

Fig. 1-(a) Orientation and grain designation; (b) orientation dependence of deformation behavior of individual grains in polycrystalline zinc.

The results of surface observations are summarized in Table I. In general, up to >12 kbars, deformation is restricted to glide on a single set of slip planes and is generally concentrated near the grain boundaries; this is in general agreement with the work of Davidson *et al.*³ This set of slip planes has been identified as the (0002).

As the pressure increases, basal-plane slip becomes more pronounced, and the nucleation of a large number of twins is also observed. These have been identified as $\{10\overline{1}2\}$ by two-surface trace analyses and the twin-matrix relationships confirmed by analysis of back-reflection Laue X-ray pictures of regions embracing a twin and matrix. In addition, the deformation becomes more inhomogeneous with the formation of bend planes and in one case a pronounced kink band. Evidence of recrystallization is also noted in the neighborhood of some of the grain boundaries. These effects are illustrated in Figs. 2 through 6. Fig. 2 shows grain C_1 of sample Zn-15 before being subjected to the hydrostatic pressure treatment. Minor amounts of basal-plane slip are seen, as well as a small twinned region. After subjecting the sample to

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Fig. 2—Grain C_1 sample Zn-15 before pressurization. Polarized light; X48. Reduced approximately 35 pct for reproduction.



Fig. 3—Grain C_1 sample Zn-15 after exposure to 26.91 kbars hydrostatic pressure. Polarized light; X48. Reduced approximately 43 pct for reproduction.

a pressure of approximately 27 kbars, various types of deformation are encountered, Fig. 3. One notes four sets of $\{1012\}$ twins, large amounts of basalplane slip showing some curvature, and shaded regions illustrative of bend-plane formation. One may also note that the grain boundary on the left in Fig. 3 has changed somewhat from that shown in Fig. 2. This will be discussed below. Figs. 4 and 5 show grain E_2 of sample Zn-15 after exposure to a hydrostatic pressure of approximately 12 kbars and after being exposed to 27 kbars, respectively. It will be noted that the intensity of basal-plane slip has increased markedly with increasing pressure and that a sharp bend plane (denoted by a discontinuous change in contrast) has formed near the left center of the grain. In addition, other less intense bend planes have formed. A grain boundary to the right of Fig. 5 has become much coarser and on examination at higher magnification, Fig. 6 appears to be made up of small grains. Other grain boundaries in this sample have similar appearance after being exposed to 27-kbar pressure.

Brinson and Hargreaves¹⁴ have also noted recrystallization in zinc at room temperature beneath hardness indentations.

The degree of misorientation across various bend planes was determined by a back-reflection Laue technique in which the beam was made to encompass the two misoriented grain portions. The misorientation was found to range from 1 to 2.5 deg in the small number of bend planes investigated. The misorientation across the sharp bend plane in Fig. 5, for instance, was 2.5 deg. The axis around which the bend took place could not be determined precisely but made an angle of between 20 and 30 deg with the basal plane. The axis of rotation that would be deduced from the usual models of bend-plane formation in zinc would be the $\langle 10\bar{1}0 \rangle$ direction. The mechanism of bend-plane formation thus appears to be more complicated when there are unusual stress conditions.

Nonbasal-plane slip was observed relatively frequently after exposure to the higher pressures. The traces, usually seen only on one surface, are consistent with $\{11\overline{2}2\}$ slip. The appearance of these traces,

Sample no. Zn-11 Faint basal-plane slip lines in A_1^1 and A_2^1 7.89 523 525 A Faint basal-plane slip lines in A_1^1 and A_2^1 11.86 282 564 A Faint basal-plane slip lines in A_1^1 and A_2^1 11.86 282 564 A Ittle change from observations at lower pressure 23.69 358 1390 A Very pronounced basal slip lines in A_2^1 and A_2^1 23.69 358 1390 A Very pronounced basal slip lines in A_2^1 and A_3^1 9.87 235 658 A Very pronounced slip markings in E_1^1 9.87 235 658 A Pronounced slip markings in E_1^1 with nucleation in E_2^1 9.87 235 658 A Pronounced slip markings in E_1^1 with nucleation in E_2^1 24.78 263 - A Very pronounced basal-plane slip traces in A_1^1 and A_2^1 24.78 263 - A Very pronounced basal-plane slip traces in A_1^1 and A_2^1 24.78 263 - A Pronounced basal-plane slip traces in A_1^1 and A_2^1 24.78 263 - A Prono	Pressure, kbar	Rate of Pressure Increase, bars per min	Rate of Pressure Decrease, bars per min	Grain	Observations
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23.69 358 1390 A Very pronounced basal slip lines; growth of existing 1012/1 twin Nucleation of new twins near grain boundary C More pronounced basal slip lines in C ₁ and C ₂ ; nucleation of large [102] twin in C ₂ D ² Pronounced slip markings E ⁺ Pronounced slip markings P E ⁺ 9.87 235 658 A B Faint basal-plane slip traces in A ₁ and A ₂ C B Paint basal-plane slip traces in A ₁ and A ₂ C B Paint basal-plane slip traces in A ₁ and A ₂ C D Paint basal-plane slip traces in A ₁ and A ₂ D Faint basal-plane slip traces in A ₁ and A ₂ D Faint basal-plane slip traces in A ₁ and A ₂ D Faint basal-plane slip traces in A ₁ and A ₂ D Faint basal-plane slip traces in A ₁ and A ₂ D Pronounced basal-plane slip traces in A ₁ and A ₂ D Pronounced basal-plane slip traces in A ₁ and A ₂ D Pronounced basal-plane slip traces in A ₁ and A ₂ D Pronounced basal-plane slip traces in A ₁ and A ₂ D Pronou	11.86	282	564	A B C D [*] E*	More pronounced basal slip lines in A_1 and A_2 Little change from observations at lower pressure Little change from observations at lower pressure Pronounced slip markings More pronounced slip markings in E_1
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11.86 348 592 A Fairly pronounced basal-plane slip in A1 and A2 B Fairly pronounced basal-plane slip in B1 and B2 C Small amount of basal slip lines in C1 and C2 D Faint basal-plane slip traces in D1 and D2 Faint basal-plane slip traces in E1 and E2 near grain boundary 26.91 532 666 A Extensive amount of basal-plane slip; large amount of twinning and bend-plane formation; presence of nonbasal slip in A2; probably {1122} B Large amount of basal-plane slip in B1 and B2; large kink formation accompanied by necking; rotations of the order of 15 deg involved C Pronounced basal slip traces in C1; less pronounced band-plane activity D Very pronounced basal-plane slip lines in D1 and D2; small amount of 2; large amount of 1012! twinning and very pronounced band-plane activity				ample no. 7n-15	
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