

depends upon just where the sum is discontinued in the lattice and agreement better than 1 to 2% could not be obtained. We did not extend our calculations beyond neighboring dipoles because there are other unknown factors which affect the indices much more than terms due to next nearest dipoles in the sum in (2). Chief among these is the polarizability and its anisotropy of the calcium atom. Its effect on the indices of refraction is much less than that of the oxygen atoms but it is far from negligible. Its contribution to the index of refraction is about 20 to 30% that of the oxygen. The anisotropy of its polarizability is also unknown. The value used for its polarizability was the one reported by Tessman et al. [13] from an examination of the indices of refraction of two alkaline earth-halide crystals namely, CaF_2 and CaCl_2 . The difference between the Ca^{2+} polarizability in these two crystals was found to be about 20%. We used the reported average value of 1.1 which is probably at best $\pm 10\%$. Following through the calculation with these values in the manner described above we find $dn_e/dP = +0.64 \times 10^{-3}/\text{kbar}$ and $dn_o/dP = +1.23 \times 10^{-3}/\text{kbar}$ respectively. These values are of the correct order of magnitude and of the proper sign. This is perhaps all that can be expected since we are essentially taking the difference between two quantities which are uncertain themselves in the second decimal place.

According to Mueller's [14] theory of photoelasticity, the change of the refractive indices of a crystal under stress depends upon (i) the change in the Coulomb field, (ii) the change in the Lorentz-Lorenz field, and (iii) the variation of the intrinsic polarizability of the ions. The calculations of these, for crystals as yet been carried out. But in the present case of calcite under hydrostatic pressure, some general conclusions can be reached regarding the variation of the polarizability with strain.

The well-known Lorentz-Lorenz condition is:

$$(3) \quad \frac{n^2}{n^2 - 1} = A N \alpha,$$

where A has a value $4\pi/3$ for cubic D lattices but for a trigonal crystal like calcite A has different value ($\neq 4\pi/3$) for both indices, N is the number of molecules per cubic volume and α is the molecular polarizability. As an approximation we shall assume that the contribution of Ca^{++} to the refractive indices of CaCO_3 is negligible and that A does not vary with hydrostatic pressure. Differentiating the above equation with respect to density, we obtain

$$(4) \quad \frac{dn}{d\rho} = [(n^2 - 1)(n^2 + 2)/6n\alpha] [1 - A_0],$$

where

$$(5) \quad A_0 = -\frac{\alpha}{\rho} \frac{\partial}{\partial \alpha} \left(\frac{\partial}{\partial \alpha} \right) = \frac{1}{\Delta \alpha} \frac{\alpha}{\Delta V/V_0}$$

is taken as the strain-polarizability parameter. With the help of (4) and the observed values of $dn/d\rho$, the values of A_0 were calculated at various pressures for both the ordinary and extra-ordinary indices, and are entered in Table I. The fact that A_0 is positive in every case implies that the polarizability of the oxygen ions decreases as the crystal is compressed, quite in accordance with the observations of Rajans and Joos [15] and also the recent conclusions

of Tessman et al. [13]. These authors have shown that the polarizability of cations decreases and the polarizability of the anions increase upon going from the free-ion gaseous state to the solid state. So a further change in the polarizabilities of the ions is expected, in the same direction, when the crystal is subjected to hydrostatic pressure. The above results are similar to those found for α -quartz [4].

From the table it is seen that the value of A_0 for the ordinary ray is larger than that for the extraordinary ray. This is as expected for a negative crystal like calcite since we expect the change in polarizability for the ordinary ray to be larger than the change for the extraordinary ray. We also note that A_0 for the ordinary ray seems to increase while A_0 for the extraordinary ray seems to decrease. No special significance should be attached to this since our uncertainty in A_0 is 5% at the lower pressures and about 1 to 2% at 7 kbar, thus the observed variation is within our experimental error.

The last column in Table 1 gives values of A_0^D , the strain-polarizability constant, but derived from the Drude-equation instead of the Lorentz-Lorenz equation. The values of A_0^D and A_0^{LL} are almost equal indicating that A_0 is not very sensitive to the type of dispersion relation used to derive it.

Acknowledgement

The authors would like to express sincere thanks to Professor Rustum Roy for his interest and encouragement.

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(Received January 4, 1968)