MEASUREMENT OF THE ELECTRICAL RESISTANCE OF IODINE AND BLACK PHOSPHORUS UNDER A PRESSURE OF UP TO 200,000 ATM

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The electrical resistance of iodine and red phosphorus was measured at room temperature under a static pressure from 1 to 200,000 atm. To produce such very high pressures, the authors used apparatus constructed at the Institute for Physics of High Pressures of the Academy of Sciences. The electrical resistance was measured by a compensation method. One sample was used to obtain variation of the electrical resistance in increasing and decreasing pressures.

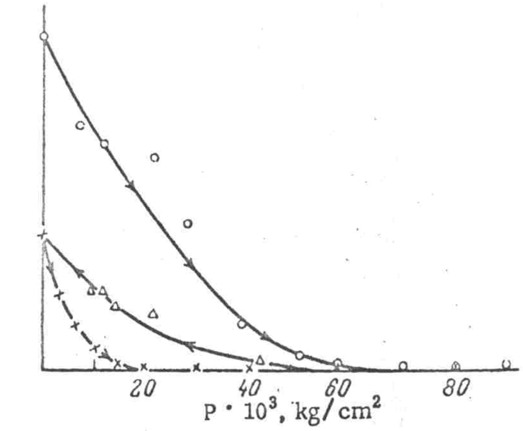

Fig. 1.

Figure 1 shows that the resistance of iodine fell rapidly with increase of pressure, approaching values characteristic of metals at about 70,000 atm. On the removal of pressure the electrical resistance of iodine rose almost back to its initial value. The resistivity fell by a factor of 10^5 under pressures used by the authors. These pressures converted an intially semiconducting material into one with metallic conduction.

Black phosphorus behaved similarly. At pressures of about 43,000 atm red phosphorus was converted irreversibly into its black modification, and this transition was accompanied by a very sharp fall of its resistance (Fig. 2). On further increase of pressure the resistance of black phosphorus reached values characteristic of metals at about 110,000 atm. When pressure was reached gradually the resistance of phosphorus rose, almost reaching its initial black-phosphorus value. At very high pressures black phosphorus behaved as a metal.

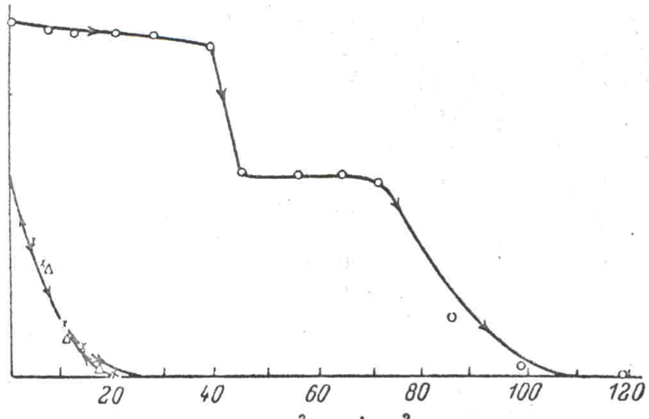

Fig. 2.

In the course of this work it was noted that the initial resistances of iodine and red phosphorus were the same. It was found that leakage currents were responsible for this. The initial resistances of iodine and red phosphorus were much higher than the leakage resistance, and consequently, most of the currents by-passed the sample in the earlier stages of the tests. With increase of pressure the resistance of our samples fell sharply and the leakage effects became less important.

The results reported lead us to a conclusion that at pressures of 150,000-200,000 atm both iodine and black phosphorus become good conductors.