lines which distinguish α_1 from α_2 falls off in the sequence $S1$, $S4$ and $S6$. A likely explanation is that even here there is some random element of structure, either within a single intercalate layer or in the intercalate layer stacking sequence.

G. S. PARRY
D. E. NIXON

Department of Chemical Engineering and
Chemical Technology,
Imperial College,
London.

Received October 30, 1967.

[1] Nixon, D. E., and Parry, G. S., *Brit. J. Appl. Phys.* (in the press).
[2] Moore, A. W., Ubbelohde, A. R., and Young, D. A. *Proc. Roy. Soc.*, A, **280**, 153 (1964).
[3] Herold, A., *Bull. Soc. Chim.*, 999 (1955).
[4] Nixon, D. E., Parry, G. S., and Ubbelohde, A. R., *Proc. Roy. Soc.*, A, **291**, 324 (1966).

THE SOLID STATE

Cleavage of Zinc Single Crystals induced by Stress Waves

WE report some observations of the dynamic cleavage of specially oriented single crystals of zinc by the reflected stress wave technique. Kolsky[1] has used this technique for studying the brittle fracture of glass and polymeric solids.

Zinc crystals[2] with a diameter of about 8 mm, a length of about 60 mm and with their potential cleavage plane (0001) perpendicular to the rod axis, were loaded with the stress wave produced by hitting a transmitter bar with a flat-faced projectile, as shown in Fig. 1. Fractures were produced by the tensile wave reflected from the interface between the zinc and styrofoam. This procedure eliminates the problems involved in gripping the specimen and reduces the problem of specimen alignment. For this crystal orientation, the shear stress on the primary slip plane (0001) $\langle 11\bar{2}0\rangle$ is nominally zero. Earlier static tests[3–6] on zinc crystals have indicated that the stress required for twinning or for slip on secondary slip systems is comparable with the cleavage fracture stress.

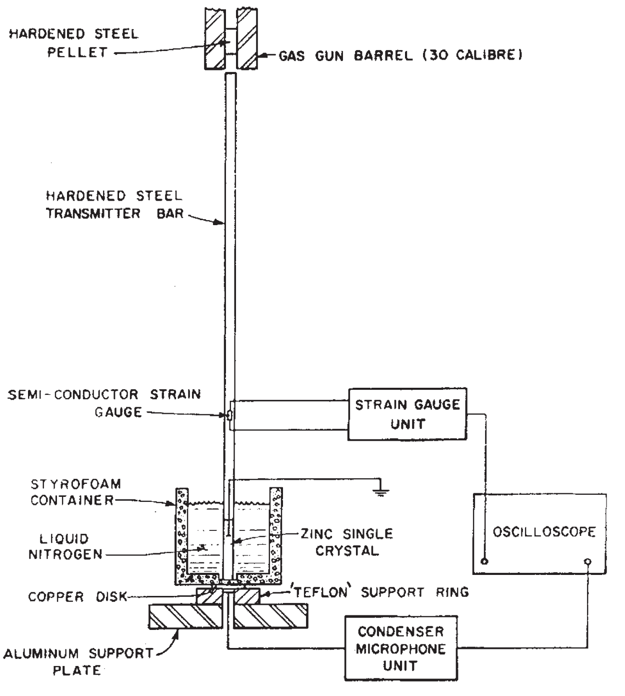

Fig. 1. Schematic diagram of testing arrangement.

The peak value of the stress wave transmitted to the zinc single crystal can be computed as the difference between the peak values of the incident and reflected waves in the transmitter bar. Cleavage was consistently observed for transmitted stress pulses with an amplitude greater than 16×10^8 dynes/cm^2 and a duration of 10 μsec. Determination of the actual stress at fracture is difficult because the pulse is attenuated as it propagates in the zinc crystal as a result of plastic deformation and because it is not clear whether fracture has occurred at the peak value of the pulse or at some lower value. An attempt to allow for these factors was made by using a condenser microphone[7] to obtain a record of the displacement of the zinc–styrofoam interface. Further work will be necessary before reliable values of the fracture stress can be given.

The cleavage surfaces were examined optically and with various X-ray diffraction techniques. The dynamically fractured surfaces seemed to be optically more specular than any which could be produced by cleaving crystals with a razor blade at liquid nitrogen temperature. The general indication from Laue back-reflexion photographs, Schultz pictures and Berg-Barrett X-ray diffraction contrast micrographs is that the dynamically fractured crystals exhibit cleavage surfaces which are appreciably less deformed than the surfaces of crystals cleaved with razors. An unfractured crystal which was repeatedly loaded became so deformed, however, that the Bragg condition was no longer obeyed over local areas greater than about 100μ in diameter.

The conclusion is that the technique is useful for studying cleavage fracture, at least in zinc crystals, in conditions for which the pre-fracture plastic flow is minimized.

This work was supported by the Army Research Office (Durham), the US National Science Foundation and the Advanced Research Projects Agency of the Department of Defense.

L. R. OLIVER

Dayco Corporation,
Springfield, Missouri.

R. W. ARMSTRONG
R. J. CLIFTON
H. KOLSKY

Brown University,
Providence, Rhode Island.

Received October 30, 1967.

[1] Kolsky, H., in *Fracture*, 281 (Technology Press, Boston, 1959).
[2] Oliver, L. R., thesis, Brown Univ. (1967).
[3] Bell, R. L., and Cahn, R. L., *Proc. Roy. Soc.*, A, **239**, 494 (1957).
[4] Gilman, J. J., *Trans. Amer. Inst. Min. (Metall.) Eng.*, **212**, 783 (1958).
[5] Stofel, E. J., and Wood, D. S., in *Fracture of Solids*, 521 (Interscience, New York, 1963).
[6] Bullen, F. P., *Trans. Amer. Inst. Min. (Metall.) Eng.*, **227**, 1069 (1963).
[7] Bodner, S. R., and Clifton, R. J., *J. Appl. Mech.*, **34**, 91 (1967).

MOLECULAR STRUCTURE

Role of Van der Waals Interaction on Hindered Rotation about Single Bonds in Simple Molecules

THE hindrance of rotation about single bonds has recently attracted considerable interest[1–3] because it greatly influences the physical and chemical properties of many organic molecules. The importance of rotations about single bonds in synthetic and biological macromolecules has also been emphasized and successful attempts have been made to derive the most stable conformations of linear macromolecules considering this effect[4–10].