Bull. Amer. Phys. Soc., 15, 1606 (1970)

BF 5. Mathematical Description of Dynamic Deformation Twinning in Shock-Wave Compression;* J. N. JOHNSON, Sandia Laboratories.--Previous physical descriptions of rate-dependent material behavior at the high strain rates achieved in plate-impact experiments have been based on dislocation mechanics. There does, however, exist the possibility that deformation twinning can also contribute to the plastic strain; twinning has been observed at low peak stresses in shock-loaded Ferrovac E iron.[1] An analytical description of deformation twinning is proposed in which the plastic shear strain γ depends on the twinning shear k and the volume fraction of twins α according to the equation $\gamma = k\alpha$. The time variation of α is obtained from various models describing the growth of twin lamellae. The mathematical description of twin growth is analogous to dislocation multiplication in the more conventional microscopic interpretations of plastic flow and is shown to adequately represent the experimental data on shock-loaded iron.

*Work supported by the U. S. Atomic Energy Commission.

[1]R. W. Rohde and J. N. Johnson, To Be Published, Proceedings of the Second International Conference on the Strength of Metals and Alloys, Pacific Grove, Calif. 1970.

BF 6. Solution of Precursor Attenuation in Single Crystals.* W. HERRMANN, Sandia Labs.-- Complete solutions of the entire flow field resulting from flat plate impact have been obtained by several numerical methods for the viscoplastic equation governing wave propagation in face-centered cubic single crystals. These solutions included variable moduli taken from third-order elasticity theory. Results have been compared to experimental data on precursor attenuation in copper single crystals.[1] In the absence of dislocation multiplication, precursor attenuation is predicted to be three orders of magnitude lower than that observed, as noted previously, and the wave profiles are qualitatively incorrect. When dislocation multiplication is included, the calculations show a sharp precursor spike which could not have been resolved by the instrumentation. However, the minimum stress and wave speeds agree with experiment. The results cast doubt on the use of linearized precursor analysis in the investigation of stress relaxation by dislocation motion.

*This work supported by the U.S. Atomic Energy Comm.
[1]O.E. Jones and J.D. Mote, J. Appl. Phys. 40,4920 (1969)

BF 7. Compound Damage Accumulation Criteria for Spallation,* LEE W. DAVISON and A.L. STEVENS, Sandia Laboratories. --Spall damage may range in level from the fracture of a few grains to complete separation of the body into disjoint parts. Spall criteria are simply formal methods of predicting whether or not some specified level of damage will be produced during a given loading event. Existing cumulative damage criteria for spallation are functionals of the local values of either the stress or strain histories at a point in a material continuum, and are so constructed that when constant fields are imposed, the rate of damage accumulation is also constant. In this report the existing class of cumulative damage criteria is generalized to provide quantitative measures of material damage incurred during a loading event, and to accommodate the possibility that the rate at which damage is accumulated may depend on the amount of damage already present as well as local values of the histories of the continuum field variables. Several conditions that must be met in order for a compound damage accumulation functional to yield plausible damage predictions are considered, and a specific example is discussed.

*Work supported by the U. S. Atomic Energy Commission.

BF 8. Observations of Secondary Slip in Shock Loaded Aluminum Single Crystals.* A.L. STEVENS and L.E. POPE, Sandia Laboratories.--High-purity single-crystal aluminum discs were shock loaded along the (100), (110), and (111) crystallographic directions to study the spall characteristics of the material. Impact stresses in the range of 11 to 18 kilobars produced slip traces on the surface of the impacted discs which indicate that a secondary slip system was activated, in addition to the primary {111} <110> system that is usually activated quasistatically.[1] Crystallographic analysis, including the calculation of the ratio of resolved shear stresses to the Peierl's (threshold) stresses for the candidate slip systems, and metallurgical techniques have been used to identify the active secondary slip system.

[1]J. P. Hirth and J. Lothe, Theory of Dislocations, McGraw-Hill, New York, p. 256 (1968).

*Work supported by the U. S. Atomic Energy Commission.

†Submitted by Lee W. Davison.

BF 9. Effect of Point Defects on Precursor Decay in LiF.* J. R. ASAY, GEORGE E. DUVALL and G. RICHARD FOWLES, Washington State Univ.--Data are presented for shock propagation along a <100> direction in single crystal LiF. Experiments were made for an impact stress of about 27 kbars and for sample thicknesses ranging from 0.25 mm to 15 mm. Mechanical properties were varied by doping the crystals with divalent impurities and through irradiation with gamma rays from a Co-60 source. For the range of point defects studied here, the yield stress obtained at low strain-rates varied monotonically with concentration from about 0.02 kbars for soft material to 1 kbar for the harder crystals. Elastic precursor decay curves obtained for corresponding materials did not exhibit the monotonic change in that a minimum in the decay rate was observed for crystals with intermediate hardness. It was also found that pre-annealing affects the mechanical properties differently for the two ranges of strain-rate employed. A comparison of these data suggests that elastic precursor decay in LiF is governed by a dislocation multiplication process.

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BF 10. Effects of Radial Release Waves in Plate-Impact Experiments.* O. E. JONES and A. L. STEVENS, Sandia Laboratories.--Experimental results from plate-impact studies and from sudden thermal loading of rods show that the amount of spall damage resulting from radially converging release waves decreases with decreasing ratio of thickness to diameter of the sample. In the use of re-