Paul Freud's primary research interest has been the investigation of the effects of pressure on the charge transport characteristics of materials. Much of his effort has been directed to the study of charge transport in metal oxides, which have properties similar to those of typical semiconductors. Dr. Freud has been associated also with a series of studies on the effects of high pressure on the properties of a broad spectrum of materials. He received his Ph.D. degree in physics from Rutgers.

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this phenomenon is provided by the high-pressure production of diamonds. Here carbon changes from one of the softest solids (graphite) into the hardest. Bismuth, a semimetal, undergoes four crystal structure changes as the pressure is increased from zero to 100 kb, while germanium, a semiconductor, becomes a metal at high pressure. Recent investigations of a number of intermetallic compounds have revealed transformations similar to that of germanium.

In the case of indium telluride, a compound investigated at Battelle-Columbus[6] and elsewhere,[7,8,9] it is found that the high-pressure and low-pressure forms of the compound have remarkably different properties. The low-pressure forms shows typical semiconducting behavior, but the high-pressure form exhibits good metallic conductivity. The metallic form of InTe can be retained metastably if the pressure is released at room temperature or below, allowing one to study the new form at ambient pressure in this metastable condition. The pressure dependence of the resistivity is plotted in Figure 4, showing the transition from semiconductor to metal at 30 kb.

In addition to being a good metal, the high-pressure form of InTe has other interesting properties. At 3.3 K the high-pressure form becomes a superconductor. If the atomic ratio of indium to tellurium in the starting material departs from one, the superconducting transition temperature can be reduced to as low as 1 K.[9]

The nuclear magnetic resonances of the In and Te nuclei in the environment of the new crystal structure have been studied,[10] leading to the discovery that the nuclear resonances in the new environment showed anomalously large shifts and broad line widths that are of important theoretical interest.

Thus, through the use of high pressure to induce polymorphic phase transitions, a means is available for preparing a solid with a variety of crystal structures.

High pressure can be a useful tool in the investigation of solid-state phenomena. To determine a specific volume dependence, a high-pressure experiment is essential. The properties of a solid can be varied in a controlled way by means of high pressure, and the interdependence of various properties can be determined. Finally, by using high pressure to induce polymorphism, typical of many solids, studies can be made of the properties of a solid in various crystal structures.

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The physical sciences and engineering, though they may have started independently . . . have now been so intertwined and integrated, and the physical sciences themselves so advanced, that given an applied goal in engineering, there is often nothing but money that stands in the way of achieving the goal, provided basic science has shown this goal to be achievable.

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