Neutron production was monitored continuously with a proton recoil counter and recorded each hour. The dose record is attached. The total beam-on time was 68.93 hours.

Following the irradiation, the sample holders were stored for a few days to allow short-lived activity to decay. Dr. Thomas removed his samples from the vacuum chamber and shipped them to BPNL. MgO-19 was returned to Dr. Chen at ORNL. The ORNL capsules were stored until they could be handcarried to ORNL. The 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 14.8MeV neutrons was changed to 458 millibarns. The results were as follows:

<u>Dosimetry Foil</u>	<u>Fluence(neutrons/cm²)</u>
Nb-641	1.85×10^{17}
Nb-642	4.62×10^{16}
Nb-653	3.35×10^{16}

<u>Dosimetry Foil</u>	<u>Fluence(neutrons/cm²)</u>
Nb-654	2.28×10^{16}
Nb-655	6.60×10^{15}
Nb-656	5.17×10^{15}
Nb-657	5.06×10^{15}
Nb-658	4.15×10^{15}
Nb-659	2.17×10^{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 AUGUST 23 TO 27, 1976

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