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Abstract**Full Text**

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TEMPERATURE DEPENDENCE OF THE ELECTRICAL RESISTANCE OF IODINE AT PRESSURES UP TO 200,000 kg/cm²

Iodine is a semiconductor with a band-gap width of ~ 1.3 eV and a high specific electrical resistivity ⁽¹⁾. Earlier the authors ⁽²⁾ investigated the change in the electrical resistance of iodine at room temperature and at pressures up to 300,000 kg/cm². It is of interest to study the temperature dependence of the electrical resistance of iodine at high pressures and to establish the change in the band-gap width with increasing pressure.

The pressure was produced in the high-pressure apparatus mentioned earlier ^(3,4). To create the temperature, the apparatus was placed in an oil bath of cylindrical form. The press load was applied to the upper punch of the high-pressure apparatus and to the bottom of the bath. Heating was carried out by passing an electric current through a spiral wound on the side surface of the bath. The voltage was set by a laboratory autotransformer. With constant voltage, grade and quantity of oil maintained, and with the axes of the high-pressure apparatus and the oil bath aligned, the curve of sample temperature versus heating time coincided to within $\pm 5\%$. The iodine sample was calibrated for temperature by means of a chromel-alumel thermocouple introduced into the high-pressure chamber under a slight compression necessary for sealing the sample. At high pressure the temperature of the sample was determined from the heating time. The resistance of the sample was measured with an MOM-3 megohmmeter in the temperature range from 20 to 135° and in the pressure range from 30,000 to 200,000 kg/cm². The substance studied was chemically pure.

In Fig. 1, the quantity $1/2kT$ is plotted along the abscissa, where k is Boltzmann's constant and T is the absolute temperature; along the ordinate is plotted the natural logarithm of the electrical resistance. Since the linear dimensions of the sample change very little with temperature and pressure, the change in the electrical resistance of the iodine sample will be directly proportional to the change in its specific resistivity. As is seen from Fig. 1, the natural logarithm of the electrical resistance at a given pressure depends linearly on $1/2kT$. The tangent of the angle of inclination of the straight line is equal to the band-gap width E of iodine (in electron-volts), which, as is seen from Fig. 2, decreases with increasing pressure from 1.06 eV at 30,000 kg/cm² to 0.4 eV at 200,000

Fig. 1

Figure 1: Fig. 1

Fig. 2

Figure 2: Fig. 2

kg/cm². This corresponds to a considerable decrease in the electrical resistivity of the iodine sample (almost by 10⁵ times at room temperature) in the pressure interval studied. It is interesting to note that the band-gap width and the electrical resistance of iodine decrease very strongly up to approximately 100,000 kg/cm², i.e., in the region of its most intense compressibility. Further decrease of these quantities slows down.

The results of our measurements agree well with the literature data (^{5,6}). The curves for E, R in Fig. 2 correspond, especially in their initial part, to Harris' s curve (⁵). Some discrepancy may be explained by differences in the method of producing temperature and especially high pressure. Harris' s measurements were carried out with a film of iodine subjected to pressure in a high-pressure apparatus between conical punches.

In our experiments the volume of the sample together with the pressure-transmitting medium was $\sim 0.5 \text{ cm}^3$.

Owing to a certain temperature gradient that was established in the sample in our experiments, the authors were able to determine the sign of the charge carriers. In the pressure interval studied, the conductivity of iodine was hole-like.

Fig. 1. Temperature dependence of the electrical resistance of iodine at high pressures (in kg/cm²):

1 –30,000; 2 –50,000; 3 –80,000;
4 –140,000; 5 –200,000.

Fig. 2. Dependence of the band-gap width E and the electrical resistance of iodine R at room temperature on pressure.

In conclusion it should be noted that more accurate values of the band-gap width can be obtained by studying the Hall effect under pressure. However, our measurements have quite satisfactory accuracy. Extending the curve E in Fig. 2 to its intersection with the ordinate axis (pressure $P = 0$), we obtain a value of the band-gap width of iodine at atmospheric pressure approximately equal to 1.3 eV, which agrees with the literature data (¹).

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