LETTERS TO THE EDITORS

Effect of Room-Temperature Recovery on Dislocation Structure in Deformed Aluminum

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Many electron-microscope studies have been carried out on the behavior of dislocations in metals. In those experiments, foil specimens used were cut out of bulky ones which were preliminarily treated under a prescribed condition. During the thinning process of the specimens, however, dislocations have a tendency to escape out of the specimens⁽¹⁾. Therefore, the density and distribution of the dislocations are strongly affected

deformation structure may be affected by room-temperature recovery. Since the specimens are held at room temperature after deformation for the preparation of foil specimen, the effect of room-temperature recovery on the deformation structure in the bulk specimens must be clarified as well as the thickness effect.

In the present experiment, the recovery effect was investigated on foil specimens of aluminum single

Photo. 1 Movement of dislocations during the room-temperature recovery. Micrographs (a) and (b) were taken immediately after and 2 days after deformation, respectively. White arrows show a fixed position, and black arrows show dislocation segments left behind along slip traces.

by the foil thickness, and thus there is a critical thickness even for measurements of the dislocation density as already reported⁽²⁾⁽³⁾.

In addition to the thickness effect, when the homologous temperature of metals is considerably high at room temperature as in the case of aluminum, their

Photo. 2 The effect of room-temperature recovery on cell structure. Micrographs (a) and (b) were taken immediately after and 2 days after deformation, respectively. Foil thickness is roughly constant, 2.5μ , all over the observed area.

crystals (99.99% purity), as shown in Photos. 1 and 2. The specimens were wedge-shaped and directly stretched in the inside of a 500 kV electron microscope with a

(1) For instance, R. K. Ham : *Phil. Mag.*, 7 (1962), 1177.
(2) H. Fujita et al. : *J. Electron Microscopy*, Japan, 14(1965), 307.
(3) K. Kawasaki and H. Fujita : *Proc. 6th Int. Cong. EM*, Kyoto, 1 (1966), 291.

(4) H. Fujita et al. : *Trans. NRIM*, 9 (1967), 54.

stretching device⁽⁴⁾. Here, one of the observed areas was selected at thin parts, Photo. 1, and the other at thick parts, Photo. 2. The local thickness of the foil specimen is indicated in the micrographs. Photos. 1 (a) and 2 (a) were taken immediately after deformation which roughly corresponds in strain to the middle of the third stage of the stress-strain curve. Subsequently, the specimen was kept at room temperature for 2 days after deformation, and Photos. 1 (b) and 2 (b) were taken at the corresponding parts, respectively.

Comparison of micrographs (a) and (b) shows that no remarkable change occurs in dislocation density, or in size and shape of the cell structure during the room-temperature recovery. As for the configuration of dislocations, however, considerable changes are observed after the recovery as follows: (a) All slip traces and most dislocation segments ($\uparrow$) which are left behind along the slip traces disappear, and a ghost contrast around tangling dislocations due to the mutual interaction of dislocations also disappear. (b) Most dislocations are slightly moved, and some of them are partly coagulated as seen at X and Y parts in Photo. 1 (b). This tendency increases with decreasing foil thickness and probably with decreasing dislocation density. (c) Most dislocation lines are sharply kinked, while they are smooth before the recovery as seen in Photo. 1 (a). It may be considered that the dislocations meet with obstacles during their movement and the dislocation

segments between the obstacles become straight due to the line tension of dislocations.

Namely, the critical thickness to get reliable information on the distribution of dislocations is considerably large only because of the recovery effect; for instance, the critical thickness in Photos. 1 and 2 is above 1.5μ . When the foil specimens are cut out of the bulky ones, the distribution of dislocations is affected not only by the room-temperature recovery but also by the foil thickness. Therefore, in order to make a study of the behavior of the dislocations in metals, especially in metals with a low melting point, it is necessary to directly observe the dislocation behavior occurring in thick foils⁽⁵⁾ whose thickness is sufficient to observe the same dislocation behavior as in the bulk specimens. The high voltage electron microscope is effectively used⁽⁵⁾ for this purpose.

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By Hiroshi Fujita* and Hiroshi Yamada**

* Faculty of engineering, Osaka University, Osaka, Japan.

** Metal Physics Division, National Research Institute for Metals, Tokyo, Japan.

(5) H. Fujita: J. Phys. Soc., Japan, 21 (1966), 1605; Proc. 6th Int. Cong. EM, Kyoto, 1 (1966), 289.