ATLAS Internal Note
INDET-NO-177
22 July 1997

# Radiation hardness of thermal compound

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**Abstract:** A multi layer sandwich of a thermal compound joint has been irradiated. The thermal conductivity of the thermal compound Dow Corning DC340 has been measured before and after irradiation. No significant effect has been found after irradiation of this compound up to doses of $3.0 \cdot 10^{14}$, p/cm$^2$.

## 1. Experimental Setup

A multi-layer of aluminum plates and thermal compound DC 340 (Dow Corning) as shown in fig. 1 has been irradiated. It consists of 2 Aluminum blocks equipped with platinum resistors to measure the temperature of the blocks. Between the two blocks 10 Aluminum plates are stacked together with eleven 35 μm thick thermal compound layers. For the assembly, 50 μm kapton tape was used as temporary spacer to produce 50 μm thick thermal compound layers. Weighting the apparatus before and after the compound was put in, reveals that the average compound layer thickness was 35μm +/- 1 μm.

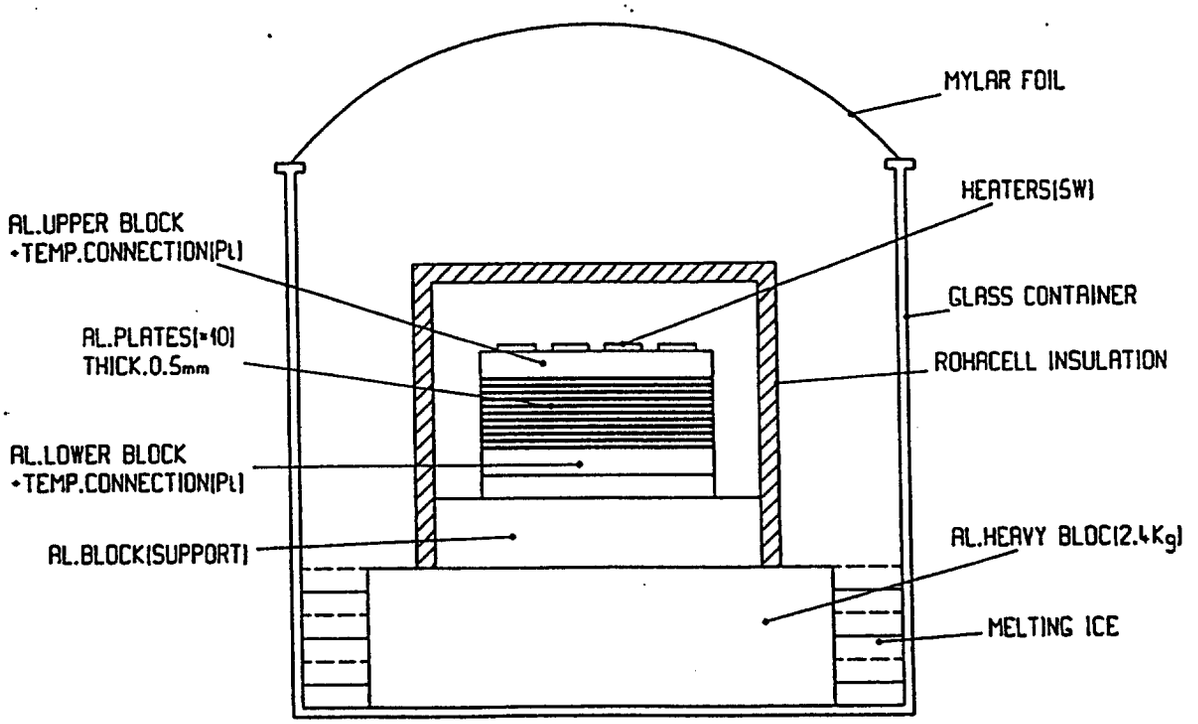


Fig. 1: Experimental arrangement.

The upper block was also equipped with a 5 W heater, and the lower block was immerged into icy water. The measured thermal gradient across the structure is then directly related to the thermal conductivity of the assembly. Since the thermal conductivity of Aluminum is much higher than the one of the thermal compound, the later is completely dominating the effect.

The block was irradiated at CERN with a proton beam with a total fluence of $2.3 \cdot 10^{14} p/cm^2$ (±10%) at the entrance and $3.0 \cdot 10^{14} p/cm^2$ (±10%) at the exit of the apparatus. The larger exit fluence is due to the production of particles within the apparatus.

Note that the upper and lower parts of the blocks were removed before irradiation in order to minimize the irradiated materiel. Therefore the Pt resistors were not affected by the irradiation.

## 2. Results

After a calibration of the Pt resistors leading to a 0.2 °C correction, the thermal conductivity measured before irradiation was 0.89 W/mK +/- 0.03 for a thermal gradient across the structure of 3.7±0.2°C with a 5W heat load. After the irradiation with a fluence between $2.3 \cdot 10^{14}$ and $3.0 \cdot 10^{14}$ p/cm$^2$, the thermal conductivity was then 0.94 W/mk +/-0.03 for a 3.5±0.2°C gradient. The measurement was performed at temperature between 0 and 10 °C. The variation of the temperature gradient, is not very significant. However, the improvement in thermal conductivity may be explained if the compound layer thickness was reduced during the irradiation process. Such a small effect cannot be excluded since the apparatus was not cooled during exposure. Therefore it is possible that the compound flowed away at the higher temperature. Such an effect would never occur at –10°C.

## 3. Others Results

### 3.1 Thermal conductivity

The thermal conductivity claimed by the manufacturer is 0.42 W/mK. Values of 0.5 W/mK and 1.25 W/mK were reported at CERN (PPE94) and by the Mechanical & Electronic Engineering Division at Los Alamos (MEED92); respectively. For the moment it is not clear to us if these discrepancies are due to material differences, measurement errors or simply because different characteristics were measured. For instance, we have measured the thermal conductivity of about 35 µm thick DC340 joints and not the one of the bulk material.

### 3.2 Irradiation

A radiation hardness test of the silicon heat sink compound Dow Corning 340 has been completed. With a total fluence of $6 \bullet 10^{13}$ neutrons/cm$^2$ no significant change in the thermal conductivity was seen and the texture of the grease was unchanged (PPE94)

## 3. Conclusion

No significant difference was observed after the irradiation of the thermal compound DC340 at a fluence between $2.3 \cdot 10^{14}$ and $3.0 \cdot 10^{14}$, p/cm$^2$. This measure confirms earlier results(PPE94).

## References:

MEED92 Mechanical & Electronic Engineering Division at Los Alamos, MEE 12-92-289

PPE94 A. Onnela et al., Technical note CMS-TN/94-248, TA1/94-24.