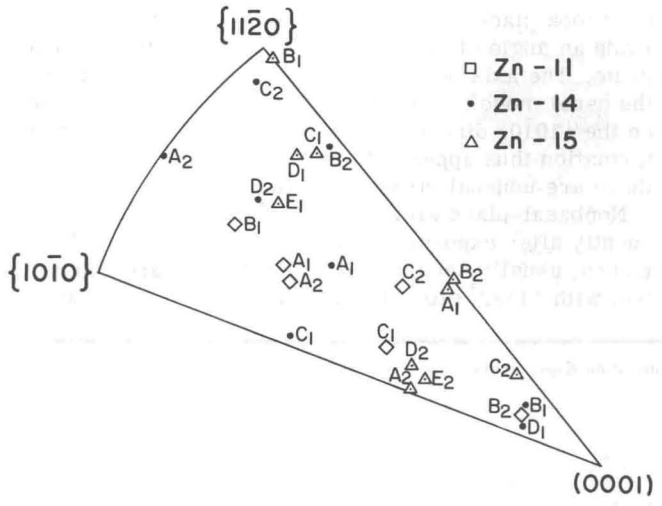
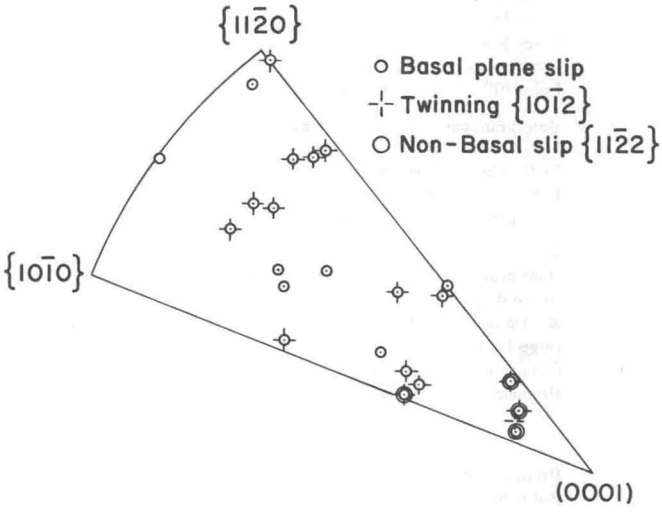


(*a*)



(*b*)

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

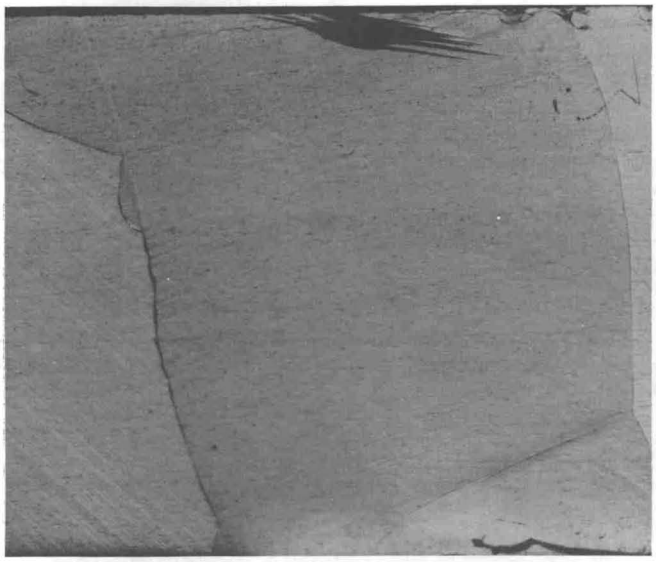


Fig. 2—Grain C_1 sample Zn-15 before pressurization. Polarized light; X48. Reduced approximately 35 pct for reproduction.

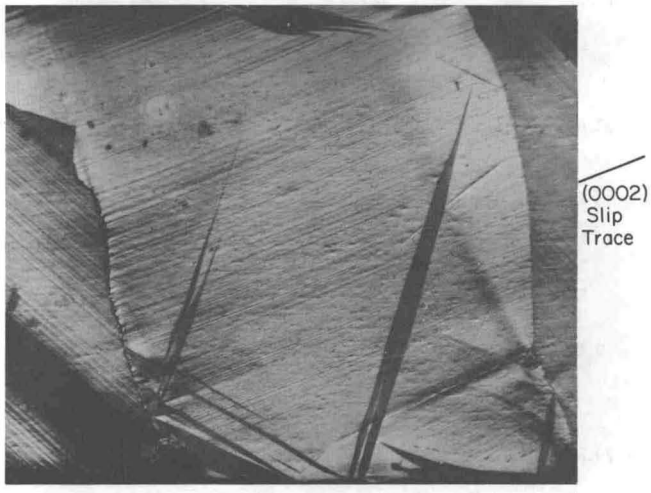


Fig. 3—Grain C_1 sample Zn-15 after exposure to 26.91 kbars hydrostatic pressure. Polarized light; X48. Reduced approximately 43 pct for reproduction.

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 $\{10\bar{1}2\}$ 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 a pressure of approximately 27 kbars, various types of deformation are encountered, Fig. 3. One notes four sets of $\{10\bar{1}2\}$ twins, large amounts of basal-plane 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 Hargreaves[14] 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 $\{11\bar{2}2\}$ slip. The appearance of these traces,

Table I. Summary of Pressurization Experiments

Pressure, kbar	Rate of Pressure Increase, bars per min	Rate of Pressure Decrease, bars per min	Grain	Observations
			Sample no. Zn-11	
7.89	523	525	A	Faint basal-plane slip lines in $A_1^\dagger$ and A_2
			B	Faint basal-plane slip lines in B_1
			C	Faint basal-plane slip lines in C_2, more pronounced in C_1
			D_2^*	Pronounced slip markings
			E^*	Faint slip lines in E_1, none in E_2
11.86	282	564	A	More pronounced basal slip lines in A_1 and A_2
			B	Little change from observations at lower pressure
			C	Little change from observations at lower pressure
			D_2^*	Pronounced slip markings
			E^*	More pronounced slip markings in E_1
23.69	358	1390	A	Very pronounced basal slip lines
			B	More pronounced basal slip lines; growth of existing $\{10\bar{1}2\}$ twin Nucleation of new twins near grain boundary
			C	More pronounced basal slip lines in C_1 and C_2; nucleation of large $\{10\bar{1}2\}$ twin in C_2
			D_2^*	Pronounced slip markings
			E^*	Pronounced slip markings in E_1; twin nucleation in E_2
			Sample no. Zn-14	
9.87	235	658	A	Pronounced basal slip traces in A_1 and A_2
			B	Faint basal-plane slip traces in B_1; bend-plane activity in B_1
			C	Basal-plane slip traces in C_1 and C_2
			D	Faint basal-plane slip traces in D_1, none in D_2
24.78	263	–	A	Very pronounced basal-plane slip traces in A_1 and A_2
			B	Pronounced basal-plane slip in B_1 and B_2; large amount of $\{10\bar{1}2\}$ twinning in B_1; nonbasal slip traces in B_1, probably $\{11\bar{2}2\}$
			C	More pronounced basal-plane slip in C_1 and C_2; nucleation of $\{10\bar{1}2\}$ twin in C_1; growth of existing twin in C_2
			D	Pronounced basal-plane slip lines in D_1 and D_2; bend-plane activity in D_1; evidence of duplex slip consistent with $\{11\bar{2}2\}$
			Sample no. Zn-15	
11.86	348	592	A	Fairly pronounced basal-plane slip in A_1 and A_2
			B	Fairly pronounced basal-plane slip in B_1 and B_2
			C	Small amount of basal slip lines in C_1 and C_2
			D	Faint basal-plane slip traces in D_1 and D_2
			E	Faint basal-plane slip traces in E_1 and E_2 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 A_2, probably $\{11\bar{2}2\}$
			B	Large amount of basal-plane slip in B_1 and B_2; large kink formation accompanied by necking; rotations of the order of 15 deg involved
			C	Pronounced basal slip traces in C_1, less pronounced in C_2; large amount of $\{10\bar{1}2\}$ twinning and very pronounced bend-plane activity
			D	Very pronounced basal-plane slip lines in D_1 and D_2; small amount of $\{10\bar{1}2\}$ twinning in D_1 and D_2; bend-plane formation in D_1 and D_2
			E	Very pronounced basal slip traces in both E_1 and E_2; extensive bend-plane activity and $\{10\bar{1}2\}$ twin formation

*Orientation of grain not determined.
†Subscripts denote surfaces observed.