approximately valid between 1.5°K and 4.2°K, on account of the energy dependence of τ_A.

A cyclotron resonance experiment has been performed at 8-mm wavelength, using Ge doped with In. In Fig. 1 is shown the inverse relaxation time due to In versus In concentration obtained through measuring the electron-resonance linewidth. Values both at 4.2°K and at 1.5°K are plotted. The lattice scattering has been subtracted through the procedure described in reference 3, and use has been made of the relation

$$1/\tau_L = 3.5\times10^8 T^{3/2}, \qquad (3)$$

which has been obtained with our pure Ge specimen. The possible effects of the accompanying donors are neglected, since their concentrations are suppressed by about two orders of magnitude. This is not strictly justifiable, however, because of the much larger cross section of the donor for electrons. Hence the $1/\tau_{\rm In}$ obtained here gives merely the upper limit for electron scattering by neutralized In. Nevertheless, the experimental points come somewhat below the theoretical lines. One may further note that $1/\tau_{\rm In}$ is larger at 1.5°K than at 4.2°K for the first three samples, thus indicating the existence of a slight temperature dependence in the relaxation time. With the heaviest doped sample, the resonance signal has failed to appear at 1.5°K, though there remains a strong photoconductance signal. For comparison, the experimental values for electron scattering by Sb in Ge by Fukai et al.[3] are also plotted along with the nearly coinciding Erginsoy's formula. One may conclude from these results that the simple Erginsoy's formula for electron scattering utterly fails for the neutralized acceptors; a modified expression based on the e^+H scattering model certainly explains the experimental results much better, but there still remains some discrepancy.

Detailed account of this work and its extension as well as the effects of various other neutralized impurities will be reported in later papers.

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GERMANIUM TELLURIDE: SPECIFIC HEAT AND SUPERCONDUCTIVITY*

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According to Cohen's[1] theoretical predictions, certain many-valley semiconductors and semimetals may be superconductors at experimentally accessible temperatures. Hein et al.[2] have examined germanium telluride containing a large number of carriers. They find that it does indeed show those changes in magnetic susceptibility with temperature to be expected of a superconductor. However, susceptibility (and resistivity) measurements do not exclude the possibility of the superconductivity being confined to unrepresentative regions of the sample.[2] The heat-capacity measurements presented here show that at least the major part of the germanium telluride sample was superconducting and, hence, that the superconductivity observed by Hein *et al.* is a true bulk effect.

A germanium telluride sample of the type used by Hein *et al.* was kindly supplied to me by Dr. J. K. Hulm. It was a specially prepared large (one gram-mole) cylinder of nominal composition $\mathrm{Ge}_{0.950}\mathrm{Te}$, annealed for 10 days at 485°C. Attached to the sample were a carbon (painted colloidal graphite) resistance thermometer, Manganin heater, copper, varnish, and a negligible amount (<0.001 mole) of lead in a superconducting heat switch. Tha apparatus was that described by O'Neal and Phillips.[3] For each series

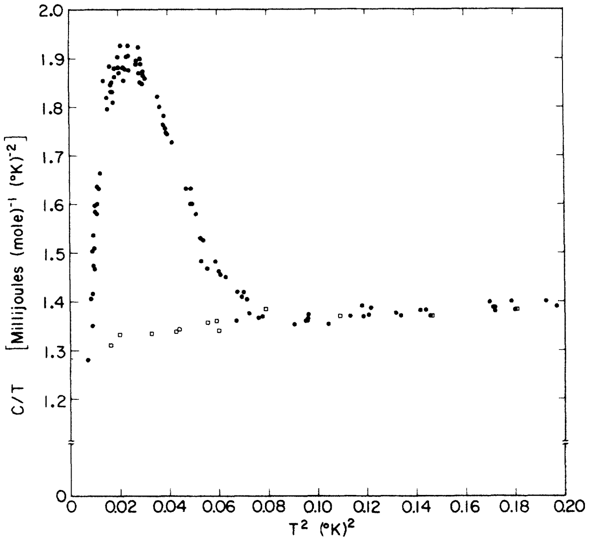

FIG. 1. Heat capacity of germanium telluride at low temperatures, with no field (circles) and with 500 gauss applied (squares).

of heat-capacity measurements, the sample was cooled (by a demagetized salt) to below 0.05°K in a field of less than 0.1 gauss. Measurements were then made covering the range from 0.1 to 1.1°K. The carbon thermometer was calibrated by the susceptibility of a cerium magnesium nitrate sphere, which was in turn calibrated against the 1958 helium vapor-pressure temperature scale.

The observed specific heat C between $T = 0.3$°K and 0.9°K is a good fit to $C = \gamma T + aT^3$. Below 0.3°K a well-defined specific-heat maximum is observed (Fig. 1). The position (0.17-0.27°K) of the high-temperature side of the maximum is at about the same temperature as the susceptibility change reported by Hein et al. The broadening of the maximum is probably due to sample inhomogeneity: It is difficult to make a large sample of high carrier concentration. A field of 500 gauss caused the maximum to disappear. The points below 0.3°K then agree well with an extrapolation of the higher temperature ones when no field was applied. Entropy considerations show that at 0°K any linear term in the specific heat, with no applied field, is less than half its value in a field of 500 gauss. Thus the existence of bulk superconductivity in germanium telluride may be considered established.

From the full set of measurements to above 0.9°K, we find the Debye characteristic temperature $\theta = 166 \pm 3$°K, and the electronic specific-heat coefficient $\gamma = 1.32 \pm 0.02$ mJ mole^{-1} (°K)$^{-2}$. It is possible to estimate from γ the number of contributing maxima in momentum space following, for example, Keesom and Seidel.[4] It is interesting to note that the γ reported here, together with reasonable values for the effective mass, indicates an effective number of maxima greater than one and probably equal to three, which is in agreement with the energy band-structure scheme for germanium telluride of Cohen, Falicov, and Golin.[5] It is hoped to do further measurements on samples of different carrier concentrations to aid our understanding of the band structure and superconductivity mechanism.

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