K. The leads were of copper foil 36 μm thick, and the polyimide film was 76 μm thick. The foil was bonded to one side of the polyimide film with thin sheets of thermoplastic polyester resin cured at 150°C, which thus exposed the polyimide film to the same curing temperature. The thermal conductivity of the polyimide film was found to be about 5 mW/(m·K) at 4.2 K.

Vespel polyimide resin is an amorphous, cast, solid form of PPMI. Locatelli, Arnaud, and Routin[7] measured the thermal conductivity of three different types (neat, filled with graphite, or filled with fibrous glass) of this resin over the range of temperature from 0.08 to about 2 K. The specimens were cylinders 5 mm in diameter and 50 mm long. Over this range of temperature the resin exhibited a linear dependence of the logarithm of thermal conductivity on the logarithm of temperature. It is risky, but possibly informative, to assume that their conductivity-temperature relation may be safely extrapolated to temperatures somewhat higher (4.2 K) than their upper limit of measurement (2 K). When such an extrapolation is performed (graphically) to estimate the thermal conductivity, a value of about 10 mW/(m·K) is found for the conductivity of neat Vespel SP 1 resin at 4.2 K. Details of the experimental technique used to measure the thermal conductivity were not given in the paper by Locatelli, et al.

Kerimid is another amorphous, solid form of PPMI. Claudet, Disdier, and Locatelli[8], using the "double flux" method[9], measured the thermal conductivity of Kerimid resin, in combination with two different types of powdered alumina filler. The two types were A_1: hexagonal, particle size, 1.5 μm; and A_2: cubic particle size, 0.02 μm. These workers also found a linear dependence between the logarithm of the thermal conductivity and logarithm of the temperature. They found the conductivity of neat resin to be 38 mW/(m·K) at 4.2 K. Admixture to the resin of 56 mass percent of A_1 alumina as filler reduced the conductivity at 4.2 K to 15.5 mW/(m·K). This was a reduction of conductivity by a factor of about 2.5 in comparison to the value for neat resin. Increasing the concentration of this same alumina filler to 65 mass percent gave a conductivity of about the same value, 14 mW/(m·K). They felt these results were in good agreement with a value (11 mW/(m·K) they cite from an earlier study by Van de Voorde[10] on neat Vespel SP4 resin. Their use of A_2 alumina as filler (57 percent by mass) reduced the conductivity at 4.2 K by a factor of 10 to 3.9 mW/(m·K) in comparison to the value for neat resin. Use of 65 percent by mass of A_2 alumina as filler reduced the conductivity at 4.2 K to 1.7 mW/(m·K), a reduction by a factor of 22. They attribute the much lower values for the specimens of resin filled with A_2 alumina to the presence of some porosity, as suggested by appreciable differences between calculated and measured densities.

Muller[11] measured the thermal conductivity of several kinds of plastic tapes (polysulfone, polyethylene, polycarbonate, polypropylene with urethane binder, and polypropylene with polyethylene binder). Such tapes were being considered for insulation of cryogenic power cables. He used a modified steady-state technique that established a temperature gradient between two copper plates separated by four layers of polymeric film. Measurements were performed with the tapes in vacuum and in helium gas at pressures from 0 to 710 kPa (0 to 100 psi). No mention was made of use of any material between the layers of film to reduce thermal contact resistance. Muller found the

SSCL-N-734

THERMAL CONDUCTIVITY OF A POLYMIDE FILM BETWEEN 4.2 AND 300K, WITH AND WITHOUT ALUMINA PARTICLES AS FILLER*

D. L. Rule, D. R. Smith and L. L. Sparks
National Institute of Standards and Technology
Chemical Engineering Science Division
Boulder, CO 80303

for the

Superconducting Super Collider Laboratory†
2550 Beckleymeade Ave.
Dallas, TX 75237

August 1990

*This work was supported by the National Institute of Standards and Technology under SSC Laboratory P.O. # 455510, for the U.S. Department of Energy.

†Operated by the Universities Research Association, Inc., for the U.S. Department of Energy under Contract No. DE-AC02-89ER40486.