

Effect of Pressure on the Absorption Edges of Some III-V, II-VI, and I-VII Compounds*

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(Received December 13, 1960)

The effect of pressure to 160 kilobars was measured on the absorption edges of the III-V compounds AlSb, GaSb, InP, and InAs, the II-VI compounds CdS, CdSe, and CdTe, and the I-VII compounds CuCl, CuBr, and CuI. It is possible to discuss the band structure of the III-V compounds with reasonable assurance relative to known group IV and III-V structures. For the II-VI and I-VII compounds, ionic and other effects must be important. A number of new phase transitions were noted at high pressure. For CuCl and CuBr the T - P curves of some of these transitions were established.

THE effect of pressure (in some cases as high as 160 kilobars) has been measured on the absorption edges of a number of III-V, II-VI, and I-VII compounds which have the zincblende or wurtzite structure at room temperature and atmospheric pressure. Previously^{1,2} results have been published on certain group IV, III-V, and II-VI compounds. In the case of CuCl and CuBr the temperature shift of the phase boundaries of several pressure-induced phase transitions was also obtained.

The experimental procedures have been previously described,^{3,4} except that the latest revised pressure calibration⁵ was used. In attempting quantitative interpretation of the results it must be kept in mind that the apparatus is not primarily suited to handling these very brittle substances, and to obtaining quantitative results in the pressure range below 20 kilobars.

A. III-V COMPOUNDS

The effects of pressure on the optical absorption spectra of the group III-V compounds AlSb, GaSb, InP, and InAs have been measured. In addition, an investigation has been made to help identify the source of an absorption band on the long-wavelength side of the absorption edge of GaSb at higher pressures.

AlSb was obtained from the Ohio Semiconductor Company, Columbus, Ohio, in the form of a section from a large polycrystalline ingot. Spectra were obtained for two samples, 11.3 and 12.4 mils in thickness. The DUR Spectrophotometer was used, with a tungsten lamp source and an RCA 7102 detector. A slit width of 2.0 mm was used on the monochromator. The resulting curves are nearly linear on a plot of $(\alpha x)^{1/2}$ vs wave number. In the pressure runs, the long-wavelength transmission and the reflection correction varied only

slightly between 10 and 50 kilobars, indicating that no crushing of the sample occurred. The shift of the absorption edge with pressure was measured from an initial value of 13 180 wave numbers at an absorption coefficient of 30 cm^{-1} , and is given in Fig. 1. The result is a monotonic red shift with increasing pressure, with a slope of -0.0016 ev/kilobar up to the highest pressure attained, 50 kilobars. The total shift at 50 kilobars is 660 wave numbers.

GaSb was provided by Dr. J. H. Racette, of the General Electric Research Laboratories, in the form of rectangular polished samples of three thicknesses, 4, 7, and 11 mils, having a carrier density of $3 \times 10^{17} \text{ cm}^{-3}$. All spectra were obtained on the infrared spectrometer, with a tungsten lamp source and a PbS detector, with a slit width of 2.0 mm on the monochromator. Spectra obtained for 11 and 4 mil samples at 1 atm located the absorption edge at 5500 cm^{-1} for an absorption coefficient of 30 cm^{-1} . The shift of the absorption edge with pressure was measured in three runs, and the results are given in Fig. 2. There is an initial blue shift having a slope of 0.0120 ev/kilobar . At 18 kilobars, there appears to be a change of slope, to about 0.0073 ev/kilobar , and between 32 to 50 kilobars the shift of the edge appears to be leveling off and beginning to go red, with a maximum blue shift of about 2750 cm^{-1} at about 45 kilobars.

In each run, a broad absorption band appeared on the long-wavelength tail of the absorption edge at higher pressures. This peak remained nearly constant

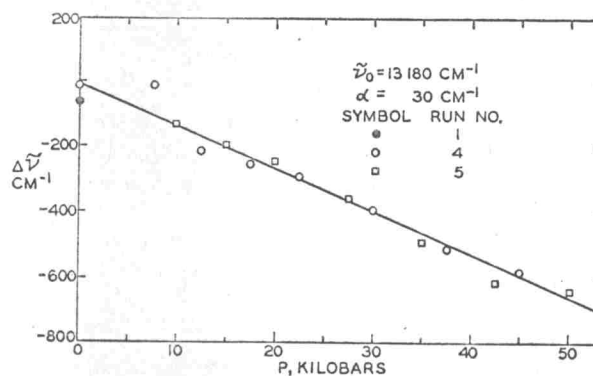


FIG. 1. Shift of AlSb absorption edge with pressure.

* This work was supported in part by U. S. Atomic Energy Commission, Chemical Engineering Project 5.

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