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 $Mg_2Sn$. 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

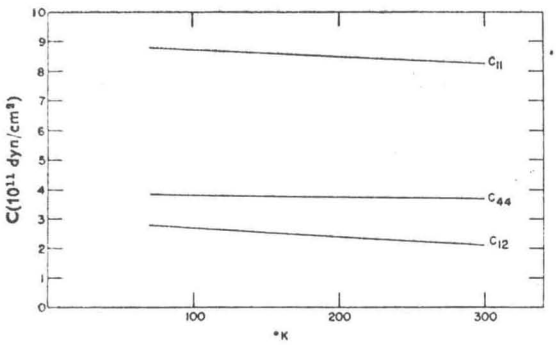


FIG. 4. Elastic constants of $Mg_2Sn$.

SHANKS.[13] He obtained a value of $0{\cdot}99\times10^{-5}/°K$ 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 $Mg_2Sn$ is somewhat different from the related compounds $Mg_2Si$ and $Mg_2Ge$. The elastic constants, especially $C_{11}$, are smaller, and $Mg_2Sn$ is less isotropic than either $Mg_2Si$ or $Mg_2Ge$. 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 $Mg_2Sn$ resemble those of GaSb except that $C_{12}$ is only about one-half of $C_{44}$ in $Mg_2Sn$. The relative magnitudes of the elastic constants, $C_{11} > C_{44} > C_{12}$, are the same as in Si and Ge. The $Mg_2X$ 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, $\epsilon_\infty$ and $\epsilon_0$, and the reststrahl (transverse optic) frequency $\omega_{IT}$ for $Mg_2Sn$. They found $\epsilon_\infty = 15{\cdot}5$, $\epsilon_0 = 23{\cdot}75$, and $\omega_{IT} = 3{\cdot}50\times10^{13}\ \text{sec}^{-1}$. From the LYDDANE–SACHS–TELLER[16] relation,

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

we found the longitudinal optic frequency, $\omega_{IL}$, to have the value $4{\cdot}33\times10^{3}\ \text{sec}^{-1}$.

*Table 1. Elastic constants of some common semiconductors*

| | $C_{11}$ (10 in. dyn/cm²) | $C_{12}$ | $C_{44}$ | $S=\dfrac{C_{11}-C_{12}}{2C_{44}}$ |
|---|---|---|---|---|
| $Mg_2Si$* | 12·1 | 2·2 | 4·64 | 1·07 |
| $Mg_2Ge$† | 11·79 | 2·30 | 4·65 | 1·02 |
| $Mg_2Sn$‡ | 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.
† Ref. 2.
‡ Present investigation.
§ Ref. 14.
‖ Ref. 15.

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 $Mg_2Sn$. 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 $Mg_2Si$ and $Mg_2Ge$. 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 $Mg_2Sn$, apparently one must account for both an ionic character and a covalent character. The infrared reflectivity spectrum of $Mg_2Sn$ is characteristic of an ionic compound. The difference in