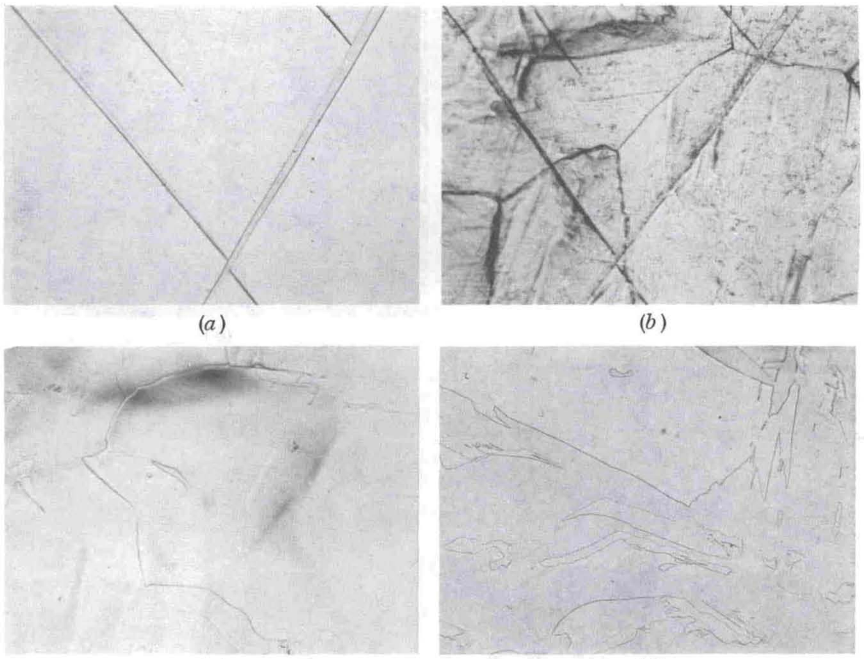
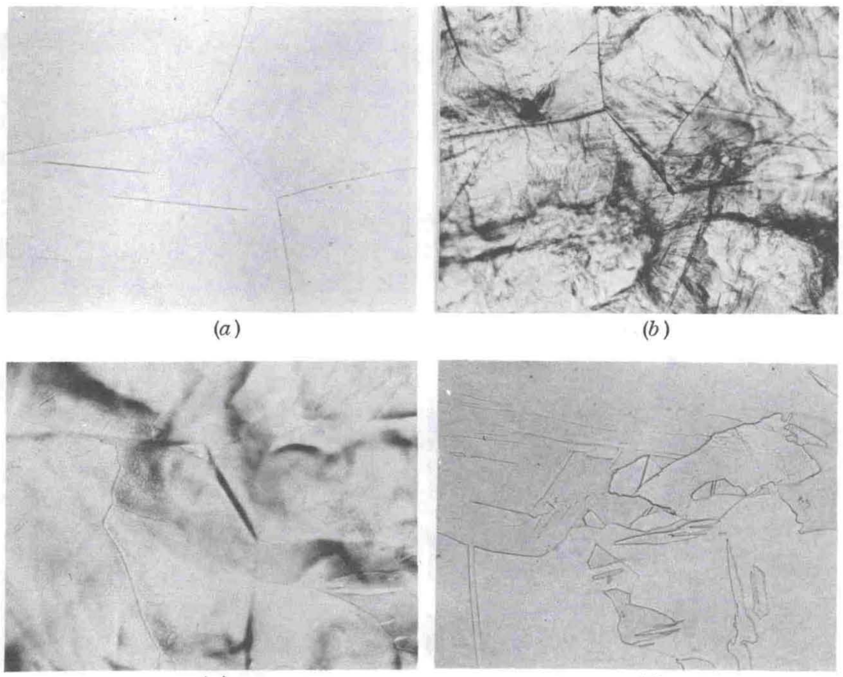


(a) (b) (c) (d)

Fig. 5—Structural changes in bismuth single crystal after I-II transition. (a) Original structure; (b) after transition; (c) intermediate repolish; (d) final structure. X100. Reduced approximately 42 pct for reproduction.

Figs. 7 and 8. In these figures, the original structure (a) represents the metallographically prepared surface prior to pressurization. The structure after transition (b) shows the same region as the original area immediately after removing the sample from the pressure cell but without further metallographic preparation. One can readily see the "ghost" image of the original structure, *i.e.*, original Phase I grain boundaries and twin bands, along with an image of the structure in the Phase II or Phase II and III regions. Considering Figs. 5 and 6, one can readily see pronounced grain boundaries depicting the polycrystalline nature of Phase II, along with substantial surface distortion due to volume change. When the sample passes through both the I-II and II-III transitions, as shown in Figs. 7 and 8, the structure is much more diffuse since two volume changes occurred. It is still possible, however, to see an image of the original structure as well as some grain boundaries probably associated with Phase II bismuth.

That the structure observed directly after transition is actually a "ghost" image depicting the history of the sample is demonstrated by its removal



(a) (b) (c) (d)

Fig. 6—Structural changes in polycrystalline bismuth after I-II transition. (a) Original structure; (b) after transition; (c) intermediate repolish; (d) final structure. X100. Reduced approximately 42 pct for reproduction.

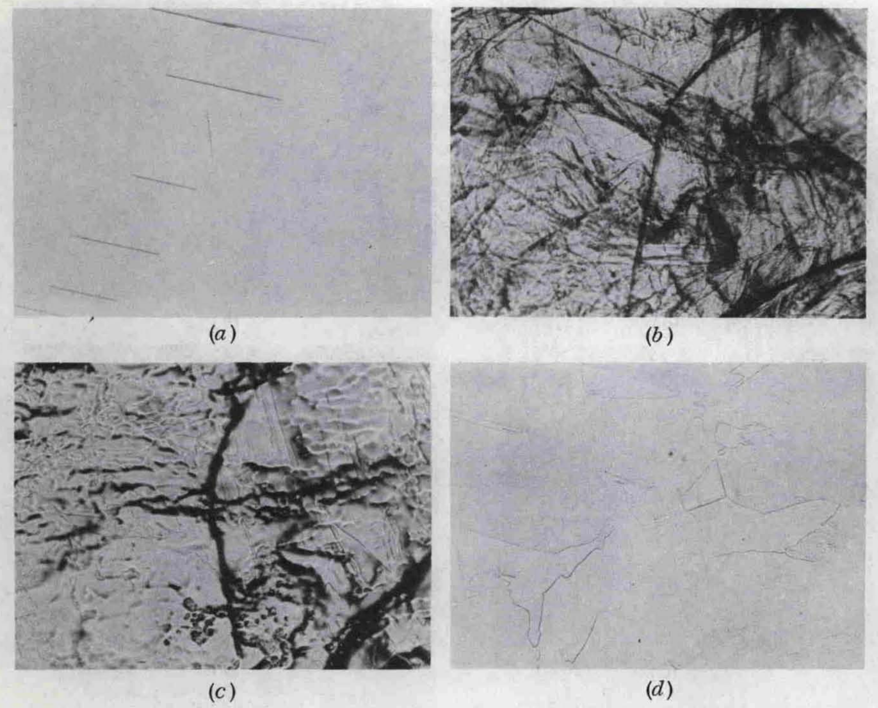


Fig. 7—Structural changes in single-crystal bismuth after I-II-III transitions. (*a*) Original structure; (*b*) after transition; (*c*) intermediate repolish; (*d*) final structure. X100. Reduced approximately 42 pct for reproduction.

by slight repolishing as shown in (*c*) of the subject figures where the gradual disappearance of the original Phase I and superimposed Phase II boundaries is evident.

As can be noted, the final or residual structure, after complete repolishing, is polycrystalline in nature and is the same whether the sample was originally single or polycrystalline or passed through the I-II or I-II and II-III transitions. It is characterized by some twinned regions, as is commonly encountered in this material, and many apparently isolated grains completely surrounded by a larger grain or matrix region.

An interesting characteristic of the polycrystalline structure resulting from cycling through the transitions is its drastically enhanced grain boundary migrations. It was observed that, regardless of the initial structure or whether it passed through the I-II or II-III transition, this residual polycrystalline structure becomes single crystalline, based on an optical observation of the polished surface, after annealing at 160°C for 3 hr. Furthermore, at 120°C for 3 hr, the residual structure consisted of only two to three grains intersecting the polished surface. As a matter of comparison, the as-extruded material, which had a grain size comparable

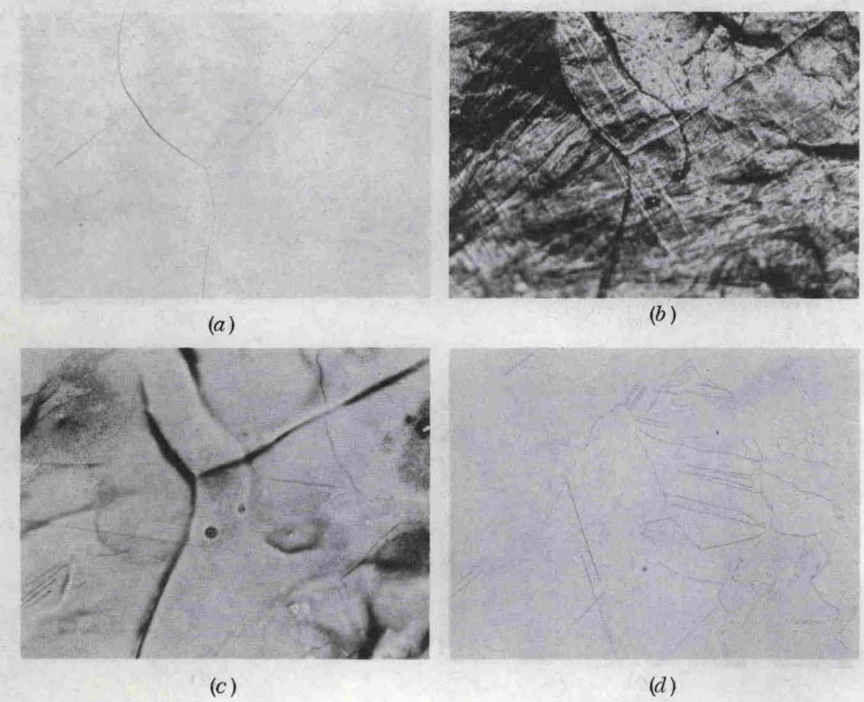


Fig. 8—Structural changes in polycrystalline bismuth after I-II-III transitions. (*a*) Original structure; (*b*) after transition; (*c*) intermediate repolish; (*d*) final structure. X100. Reduced approximately 42 pct for reproduction.