

tively overruns these unfavorable regions, resulting in isolated regions surrounded by material of the same orientation as the untransformed region.

The specimen would undoubtedly revert completely back to a single crystal if given enough time during the transition period or at elevated temperatures where diffusion would be enhanced.

Which of the above phenomena is the more important cannot be ascertained from available evidence. It is likely that the final structure is a manifestation of the combined effects of both mechanisms.

When the specimen completely transforms, as shown in Figs. 5 through 8, Phase I nucleates and grows from Phase II in many initially independent regions. However, as was previously discussed, it is felt that the high anisotropy of the linear compressibility again enhances the growth of some grains during the decrease of pressure, while retarding the growth of others to such an extent that some unfavorably oriented areas are effectively overrun and surrounded.

Partial I-II transformation in annealed and as-extruded polycrystalline structures is shown in Figs. 10(a) and 10(b), respectively. As can be noted, the original Phase I grain boundaries, including those along which severe anisotropy-induced deformation has occurred, do not appear to be preferential sites for Phase II nucleation. Although in photomicrograph (a) of this figure transformation appears to be associated with a Phase I boundary in one area, in another region it is independent. This lack of any significant dependency of the I-II transformation on Phase I boundaries is more clearly shown in (b) which bears out the insensitivity of the transition pressures and rate to initial structure. The formation of Phase III from II is even further removed from the original Phase I structure; thus one would not expect to encounter any structural sensitivity.

CONCLUSIONS

1) The bismuth I-II and II-III transition pressure and transformation rate are structure-insensitive with respect to the presence of grain boundaries and associated localized plastic deformation.

2) The I-II and II-III transitions are completely isobaric for increasing hydrostatic pressures. The III-II also occurs isobarically but, at very slow pressurization rates, there is a tendency for the final stages of the II-I transition to extend over a narrow range of 200 to 300 atm.

3) Even under very slow pressurization rates consisting of 100-atm increments with 5-min stabilization periods, there is a measurable hysteresis in both the I-II and II-III transitions amounting to an

average of 0.71 and 0.55 k-atm, respectively. The magnitude of the hysteresis in the transitions increases with increasing pressurization rates.

4) The final structure is the same regardless of initial structure or whether the specimen had passed through the I-II or the I-II and II-III transitions. This residual structure is polycrystalline and contains many small isolated grains. This structure will become single crystalline as a result of a low-temperature short-time anneal that has little effect on unpressurized polycrystalline material. This enhancement of boundary migration is attributed, in part, to the release of stored elastic strain energy resulting from the anisotropy of the linear compressibility.

5) The formation of Phase II, which is polycrystalline, from Phase I occurs independently of any original grain boundaries. In the case of partial transformation, the orientation of Phase I formed from Phase II upon decreasing pressure is effectively the same as the original Phase I in the untransformed regions.

6) Under equilibrium, or near equilibrium, pressurization, there is a substantial waiting period at pressure before initiation of transformation. Under these conditions, the actual transitions will require up to several minutes for completion in a manner indicating a nucleation and growth-type transformation mechanism. Under faster pressurization rates, the transformation may be completed in as little as a few seconds.

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