offset when the high pressure data are extrapolated to zero pressure.

Comparison of hydrostatic and shock compression curves for both sapphire and quartz show differences in volume at a given pressure of about 1 per cent. The reason for this is not understood.

The present theoretical and experimental descriptions of yield mechanisms in solids and shear strength effects at high pressure are inadequate to characterize solids other than metals. Brittle material classifications under static conditions do not adequately characterize those materials which are known to respond as elastic–plastic or elastic–isotropic. There is evidence for different shear-failure mechanisms and different shear strength effects between single crystals and polycrystals and for crystals shocked in various crystallographic directions.

When the shear strengths of solids approach the theoretical shear strength values under shock loading, elastic–isotropic response and changes in shear sensitive properties should be anticipated. It is central to our understanding of the compressional behavior of solids under large anisotropic compressions to accomplish further detailed investigations of HEL values and compression curves for stresses immediately above the Hugoniot elastic limit.

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REFERENCES

1. DRICKAMER H. G., LYNCH R. W., CLENDENEN R. L. and PEREZ-ALBUERNE E. A., In *Solid State Physics* (Edited by F. Seitz and D. Turnbull), Vol. 19, Academic Press, New York (1966).
2. ANDERSON O. L., *J. Phys. Chem. Solids* **27**, 547 (1966).
3. MCQUEEN R. G. and MARSH S. P., *J. appl. Phys.* **31**, 1253 (1960).
4. RICE M. H., MCQUEEN R. G. and WALSH J. M., In *Solid State Physics* (Edited by F. Seitz and D. Turnbull), Vol. 6, Academic Press, New York (1958).
5. DEAL W. E. JR., In *Modern Very High Pressure Techniques* (Edited by R. H. Wentorf, Jr.), Butterworths, Washington (1962).
6. KARNES C. H., In *Mechanical Behavior of Materials Under Dynamic Loads* (Edited by U. S. Lindholm), Springer-Verlag, New York (1968).
7. GRAHAM R. A., *J. bas. Engng* **89**, 911 (1967).
8. GRAHAM R. A. and HUTCHISON R. E., *Appl. Phys. Lett.* **11**, 69 (1967).
9. WOOD, D. S., *J. appl. Mech.* **19**, 521 (1952).
10. FOWLES G. R., *J. appl. Phys.* **32**, 1475 (1961).
11. LUNDERGAN C. D. and HERRMANN W., *J. appl. Phys.* **34**, 2046 (1963).
12. BARKER L. M., LUNDERGAN C. D. and HERRMANN W., *J. appl. Phys.* **35**, 1203 (1964).
13. BUTCHER B. M. and CANNON J. R., *AIAA Journal* **2**, 2174 (1964).
14. BUTCHER B. M. and MUNSON D. E., In *Proceedings Fourth Symposium on Detonation* ACR-126, Office of Naval Research, U.S. Government Printing Office (1965).
15. BUTCHER B. M. and KARNES C. H., *J. appl. Phys.* **37**, 402 (1966).
16. MUNSON D. E. and BARKER L. M., *J. appl. Phys.* **37**, 1652 (1966).
17. GRAHAM R. A., ANDERSON D. H. and HOLLAND J. R., *J. appl. Phys.* **38**, 223 (1967).
18. HERRMANN W., In *Wave Propagation in Solids*, American Society of Mechanical Engineers, New York (1970).
19. JONES O. E. and GRAHAM R. A., In *Accurate Characterization of the High-Pressure Environment* (Edited by E. C. Lloyd), National Bureau of Standards Special Publication 326, March 1971.
20. See a recent comprehensive summary in GRAHAM R. A. and JONES O. E., Sandia Laboratories Report SC-R-68-1857 (Oct. 1968).
21. JONES O. E., NEILSON F. W. and BENEDICK W. B., *J. appl. Phys.* **33**, 3232 (1962).
22. VAN THIEL M. and KUSUBOV A., In *Accurate Characterization of the High-Pressure Environment* (Edited by E. C. Lloyd), National Bureau of Standards Special Publication 326, March 1971.
23. NEILSON F. W. and BENEDICK W. B., *Bull. Am. phys. Soc.* **5**, 511 (1960); also Sandia Laboratories Report SCR-502 (April 1962).
24. WACKERLE J., *J. appl. Phys.* **33**, 922 (1962).
25. FOWLES G. R., Poulter Laboratories Technical Report 003-61, Stanford Research Institute (1961); also *J. geophys. Res.* **72**, 5729 (1967).
26. DUVALL G. E. and FOWLES G. R., In *High Pressure Physics and Chemistry* (Edited by R. S. Bradley), Vol. 2, Academic Press, New York (1963).
27. AHRENS T. J. and LINDE R. K., In *Behavior of Dense Media Under High Dynamic Pressures*, Gordon and Breach, New York (1968).
28. AHRENS, T. J., GUST W. H. and ROYCE E. B., *J. appl. Phys.* **39**, 4610 (1968).
29. MUNSON D. E., Sandia Laboratories Report SC-RR-69-803 (Jan. 1970).

30. MCWHAN D. B., *J. appl. Phys.* **38**, 347 (1967).
31. BROOKS, W. P. and GRAHAM R. A., *Bull. Am. phys. Soc.* **11**, 414 (1966).
32. GRAHAM R. A. and INGRAM G. E., In *Behavior of Dense Media Under High Dynamic Pressures*, Gordon and Breach, New York (1968).
33. GRAHAM R. A., NEILSON F. W. and BENEDICK W. B., *J. appl. Phys.* **36**, 1775 (1965).
34. INGRAM G. E. and GRAHAM R. A., to be published in *Proceedings Fifth Symposium on Detonation*, Pasadena, Calif. (Aug. 18–21, 1970).
35. HEARMON R. F. S., *An Introduction to Applied Anisotropic Elasticity*, Oxford University Press (1961).
36. GIESKE J. H. and BARSCH G. R., *Phys. Status Solidi* **29**, 121 (1968).
37. BARKER L. M. and HOLLENBACH R. E., *J. appl. Phys.* **41**, 4208 (1970).
38. GRAHAM, R. A. and INGRAM G. E., *Bull. Am. phys. Soc.* **14**, 1163 (1969).
39. HART H. V. and DRICKAMER H. G., *J. chem. Phys.* **43**, 2265 (1965).
40. COTTRELL A. H., *Dislocations and Plastic Flow in Crystals*, Oxford at the Clarendon Press (1958).
41. KELLY A. H., *Strong Solids*, Clarendon Press, Oxford (1966).
42. BRENNER S. S., *J. appl. Phys.* **27**, 1484 (1956), see values given in Ref. [41].
43. GRAHAM R. A., JONES O. E. and HOLLAND J. R., *J. Phys. Chem. Solids* **27**, 151 (1966).
44. GUST W. H. and ROYCE E. B., *J. appl. Phys.* **42**, 1897 (1971).
45. MURRI W. J. and ANDERSON G. D., *J. appl. Phys.* **41**, 3521 (1970).
46. AHRENS T. J., *J. appl. Phys.* **37**, 2532 (1966).
47. LINDE R. K. and DECARLI P. S., *J. chem. Phys.* **50**, 319 (1969).
48. ANDERSON O. L., In *Physical Acoustics* (Edited by W. P. Mason), Vol. III-B, Academic Press, New York (1965).
49. GUST W. H. and ROYCE E. B., *Bull. Am. phys. Soc.* **13**, 901 (1968).

The reviewer called our attention to static compression measurements of C_{111} and C_{333} reported by R. E. Hankey and D. E. Schuele, *J. Acoust. Soc. Am.* **48**, 190 (1970). These authors also report values obtained by J. H. Gieske in a Ph.D. thesis at Penna. State University. The various values are shown below.

Comparison of third-order constants[a]

	Gieske	Hankey *et al.*	Present Work
C_{111}	−3·92	−3·87	−3·6
C_{333}	−3·10	−3·34	−3·6

[a] All units are 10^{13} dyne cm^{-2}.

Differences between the static and shock compression may involve fourth-order constant contributions.