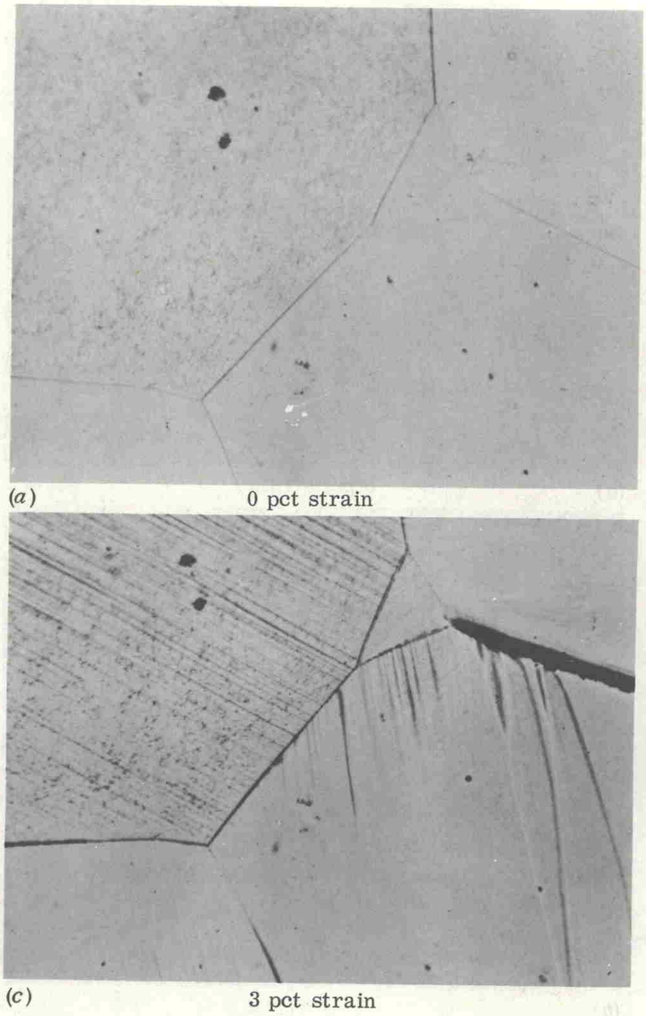


Fig. 9—Bismuth deformed in uniaxial compression showing slip in early and twinning in later stages. X100. Enlarged approximately 5 pct for reproduction.

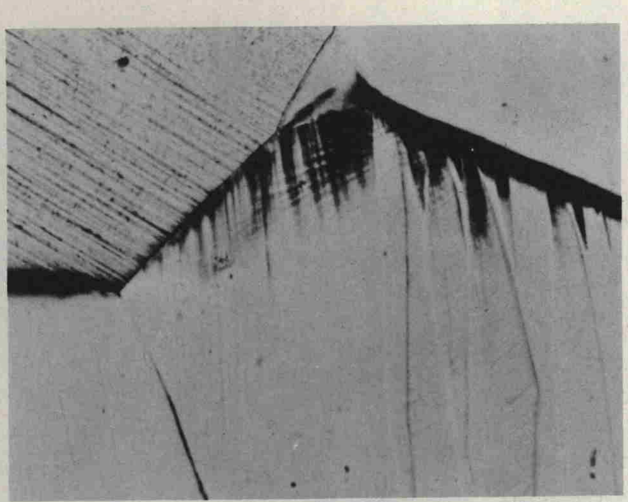
For pressures above 10,000 atm, proportionate amounts of a pentane-iso-pentane mixture was added.

RESULTS AND DISCUSSION

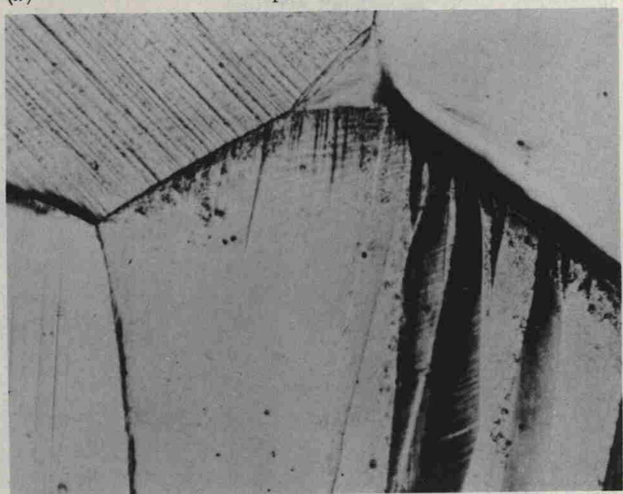
Using the experimental procedure and apparatus described, Figs. 2 through 7 are representative of the type and magnitude of the plastic deformation found in many polycrystalline bismuth samples subjected to pressures of up to 20,000 atm. The single crystals tested simultaneously with all polycrystalline samples exhibited no signs of plastic deformation. Even in such an anisotropic material as bismuth, the deformation in a single crystal under hydrostatic compression should be completely elastic in nature. Finding no permanent deformation in the single crystals, then, substantiates that there were no extraneous nonhydrostatic force components introduced to the polycrystalline samples during pressurization. The plastic deformation shown then must result from the localized shear stresses induced by the hydrostatic compression of a polycrystalline material exhibiting a high degree of anisotropy in its elastic properties.

The pressure-induced plastic deformation is initially highly localized, occurring first between those grains having a relative crystallographic orientation resulting in the highest induced shear stress which, when resolved, exceeds the yield stress of the grain, or grains concerned. In samples with 6-10 grains intersecting the polished surface, deformation is readily detectable in isolated areas at pressures as low as 5000 atm as shown in Figs. 2 through 6. Although not shown, very slight deformation was noted between grains in isolated cases at pressures as low as 2000 atm. As the pressure level is increased, the deformation increases in intensity and randomness throughout the entire sample. The widespread nature and randomness of this deformation, particularly at the higher pressure levels, can readily be seen in Fig. 7 which is representative of the smaller grained as-extruded structure.

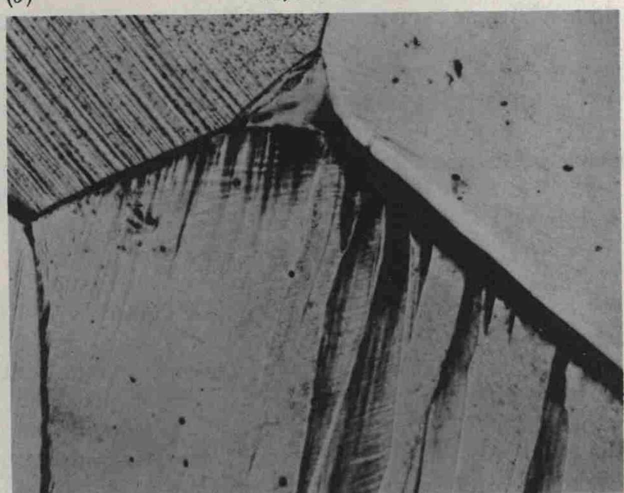
The observed plastic deformation was of two characteristic types. The first type, shown in various degrees in Figs. 2 through 7, is concentrated along the grain boundaries. As the pressure is increased, this area of highly concentrated deforma-



(*a*) 0 pct strain

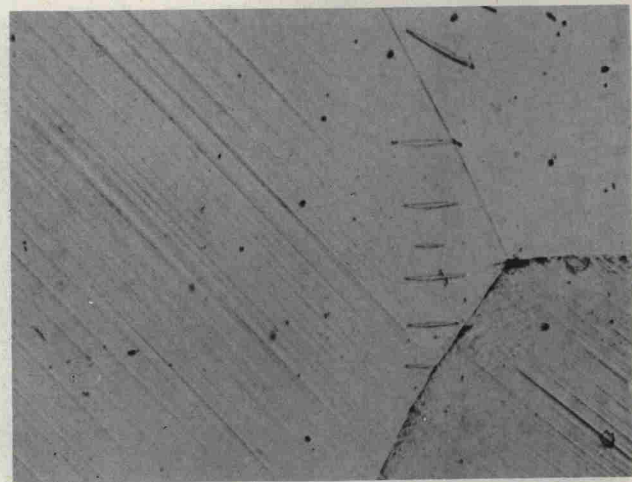


(*b*) 15,000 atm

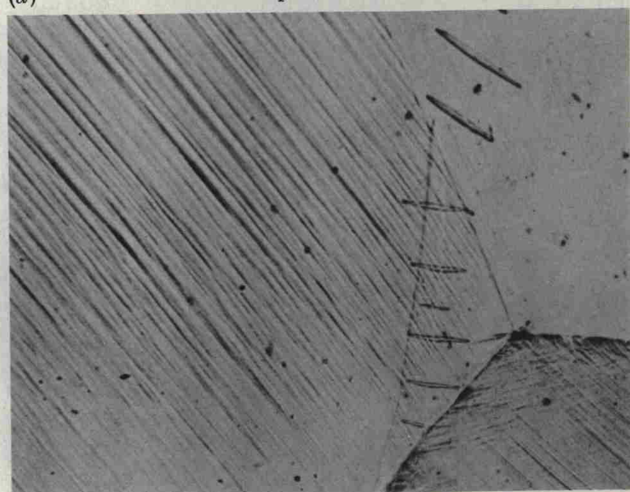


(*c*) 20,000 atm

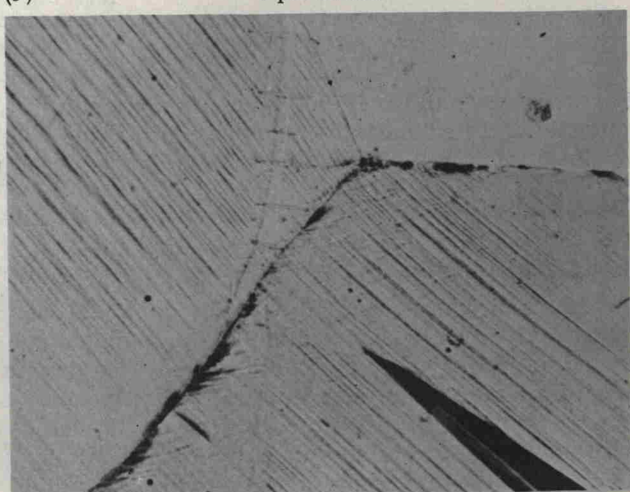
Fig. 10—Extreme pressure induced deformation superimposed on bismuth previously deformed 5 pct in uniaxial compression. X100. Enlarged approximately 5 pct for reproduction.



(*a*) 0 pct strain



(*b*) 3 pct strain



(*c*) 5 pct strain

Fig. 11—Uniaxial compression of specimen previously subjected to 20,000 atm pressure. X100. Enlarged approximately 6 pct for reproduction.

tion expands towards the center of the grain in a readily visible series of steps corresponding to the various pressure test levels. This deformation occurs only on one side of the boundary or the other.

Although it is difficult to ascertain precisely what mechanism, or mechanisms, are involved in this type of plastic deformation, close observation yields some indications. As clearly shown in Figs. 2 and 3, the slip lines of the grain, in which only