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The Dependence of Thermoelectric Power and Conductivity of n-Type Indium Antimonide on Hydrostatic Pressure

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We measured the thermoelectric power and resistivity of n-type InSb at room temperature using hydrostatic pressure up to 16 katm. The experimental setup was described previously (1). Samples of InSb with electron concentration ranging from 1.6×10^{17} to 7.2×10^{18} cm^{-3} were measured. For such concentrations all electrons around room temperature are of impurity-origin and the Hall constant is temperature independent. Therefore an increase of pressure cannot influence the electron concentration and all changes of electrical properties of the sample are caused by changes of effective masses of electrons and of the scattering mechanism.

Our experimental results are presented in Figs. 1 and 2. The thermoelectric power increases in samples with small electron concentrations. With rise of concentration the slope of $\alpha(p)$ decreases. In the samples with the highest electron concentration α decreases with increase of pressure. The relative increase of resistivity $\frac{1}{\varrho}\frac{d\varrho}{dp}$ is practically the same in all measured samples.

We compared these results with the calculated dependence $\alpha(p)$ and $\varrho(p)$. We assumed in our calculations that the conduction band is a nonparabolic one with an $\varepsilon(k)$ dependence described by Kane's theory. This assumption was very well confirmed in all works on InSb.

We took into account a mixed scattering mechanism of electrons on optical and acoustical phonons and ionized impurities, in the same way as it was done previously (2, 3). The results of calculations based on the above assumptions were in good agreement with the observed dependence of mobility and thermoelectric power on concentration of electrons and temperature (2, 3).

We assumed also that constants in the expressions for relaxation times in each particular scattering mechanism are pressure independent. The contribution of

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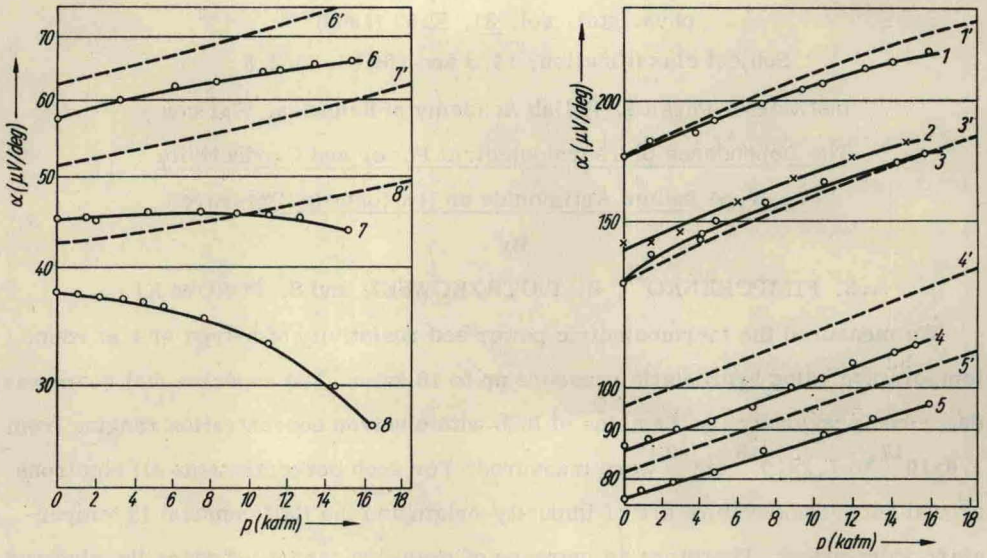

Fig. 1. Dependence of thermoelectric power on pressure; solid curves - experiment, dashed curves - theoretical, electron concentration:
1. 1.6×10^{17} cm^{-3}, 2. 3.2×10^{17} cm^{-3}, 3. 3.7×10^{17} cm^{-3}, 4. 8.2×10^{17} cm^{-3}, 5. 1.25×10^{18} cm^{-3}, 6. 2.54×10^{18} cm^{-3}, 7. 4.3×10^{18} cm^{-3}, 8. 7.2×10^{18} cm^{-3}

the particular scattering mechanisms can be pressure dependent because the energy of electrons and their effective mass depend on pressure. These quantities depend on the energy gap which is increasing linearly with pressure. The value $\gamma = d\varepsilon_g/dp = 14\times10^{-6}$ eV/atm was taken because, according to our measurements and calculations for intrinsic InSb (4), this value is more probable than Keyes' one $\gamma = 15.5\times10^{-6}$ eV/atm (5). The calculated theoretical curves are shown in Figs. 1 and 2. The agreement between theory and experiment for purer samples is reasonable. It disappears for havily doped samples. In particular we cannot explain the independence of $d\lg\varrho/dp$ on electron concentration and the decrease of α with increase of pressure for havily doped samples.

If we assume that constants in the expressions for relaxation times in each particular scattering mechanism are pressure dependent we still cannot explain these facts. The change of such constants as dielectric constant, deformation potential, sound velocity, frequency of optical phonons should be of the order 100% per 10 katm which seems to be unreasonable.