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DT FUSION NEUTRON IRRADIATION OF LLL NIOBIUM TENSILE SPECIMENS AT 700°C

S. C. MacLean

March 30, 1977

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DT FUSION NEUTRON IRRADIATIONS OF LLL NIOBIUM

TENSILE SPECIMENS AT 700°C

ABSTRACT

The DT fusion neutron irradiation of five LLL niobium tensile specimens at 700°C is described. The sample position, beam-on time, and neutron dose record are given. The maximum neutron fluence on any sample was 1.03×10^{17} neutrons/cm².

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DT FUSION NEUTRON IRRADIATION OF LLL NIOBIUM

TENSILE SPECIMENS AT 700°C

October 5, 1976

Unclassified

Susan C. MacLean

The Rotating Target Neutron Source (RTNS) irradiation of the week August 16 to 20, 1976 was scheduled for Dr. Jack B. Mitchell of LLL. He provided five niobium tensile specimens to be held at 700°C during the irradiation.

The niobium tensile specimens had been annealed at 1200°C for one hour. They measured approximately 28.6 mm long, 9.5 mm wide and 0.5 mm thick with gauge sections about 6 mm long and 1.6 mm wide. Six niobium dosimetry foils of the same shape and size but 0.14 mm thick were numbered and then washed in trichloroethylene and rinsed in methyl alcohol.

A three piece platinum capsule was also washed and rinsed in the same manner. The capsule had two external pieces that held the third piece which was hollow in the shape of a dog bone to hold the tensile specimens. The order of stacking within the platinum capsule, starting with the material nearest the neutron source, was as follows:

Capsule front

NB-635

Nb-5693

Nb-636

Nb-5694

Nb-637

Nb-5699

Nb-638

Nb-5708

Nb-639

Nb-5712

Nb-640

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 Fran Silva. 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 700°C with an absolute accuracy of $\pm 10^{\circ}\text{C}$.

A copper foil with a 6 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 to 700°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 August 16 to 20, 1976. 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 73.80 hours.

The platinum capsule was stored for a few weeks following the irradiation. The capsule was opened by hand shearing the welded bead from it. The niobium 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 Ruth 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 isomer of niobium 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-635	1.03×10^{17}
Nb-636	8.94×10^{16}
Nb-637	7.81×10^{16}
Nb-638	6.75×10^{16}
Nb-639	6.02×10^{16}
Nb-640	5.35×10^{16}

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 AUGUST 16 TO 20, 1976

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