the semiconductor interact with the lattice vibrations and cause a shift in the energy bands that determine E_g. As the temperature increases, the lattice vibrations become stronger, and E_g changes. The temperature increase also causes the lattice to expand and the energy gap to change.[3] To separate the two possible causes of the temperature dependence, a high-pressure experiment is required to determine how the energy gap varies with volume. When this value is known, the total temperature dependence of the energy gap can be separated into the portion due to the temperature increase and that due to the volume increase associated with the thermal expansion, as expressed in mathematical terms in Figure 1. The pressure and temperature dependence of the energy gap for germanium is illustrated in Figure 2.

Pressure Dependence of the Thermoelectric Power of Germanium

The use of high pressure to vary the parameters that describe a particular phenomenon is illustrated by recent research findings on the thermoelectric power (T.E.P.) of germanium.[4] The T.E.P. of germanium exhibits a marked increase below 150 K because of the "phonon drag" effect, a phenomenon caused by the interaction of the electron (or hole) electrical current with the lattice heat current. The theory of this phenomenon indicates a definite dependence on three parameters: μ, the carrier mobility; m^*, the effective mass of the current carriers; and c, the elastic constant.[5] Values for the pressure dependence of these parameters have been measured and reported in the literature; the theory of the phonon drag effect and the experimental results of the pressure dependence can be compared directly, as shown in Figure 3.

In this study, measured values for *p*-type and *n*-type germanium were compared with the values calculated from the theoretical expression. The results show an agreement between the calculated and measured pressure dependence, indicating that the theoretical treatment is correct to within the accuracy of the experiment.

Polymorphism

The third example of high-pressure research of interest in solid-state physics involves the creation of new forms of materials through polymorphic phase transitions. Under conditions of high pressure and sometimes elevated temperature also, many solids change crystal structure and exhibit new and interesting properties. The most spectacular demonstration of

$Q_{ph} = f(m^*, \mu, c)$ Phonon drag contribution to the thermoelectric power is a function of the variables m^* (the effective mass of the current carriers), μ (carrier mobility), and c (the elastic constant).

The change with pressure of Q_{ph} can be expressed in terms of the change with pressure of the variables m^*, μ and c.

$$\frac{dQ_{ph}}{dp} = \frac{\partial f}{\partial m^*}\frac{\partial m^*}{\partial p} + \frac{\partial f}{\partial \mu}\frac{\partial \mu}{\partial p} + \frac{\partial f}{\partial c}\frac{\partial c}{\partial p}$$

$\frac{dQ_{ph}}{dp}$ the change with pressure of Q_{ph} is the quantity measured in the experiment.

$\frac{\partial m^*}{\partial p}, \frac{\partial c}{\partial p}, \frac{\partial \mu}{\partial p}$ are measured in independent experiments.

$\frac{\partial f}{\partial m^*}, \frac{\partial f}{\partial c}, \frac{\partial f}{\partial \mu}$ are derived from theory.

Experimental and theoretical values of $\frac{dQ_{ph}}{dp}$ are then compared.

$\left(\frac{dQ_{ph}}{dp}\right)$ experiment ? $\frac{dQ_{ph}}{dp}$ theory

Fig. 3. *Pressure Dependence of Thermoelectric Power. The analysis shows how the theoretical expression for the phonon drag contribution to thermoelectric power is used to derive the pressure coefficient of Q_{ph} using the pressure coefficients of parameters that are measured in independent experiments. This derived pressure coefficient is then compared with the experimentally determined pressure coefficients of Q_{ph}.*

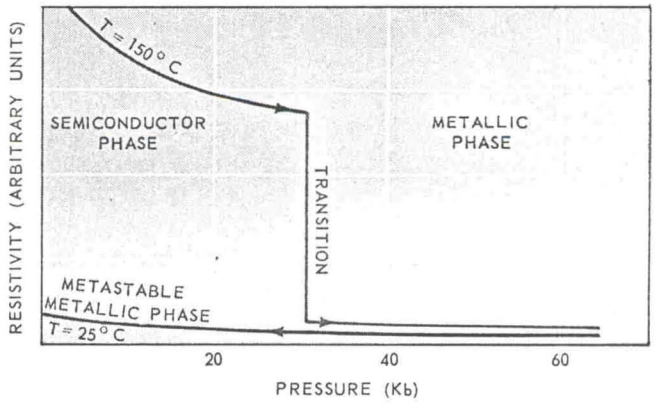

Fig. 4. *A Plot of the Resistivity vs Pressure of Indium Telluride. The increasing pressure cycle at 150 C is shown by the upper curve, in which the transition from semiconductor phase to metallic phase is indicated by the sharp drop in resistivity at 30 kb. The lower curve shows the retention of the metallic phase in a metastable state when the pressure is released at 25 C.*