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DT FUSION NEUTRON IRRADIATION OF LLL COPPER TENSILE
SPECIMENS AT 210°C AND SLL FIBER OPTIC BUNDLES

Susan C. MacLean

December 17, 1975

Unclassified

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The RTNS irradiation starting October 20, 1975, was reserved for Drs. Jack B. Mitchell and Richard A. Van Konynenburg of LLL for a high temperature run. Five copper tensile specimens were to be held at 210°C during the irradiation.

Dr. Laurence M. Watkins of Sandia Livermore Laboratory (SLL) provided two fiber optic bundles for room temperature irradiation. He requested fluences of 5×10^{11} neutrons/cm² on one bundle and 5×10^{12} neutrons/cm² on the second bundle. Four 0.127 mm thick niobium dosimetry foils, approximately 250 mm square, were stacked and attached to each fiber optic bundle. Bundle 1 with Nb-526 a, b, c, and d was placed 1.61 meters from the neutron source for one day of irradiation. Bundle 2 with Nb-527 a, b, c, and d was 1.14 meters from the neutron source for five days of the run.

The copper tensile specimens were annealed at 600°C for one hour. The samples measured approximately 28.6 mm long, 9.5 mm wide, and 0.5 mm thick. They were stacked with six niobium dosimetry foils of the same size and shape. The dosimetry foils were 0.127 mm thick. The stack of samples and foils was loaded into a three piece platinum capsule. Two external pieces held a third internal piece which was hollow in the shape of a dog-bone to hold the tensile specimens. The capsule parts and dosimetry foils

had been washed with trichloroethylene and rinsed with methyl alcohol twice.

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

Capsule Front

Nb-520

Cu-5732

Nb-521

Cu-5737

Nb-522

Cu-5741

Nb-523

Cu-5743

Nb-524

Cu-5754

Nb-525

Capsule Back

The front of the loaded capsule was marked to indicate the sample orientation. It was then clamped between two copper heat sinks and delivered to Harold Dyer. He evacuated the capsule overnight to about 13 mPa (10^{-4} torr) before electron beam welding it shut.

Three chromel-alumel thermocouples were spot welded to the rim of the capsule. One thermocouple was put on each side of the capsule and the third was placed midway between the other two on the rim.

For heating during the irradiation, the capsule was inserted into an alumina firebrick insulator and attached to the infrared reflector furnace

designed by Robert Hibbard, formerly of LLL. Essentially, this furnace consists of a tungsten-quartz-iodide lamp and an aluminum reflector in the shape of an ellipsoid of revolution (Research Inc. "Spot Heater"). The lamp is placed at one focus and the capsule at the other. The lamp power is supplied by an SCR device. This is controlled by a Leeds and Northrup CAT controller which monitors one of the chromel-alumel thermocouples on the rim. This device was able to control the capsule temperature to within $\pm 5^{\circ}\text{C}$ of the set point during the irradiation. The temperature was controlled at 210°C with an absolute accuracy of $\pm 10^{\circ}\text{C}$.

A copper foil with a 9 mm diameter hole was centered on cross hairs on the back of the target and irradiated briefly. An autoradiograph of the copper foil showed the position of the neutron beam in relationship to the cross hairs so that the capsule could be centered with the beam.

The capsule was heated at 210°C and allowed to stabilize for about five minutes prior to beginning each irradiation shift. The heater was shut down about five minutes after the beam went off and the capsule was allowed to cool to room temperature during the periods between shifts.

The irradiation was carried out by the LLL E Division Accelerator Staff during the period October 20 to 30, 1975. The 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 117.05 hours. Fiber optic bundle 1 was removed after 11.20 hours and fiber optic bundle 2 was removed after 59.10 hours of irradiation.

The fiber optic bundles were returned to Sandia Livermore Laboratory. The niobium dosimetry foils from the bundles were delivered to Ruth N. Anderson in the LLL Radiochemistry Division for gamma ray counting.

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The capsule was stored for several days following the irradiation to allow for decay of short-lived isotopes. An autoradiograph of the capsule showed that the centering of the samples with the center of the neutron beam had been within 1 mm. The capsule was opened by hand shearing the welded bead from it. The copper tensile specimens were returned to J. Mitchell. The niobium dosimetry foils were cut and weighed so that only the portions corresponding to the gauge section of the samples were delivered to R. Anderson for gamma ray counting.

The average fluence on each dosimetry foil was calculated using the method described in UCRL-51393, Rev. 1. However, the cross section value for the activation of the 10.16 day niobium isomer 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-520	2.02×10^{17}
Nb-521	1.71×10^{17}
Nb-522	1.44×10^{17}
Nb-523	1.24×10^{17}
Nb-524	1.09×10^{17}
Nb-525	9.37×10^{16}
Nb-526 a, b, c and d	3.78×10^{11}
Nb-527 a, b, c and d	3.53×10^{12}

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.

RTNS IRRADIATION OF OCTOBER 20 TO 30, 1975

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