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COMMENT

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Dislocation Arrangements in Deformed Single Crystal Molybdenum*

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At The Franklin Institute Laboratories attention has been focussed on the direct observation of dislocation configurations produced by the deformation of single crystals of molybdenum of controlled orientation. The high-purity single crystals (~99.995%) were grown by the electron beam floating zone technique, and thin foils were prepared from the bulk single crystal tensile specimen. Specimen orientations were such that the $(\bar{1}01)$ $[111]$ slip system was subjected to the highest resolved shear stress. In most cases the crystals were sliced and thinned parallel to the $(\bar{1}01)$ slip plane. Crystals were deformed in tension at room temperature to strains of 1.5%, 3.6%, and 7.0% respectively, and at $-196°C$ to strains up to ~3%. The room temperature deformation behavior may be summarized thus:

(1) Dislocation density in the as-grown crystal is low. Sub-boundaries and three-fold nodes are evident in isolated regions.

(2) In the early stages of deformation (up to ~4% strain), dislocations of predominantly screw character are frequently observed. (Figs. 1 and 2) Many of the screw dislocations have cusp-shaped segments along the length. At this level of strain, the early stages of dislocation tangling are apparent.

(3) Dislocation loops of varying size are visible both in dislocation free areas and in close proximity to the long screw dislocations.

(4) At 7% strain, dense tangles of dislocations are observed, and the initial stages of cell wall formation are apparent. (Fig. 3)

(5) In certain areas, isolated grains or clusters of grains ~$1/2\mu$ dia. are observed embedded in the single crystal matrix. The completely isolated nature of these grains provides a very clear picture of the role of the grain boundary, both as a source and as an obstacle for dislocations. The origin of these grains is believed to be related to the minor variations in the temperature gradient

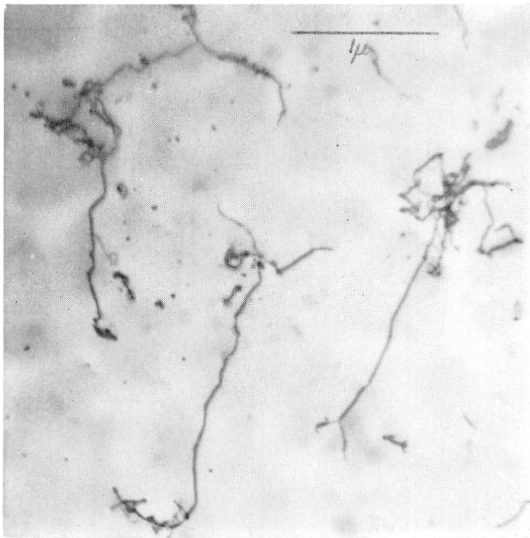

Fig. 1. Molybdenum deformed 1.5% at room temperature.

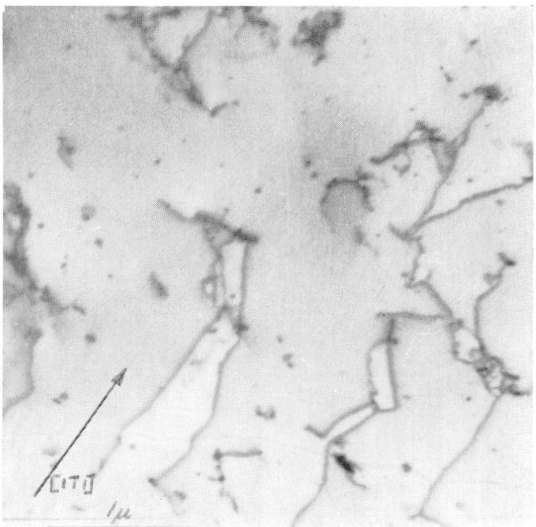

Fig. 2. Molybdenum deformed 3.6% at room temperature. Plane of foil is (011) with $[1\bar{1}1]$ the active Burgers vector.

* Presented by H. G. F. Wilsdorf.

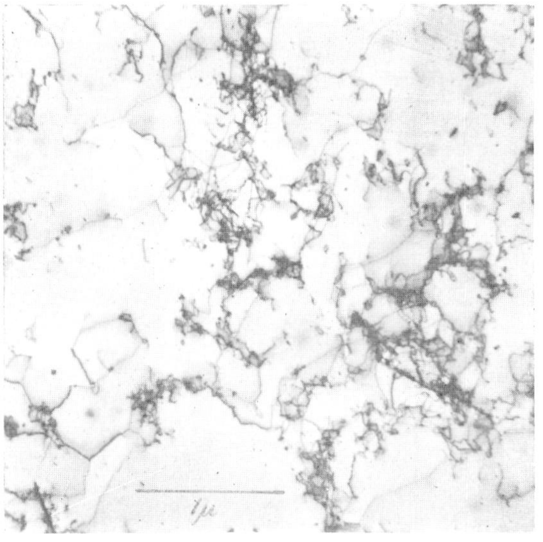

Fig. 3. Molybdenum deformed 7.0% at room temperature.

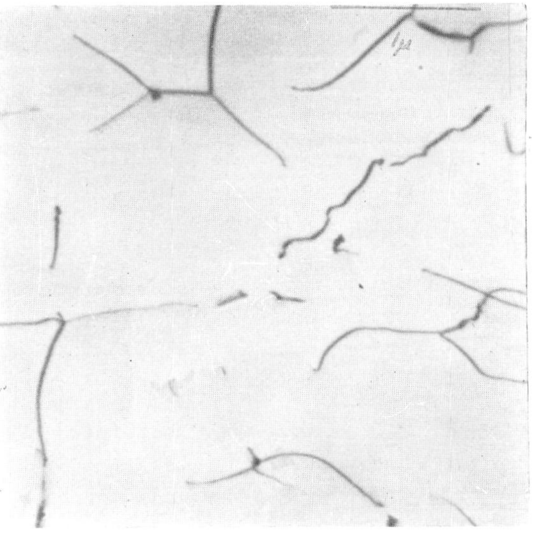

Fig. 4. Molybdenum deformed 1% at $-196°C$.

existing along the crystal during growth.

In previous papers the theory has been developed that tangled dislocation structures of the type observed (Fig. 1-3) are due to the interactions between dislocations and point defets in a composite phenomenon called "mushrooming".[1] Mushrooming is thermally activated and must cease at low tempera tures, as had already been observed in the case of aluminum.[2] In order to confirm this prediction the dislocation structure of molybdenum single crystals deformed at $-196°C$ have also been examined. Initial observations are in full agreement with the predictions as shown in Fig. 4, for a material strained $\sim 1\%$. The dislocations are smoother in appearance and are generally straight over large distances.

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