

where P_1 is the pressure of any circular ring about the center and A_1 is the area of the ring. Thus, the denominator is the total area of the diamond equal to πr_o^2 . \bar{P} , the average pressure is assumed to be equal to the applied pressure, P_a , as should be the case for the frictionless system. Now as $1 \rightarrow \infty$, we can apply the integral over all pressures from 0 to P_m , the maximum pressure in the cell.

$$\bar{P} = \int_0^{P_m} A_1 dP / \pi r_o^2 = \int_0^{P_m} r^2 dP / r_o^2$$

We can evaluate r^2 in terms of P since from relation (3)

$$r^2 = 1 - (aP - bP^2/aP_m - bP_m^2)$$

Therefore

$$\bar{P} = \int_0^{P_m} dP - (1/aP_m - bP_m^2) \left(\int_0^{P_m} aP dP - \int_0^{P_m} bP^2 dP \right)$$

$$P_a = \bar{P} = P_m - \left[(aP_m^2/2) - bP_m^3(3) \right] (1/aP_m - bP_m^2)$$

$$\text{from which } P_a/P_m = 0.5 + 6(aP_m - bP_m^2)/bP_m^2. \quad (4)$$

From this relation P_m can be determined when the applied pressure is known. Since the b term is generally small, there is no significant effect on P_m at low pressures. For example, for sodium chloride at 10 kbar, $P_m/P_a = 1.997$.

Term r_a can be determined by combining expressions (2) and (3) to obtain

$$r_a^2/r_o^2 = 1 - (aP - bP^2/aP_m - bP_m^2) \quad (5)$$

The effect of P on r_a is greater than the P_m/P_a relation above, e.g., at $P_m = 10$ kbar with sodium chloride, $r_a = 0.692 r_o$ while at 40 kbar, $r_a = 0.621 r_o$.

Thus, it can be seen that at low pressures

$$\lim_{P_a \rightarrow 0} P_m/P_a = 2.0 \text{ and } \lim_{P_a \rightarrow 0} r_a/r_o = 0.707$$

The limits of these relations cannot as yet be determined at higher pressures as compressibility data above 40 kbar is not adequate. In general, therefore, this theory predicts $P_m/P_a \leq 2.0$ and decreases with increasing pressure. Further, $r_a \leq 0.707 r_o$ and decreases (or moves toward the center) as pressure increases.

The agreement of the experimental data with this theory is very good with regard to the general shape of the pressure distribution curve. The curves shown in Figs. 11, 13 and 14 all have less

parabolic character as the pressure increases toward the center as predicted by relation (2) and demonstrated in Fig. 12. The calculated curve for pure thallium bromide is given in Fig. 16 along with the experimental points. As indicated earlier, the diamonds were not aligned properly to get exact agreement but the shape is fairly well established. A further example using a more compressible material at a higher pressure is given in Fig. 17. This curve is taken from a sample of nickel dimethylglyoxime diluted with 2 parts sodium chloride at an applied pressure of 20 kbar. At this pressure the calculated deviation from parabolism at the center is noticeable but in quite good agreement with the data.

The relation $P_m/P_a \leq 2.0$ is not so well verified by our experiments particularly at low applied pressures. This is probably due to the improper alignment of the diamonds and the incomplete redistribution of the material between the diamonds at low pressures as discussed earlier. At higher pressures the values are less than 2.0 as predicted by the theory, Table 1. Predicted values are not given at pressures greater than 20 kbar since adequate compressibility data are not available. At 20 kbar the experimental values from well-aligned diamonds agree quite well with the calculated value for the pure alkali halide.

A further test of the P_m/P_a relation will be pursued when compressibility data over a larger pressure range becomes available at 25 deg. This may require a modification of equation (4) to include a greater pressure dependence.

Experimental and calculated values of r_a are given in Table 2 for different materials at 20 kbar, as well as some experimental values at 40 kbar. The agreement is about the same as that for the P_m/P_a relation. Thus, relation (2) adequately describes the pressure distribution of these substances in the diamond high pressure cell if distributed uniformly between properly aligned diamonds.

CALCULATION OF COMPRESSIBILITY FROM PRESSURE-DISTRIBUTION DATA

Compressibility data have been applied quite satisfactorily to the determination of the pressure distribution in the diamond-anvil high-pressure cell. The fact that the main barrier to giving the theory a rigorous test is the lack of adequate compressibility data suggests that the pressure gradient within the cell be applied to the determination of compressibilities. The method requires a reference compressibility much the same as the pressure distribution required a reference to the applied or maximum pressure. However, 1