

This is why the symmetry is only an approximate symmetry and not an exact one. Five-fold symmetry does not allow the packing of atoms in space to proceed in an exactly ordered fashion. Because of the mobility in the geometric orientation of the molecules in the clusters, the acquisition of information regarding their structure is quite difficult. However, it has been shown geometrically, that in clusters of small size, 5-fold symmetry gives rise to more bonds than close packing does. From this fact comes the stability of the five-symmetric structure in liquids and also the difficulties associated with the conversion of liquids to solids (homogeneous nucleation).⁽⁹⁾

Going back to Tait's Law, it seems strange that liquids having one sort of symmetry should obey Tait's Law for the isothermal compressibility, while polycrystalline solids which are very much like liquids except in the matter of symmetries, should follow other laws. This is especially so in view of the meaning ascribed to the Tait coefficients by association theory. This paper is then devoted to an examination of the behavior of solids undergoing isothermal compression in light of Tait's Law.

2. THEORY

The experimental difficulties in determining the isothermal compressibility are considerable.⁽¹⁰⁾ These difficulties are further compounded by the fact that there has been in the past no theoretical generalization, which could be used to evaluate the meaning of the values that come from such measurements. This lack has resulted in the representation of the various experimental results in a variety of empirical or semi-empirical laws.⁽¹¹⁾ Bridgman in his work has found that he could express the compressibility of many but not all solids empirically by using the first two terms of an alternating power series in terms of the pressure [equation (2)].

$$-\Delta v/v_0 = AP - BP^2 \pm \text{higher terms} \quad (2)$$

This particular series which was probably chosen by Bridgman on purely empirical grounds of good fit can be shown to have a theoretical basis and to be a truncated version of Tait's Law. Differentiating equation (2) we have

$$-(\partial v/\partial P)_T = Av_0 - 2Bv_0P \pm \text{higher terms} \quad (3)$$

The expansion of the denominator in Tait's Law [equation (1)] yields

$$-(\partial v/\partial P)_T = J(L+P)^{-1} \\ = J \left(\frac{1}{L} - \frac{P}{L^2} + \frac{P^2}{L^3} - \frac{P^3}{L^4} + \dots \right) \quad (4)$$

It can readily be seen that equation (3) is identical to equation (4) if

$$Av_0 = J/L \\ 2Bv_0 = J/L^2 \quad (5)$$

etc. for higher terms.

In Bridgman's work he found that the higher terms could be neglected for most solids. The necessary condition here is that

$$P/L \ll 1$$

If this condition holds then a slight adjustment of the retained coefficients will fit the data, especially if a too precise fit is not demanded. Further, the experimental discrepancies in the data render exact fits unnecessary.

Another empirical approach at high pressures was presented by LEVITT⁽¹²⁾ which he portrays as "A limiting law at the upper end of the pressure range." He has applied this approach to gases, liquids and solids at high pressures with success. His approach leads to equation (6)

$$-\left(\frac{\partial v}{\partial P}\right)_T = \frac{v^2}{BP} \quad (6)$$

with B a constant. If one compares this with the Tait equation [equation (4)], one sees that at high pressures where $P \gg L$, if one sets

$$B = v^2/J \quad (7)$$

we can obtain equation (6). Since $(\partial v/\partial P)$ decreases with the rise in pressure, the volume approaches a constant value and thus, as a first approximation, v^2 and hence B may be taken as constants. Thus this empirical approach is an approximation form of the Tait equation. In another publication we show the exact nature of this approximation.⁽²⁴⁾

It can be concluded that, in the limits at least, Tait's Law is obeyed by most solids. The question then arises: Is Tait's Law obeyed by such substances whose compressibilities cannot be expressed by the simple two-term power series of

Bridgman? The hypothesis is that many compounds follow Tait's law although he did not use it. BEECROFT and others have shown various temperatures could fit their data by alternating power series truncating the series and empirically fitting the bits of evidence. The Law should be a simple Bridgman law. What is needed are sets of data and pressure values for the simple law.

Such data are available for alkali metals. The law runs on the order of 100,000 kg/cm² at room temperature. The data given are entitled "Compressibilities of 100,000 kg/cm² compressions,"⁽¹⁴⁾ and the data were reported in a set of values, 0.1 kg/cm².⁽¹⁵⁾ The values of the law at 4.2°K have been reported at 77°K. The law is not sufficient to describe recent work. The results for such pressures up to 100,000 kg/cm² has not been reported other than as reported in a

The calculation of the specific volume was generally