for $\Delta\rho/\rho_M$ obtained in [1] for the paramagnetic region.

It is not yet clear what determines the value of the coefficient A in Eq. (5). It is possible that the assumptions made were too rough; in particular, this applies to the assumption that it is not important whether the magnetic resistance varies due to changes of the spontaneous magnetization under the action of temperature or due to changes in the external magnetic field. Unfortunately, sufficiently accurate determination of the coefficient A meets with great experimental difficulties because a small relative error in determining J_S and J far from the Curie point leads to a large error in the coefficient A in Eq. (5).

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THERMAL CONDUCTIVITY OF SOLID He^4

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Submitted to JETP editor March 14, 1964

J. Exptl. Theoret. Phys. (U.S.S.R.) 46, 1926-1927 (May, 1964)

SOLID helium is the most convenient substance for investigating heat transfer processes in a dielectric crystal. Chemical impurities are absent and the high compressibility makes it possible to vary the Debye temperature by a factor of nearly 2 using relatively low pressures (up to 250 atm), thereby enabling one to check the applicability of various theoretical heat transfer models keeping the lattice symmetry fixed. The first measurements of the thermal conductivity of helium were carried out by Webb et al. [1,2] but their method did not allow control over the growth of the crystals. The defective structure of the crystals obtained by this method was confirmed, for example, by the 20-fold increase of the thermal conductivity after annealing, as observed by Fairbank et al. [3-5] Shal'nikov [6] developed a method which made it possible to observe directly the process of helium solidification. Using this method, the present author grew helium crystals in a glass ampoule at practically constant pressure. Some results of the measurements of the properties of samples prepared in this way are given below. A more detailed presentation of the results and a description of the technique will be given in a separate communication.

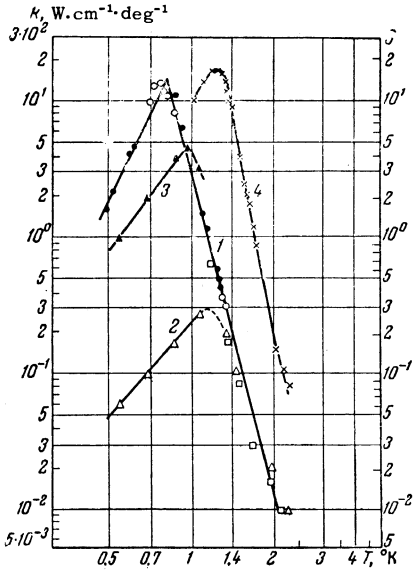

FIG. 1

Figure 1 gives values of the thermal conductivity of solid He^4 as a function of temperature. Curve 1 represents a crystal grown in 1.5 hours at a pressure of 82 atm ($\Theta_D = 33.7°K$ [7]). A series of black and open circles represents two different sets of measurements on samples ~2.5 mm in diameter; squares represent measurements on a sample 6 mm in diameter. Curves 2 and 3 illustrate the measurements of Webb and Fairbank for crystals of the same density before and after annealing. For comparison, curve 4 gives the results of the present author's measurements for a crystal grown at 185 atm ($\Theta_D = 43.5°K$ [7]).

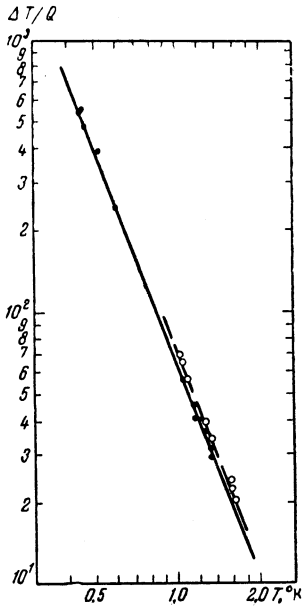

FIG. 2

Heating of the crystals prepared by the author to a temperature close to the melting point had practically no effect on the thermal conductivity, indicating a high degree of perfection of the samples. The temperature dependence of the thermal conductivity of crystals grown in separate runs but under the same pressure differed a little, which could be explained by inaccuracies in the establishment of the pressure at which crystals were grown and by the possibility of the formation of crystals of various orientations. A comparison of our results with the data of other workers [1,5] shows good agreement (our results are slightly lower) at low thermal conductivities. However, the maximum thermal conductivity obtained by the present author is about 2.5 times greater than the thermal conductivity of an annealed crystal in Fairbank's tests. The deviation from the cubic dependence observed in our experiments on cooling beyond the maximum thermal conductivity should be compared with Gurzhi's work [8], who discussed transport processes for long effective paths.

Data were obtained also on the Kapitza discontinuity at the solid helium—copper boundary (cf. Fig. 2; crystal at 185 atm; different points represent different tests). The order of magnitude of the observed temperature drop (given in Fig. 2 per unit emitted power in relative units) is in agreement with the predictions of Khalatnikov's theory.[9] The value of the power exponent in the temperature dependence of the thermal resistance at the boundary was 2.5 ± 0.2 for various crystals.

In conclusion, the author wishes to express his gratitude to P. L. Kapitza, who made it possible to carry out this work at the Institute for Physics Problems, to A. I. Shal'nikov for his constant interest and valuable advice, and to D. I. Vasil'ev for help in the experiments.

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