pressure corrections that are less than shear strength corrections for pressures up to about 1 Mb. The thermal pressure calculations were made with a Mie-Grüneisen equation of state. The calculated values are in good agreement with values reported for high-density polycrystalline Al_2O_3 by *Ahrens et al.* [1968].

The ultrasonic and low-pressure shock modulus values for sapphire are used in (2) to determine the 300°K isothermal compression curve shown in Figure 1. The shock-compression data are corrected for shear strength effects and for the thermal pressure. The static isothermal compression data of *Hart and Drickamer* [1965] are also shown. Agreement between the ultrasonic extrapolation based on (2) and the shock data is better than that noted in previous comparisons. For pressures greater than 1250 kb the shock data show a discontinuous change that cannot be fit by a smooth curve. Even though the ultrasonic and shock data are in good agreement the shock compressions are systematically larger than those predicted from the ultrasonic data.

When the B_0' value obtained from the shock data between 175 and 350 kb is used in (2), the calculated isothermal compression curve is in significantly better agreement with the shock data of McQueen and Marsh from 500 to 1250 kb than that obtained from the ultrasonic moduli. In effect, the higher-pressure shock data confirm the B_0' value measured under shock at lower pressures. The pressure range of the shock data is large enough that higher-order pressure derivatives of the bulk modulus, if significant, should affect the compressions significantly. However, the results show that higher-order bulk modulus values are not needed to describe the data.

There appears to be a significant difference between the ultrasonic and shock values for B_0'. It is possible that the large shear stresses resulting from the large Hugoniot elastic limit alter the properties of the sample. In the yielded state the material could possibly have a different character than the unstressed crystal. In fact, the B_0' value obtained from single-crystal shock data is in better agreement with the polycrystalline value of B_0' obtained ultrasonically than with the single-crystal ultrasonic value.

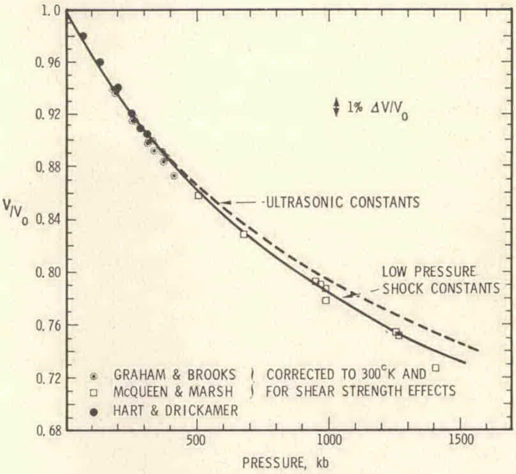

Fig. 1. High-pressure isothermal compression curves for sapphire. The dotted and solid lines are the relationships predicted by the Murnaghan equation with constants derived ultrasonically [*Gieske and Barsch,* 1968] and with constants derived from the low-pressure shock data of *Graham and Brooks* [1971]. The shock data are corrected for thermal pressure and shear strength offsets. The static isothermal compression data of Hart and Drickamer are also shown. The extent to which the data agree with the Murnaghan relations provides a direct measure of the adequacy of the linear bulk modulus approximation for sapphire. The agreement between all experimental points and the isothermal compression curve is thought to be within the experimental error of the measurements.

In any event, when the B_0' value derived from shock data is used in the Murnaghan equation, systematic differences between experimental observations and extrapolations of lower-pressure data are eliminated. The shock compression data to 1250 kb scatter randomly by about ±½% in relative volume about the Murnaghan equation. Thus, the linear bulk modulus approximation is confirmed within the accuracy of the shock data and the shear strength correction. Although there is a difference between the ultrasonic and shock values for B_0' the basic assumption of a linear bulk modulus from 175 to 1250 kb is confirmed. The present work emphasizes the importance of the shear strength correction; uncertainties in the degree to which this effect can be described unequivocally limit the value of higher-order bulk modulus descriptions of the compression of sapphire.

CONCLUSION

Recent shock compression data permit an evaluation of shear strength effects encountered in the shock compression of sapphire. When this effect is accounted for, the extrapolation of ultrasonic data based on a linear bulk modulus approximation shows good agreement with shock compression data confirming the validity of the model for Al_2O_3. The Murnaghan equation gives even better agreement with shock data if the pressure derivative of bulk modulus obtained from shock data is used. The linear bulk modulus approximation gives a precise fit to the shock data from 175 to 1250 kb.

The pressure derivative of the bulk modulus determined from the shock data is about 15% lower than the ultrasonic value and in better agreement with ultrasonic values for polycrystalline than single-crystal Al_2O_3. This result may be indicative of changes in the properties of shock compressed Al_2O_3 caused by the unusually large shear stresses in the shock compression experiments.

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