The isotropy coefficient, $S = (C_{11} - C_{12})/2C_{44}$, which has the value 1 for an isotropic crystal, was found to be 0.84 for Mg₂Sn. The temperature dependence of the elastic constants is shown in Fig. 4. Sample lengths and densities were corrected for thermal expansion using the coefficient of linear expansion which was determined by

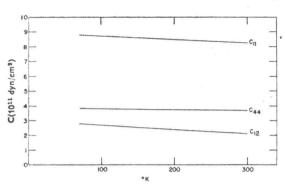


Fig. 4. Elastic constants of Mg2Sn.

Shanks.⁽¹³⁾ He obtained a value of 0.99×10^{-5} /°K from the temperature dependence of the lattice constant as measured from X-ray diffraction patterns.

Listed in Table 1 are the elastic constants for a number of common semiconductors. It should be noted that Mg₂Sn is somewhat different from the related compounds Mg2Si and Mg2Ge. The elastic constants, especially C_{11} , are smaller, and Mg₂Sn is less isotropic than either Mg₂Si or Mg₂Ge. A similar reduction in the values of the elastic constants can be seen in a comparison of GaAs and GaSb and of InAs and InSb. In fact, the elastic constants of Mg₂Sn resemble those of GaSb except that C_{12} is only about one-half of C_{44} in Mg₂Sn. The relative magnitudes of the elastic constants, $C_{11} > C_{44} > C_{12}$, are the same as in Si and Ge. The Mg₂X compounds are more isotropic than any of the other semiconductors listed.

INTERATOMIC FORCE MODELS

Kahan et al. (3) have measured the high and low frequency dielectric constants, ϵ_{∞} and ϵ_{0} , and the reststrahl (transverse optic) frequency ω_{IT} for Mg₂Sn. They found $\epsilon_{\infty}=15\cdot5$, $\epsilon_{0}=23\cdot75$, and $\omega_{IT}=3\cdot50\times10^{13}\,\mathrm{sec^{-1}}$. From the Lyddane-

Table 1. Elastic constants of some common semiconductors

| | C ₁₁ (10 in. dyn/cm ²) | C_{12} | C_{44} | $S = \frac{C_{11} - C_{12}}{2C_{44}}$ |
|---------------------|---|----------|----------|---------------------------------------|
| Mg ₂ Si* | 12.1 | 2.2 | 4.64 | 1.07 |
| Mg2Get | 11.79 | 2.30 | 4.65 | 1.02 |
| Mg ₂ Sn‡ | 8.24 | 2.08 | 3.66 | 0.84 |
| Si§ | 16.57 | 6.39 | 7.95 | 0.64 |
| Ge§ | 12.88 | 4.83 | 6.71 | 0.60 |
| GaAs | 11.92 | 5.97 | 5.38 | 0.55 |
| GaSb | 8.85 | 4.04 | 4.33 | 0.56 |
| InAs | 8.33 | 4.53 | 3.96 | 0.48 |
| InSb | 6.75 | 3.47 | 3.16 | 0.52 |

^{*} Ref. 1.

Sachs-Teller⁽¹⁶⁾ relation,

$$rac{\omega_{IL}}{\omega_{IT}} = \sqrt{\left(rac{\epsilon_0}{\epsilon_\infty}
ight)}$$
 ,

we found the longitudinal optic frequency, ω_{IL} , to have the value $4.33 \times 10^3 \, \mathrm{sec}^{-1}$.

From our measurements of the elastic constants and the above optical constants, it appeared feasible to make a calculation of the phonon dispersion curves for Mg2Sn. Three different force constant models were employed in our calculation. The first two, model I and model II, were point ion models, previously proposed by Whitten et al.(1) and Chung et al.(2) for Mg2Si and Mg2Ge. Models I and II differed only in the assumptions made concerning the short range forces between next nearest neighbors. The third model was a slight modification of the shell model as first proposed by DICK and OVERHAUSER (17) and successfully used by many authors. (18) Although few tests of the validity of our calculated phonon dispersion curves are currently available, it is clear that the shell model provided the best fit to the Debye curve as a function of temperature (see Fig. 5).

To construct a physically plausible picture of Mg₂Sn, apparently one must account for both an ionic character and a covalent character. The infrared reflectivity spectrum of Mg₂Sn is characteristic of an ionic compound. The difference in

2,

alated to

2.5 perrom the

100 SHEAR

100 LONG

and [110]

III LONG

direction. es in Fig. 2.

[†] Ref. 2.

[‡] Present investigation.

[§] Ref. 14.

^{||} Ref. 15.