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Astronuclear
Laboratory

WANL-TME-1960 Rev. 1

TEST SPECIFICATION

Beryllium Thermal Conductivity

Irradiation Test 37/W414

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I. Experiment Identification

- A. Experiment Design Reference - Letter from M. T. Johnson to J. L. Dooling,
12/11/68.
- B. Sponsor - WANL Subject: Thermal Conductivity of Irradiated
- C. Test Facility - ORNL-BSR Beryllium and Graphite

II. Purpose of Experiment

- 1. To determine thermal conductivity of beryllium
 - a) from $< 100\text{K}$ ($< 180\text{R}$) to $\sim 500\text{K}$
 - b) to 5×10^{18} nvt $E > 1$ Mev.
 - c) for transverse and longitudinal material directions
- 2. To determine thermal conductivity and electrical resistivity correlation over ranges in (1) to facilitate future program requirements for determination of physical properties.
- 3. To establish annealing function over ranges in (1).

III. Drawings

ORNL Drawing 001D Rev. 1 - Physical Property Specimens (WANL DWG 388D586)

IV. Equipment List

- A. To be provided by WANL
 - 1. Specimens (as shown on ORNL Drawing 001D Rev. 1)
 - 3 transverse "absolute specimens" (Type M-2)
 - 3 longitudinal "absolute specimens" (Type M-2)
 - 4 transverse "comparative longitudinal specimens" (Type M-1)
 - 4 longitudinal "comparative longitudinal specimens" (Type M-1)
 - 5 transverse "absolute specimens" (Type W-1)
 - 5 longitudinal "absolute specimens" (Type W-1)

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B. To be provided by ORNL

1. Test facility for irradiating beryllium at $< 100\text{K} (< 180\text{R})$ to 5×10^{18} nvt $E > 1 \text{ Mev}$ periodically determining thermal conductivity and electrical resistivity with additional capability of performing post-irradiation pulse-annealing.

V. Test Environment

A. Temperature

1. Irradiation temperature $< 100\text{K} (< 180\text{R})$
2. Post-irradiation temperatures to $\sim 500\text{K}$.

B. Neutron fluences 5×10^{17} , 2×10^{18} , 5×10^{18} , nvt $E > 1 \text{ Mev}$.

VI. Facility Requirements

- A. As determined by ORNL with LN_2 requirement.

VII. Dosimetry

- A. Thermal and fast neutron dosimetry to be reported to $< \pm 20\%$.

VIII. Data Requirements

A. Accuracy Requirements (Maximum)

Fluence	$\pm 20\%$ $E > 1 \text{ Mev}$
Irradiation Temp.	$\pm 5\text{K}$
Thermal Conductivity	$\pm 10\%$ reported in $\text{W}/(\text{cmK})$
Measurement Temp.	$\pm 5\text{K}$
Annealing Temp.	$\pm 5\text{K}$
Electrical Resistivity	$\pm 1\%$ reported in $\mu\Omega - \text{cm}$

An error analysis by ORNL is considered part of the project. Established accuracies will be reported and indicated as bands on curves. A format for pictorial presentation is included as Figure 1.

IX. Test Description

WANL will supply characterization and determine thermal conductivity for the 8 comparative specimens (M-1) from LN_2 temp. to 470 K. WANL will also supply characterization and electrical resistivity for the 6 absolute specimens (M-2) and the 10 S.S. specimens (W-1) from LN_2 temp. to 470 K. WANL will transmit these specimens to ORNL. ORNL will then determine the thermal conductivity of the 8 comparative specimens (M-1) and thermal conductivity and electrical resistivity of the 6 absolute specimens (M-2) from LN_2 temp. to 470 K. These data will be compared with the WANL data and ORNL/WANL concurrence relative to the validity of this comparison will be made. ORNL will then install one of the W-1 specimens (with external heater) in the standard ORNL thermal conductivity apparatus modified as necessary and determine thermal conductivity and electrical resistivity from LN_2 temp. to 370 K. This same specimen will be mounted in the reactor "in situ" apparatus and thermal conductivity and electrical resistivity will be determined again and compared with the laboratory results. If this comparison is valid, the following irradiation procedure will then be followed:

1. Irradiate to $5 \times 10^{18} \text{ n/cm}^2$ $E > 1 \text{ Mev}$ at T_1 (lowest irradiation temperature) determining thermal conductivity and electrical continuously if possible but as a minimum at 1, 2, 5, 10, 20, and 50×10^{17} at T_2 (lowest measurement temperature).
2. Anneal from 80° K to T_3 (maximum annealing temperature) according to Figure 2.
3. Irradiate the same specimen to $2 \times 10^{18} \text{ n/cm}^2$ at T_1 as a minimum determining thermal conductivity and electrical resistivity at 1, 2, 5, 10, and 20×10^{17} .
4. Anneal as in (2).
5. Irradiate to 5×10^{17} at T_1 , determining thermal conductivity and electrical resistivity as a minimum at 1, 2, and $5 \times 10^{17} \text{ n/cm}^2$.
6. Anneal as in (2).
7. Irradiate a new specimen to $2 \times 10^{18} \text{ n/cm}^2$ at T_1 as a minimum determining thermal conductivity and electrical resistivity at 1, 2, 5, 10, and $20 \times 10^{17} \text{ n/cm}^2$ at T_2 .
8. Anneal as in (2).
9. If the data in (7) cannot be pooled with data from (3) because of an unrecoverable effect from the 5×10^{18} irradiation, then another specimen will be irradiated and measured to steps (1) and (2).

The electrical resistivity measurements during the pulse annealing will determine whether a steady-state condition obtains in one hour. These data will be supplied to WANL for periodic review in order to provide continuing program planning. It is conceivable that times at temperatures, fluences, and other experimental parameters may be changed during the duration of experimentation. The post-irradiation pulse-annealing procedure will be continued at least to room temperature or until the annealed value of K is within 5% of the unirradiated value of K . Upon initiation of LN_2 , all events affecting temperature of test specimens will be recorded.

Figure 1 Format of Pictorial Data Presentation Requirement

FIGURE 2
Schematic Pulse-Annealing Spectrum
for Beryllium

- Measurements of ρ as function of pulse time; of
K S at end of pulse
+ Single measurement of ρ , K, and S.