polycrystalline industrial-grade metals is determined to a significant degree by the kinetics of changes in dislocation structure.

LITERATURE CITED


ELECTRON MICROSCOPE STUDY OF THE DISLOCATION STRUCTURE OF MOLYBDENUM SINGLE CRYSTALS IN FATIGUE

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An explanation of the dislocation mechanism of fatigue in single crystals using the method of transmission electron microscopy is presented in works in which copper [1, et al.], aluminum [2, et al.], and germanium and silicon [3, et al.] were employed. Molybdenum has been studied only in the polycrystalline state [4, 5]. The present work is devoted to a study of molybdenum single crystals produced by electron-beam melting, with load axis orientations as shown in Fig. 1. Fatigue tests in symmetrical tension—compression were conducted at room temperature on unit MUN-1 by the method described in [6]. Loading frequency was 36 Hz. For the investigation, we prepared circular specimens (6-mm diam.) with the area to be observed, 3.5 mm wide, having a fixed orientation along the axis [6]. The working surface of the specimens was electrolytically polished before testing.

Fig. 1. Orientation of tensile axis and slip system in the investigated molybdenum single crystals.

Fig. 2. Traces of dislocation slip in the {110} plane typical of crystals of the first group (a) and in the {212} plane for crystals of the second group, tested at $\sigma_d = 35$ kgf/mm$^2$ for $5 \cdot 10^5$ cycles (b).

Fig. 3. Dislocation structure of a molybdenum crystal in the original condition.

Transmission electron microscopic investigation of failed specimens was conducted on electron microscope UFEMV-100V. The following method of preparing objectives was used. Pieces $3.5 \times 3.5 \times 1$ mm were cut from the surface layer of the working part of the specimen and thinned mechanically to a thickness of 0.12-0.15 mm so that the specimen surface was left undamaged. To prepare foil from the surface layers of the specimen material, one side (surface) was protected with an acid-resistant polyethylene film. Thinning to a thickness of 5-10 $\mu$m was done in a reagent containing 7 parts methanol and 1 part sulfuric acid at a voltage of 10 V and a current of 0.4 A.

In the tests, we studied the slip lines visible on the plane areas within the confines of the surface section areas. The time of appearance of traces of slip depends on the load amplitude. It was established that in the {110} plane of crystals of the first group there appears a system of parallel, straight slip traces (Fig. 2a). In the perpendicular plane {112}, the slip traces have the form of short hatchings. Slip in these crystals occurs by the system (101) [111] with a Schmid factor $S = 0.377$ (see Fig. 1).