Technical University of Denmark

Prediction of dislocation boundary characteristics

Winther, Grethe

Publication date:
2016

Document Version
Peer reviewed version

Prediction of dislocation boundary characteristics

Author: <u>Grethe Winther</u>

Affiliation: Department of Mechanical Engineering, Technical University of Denmark, grwi@mek.dtu.dk

ABSTRACT

Plastic deformation of both fcc and bcc metals of medium to high stacking fault energy is known to result in dislocation patterning in the form of cells and extended planar dislocation boundaries. The latter align with specific crystallographic planes, which depend on the crystallographic orientation of the grain [1]. For selected boundaries it has been experimentally verified that the boundaries consist of fairly regular networks of dislocations, which come from the active slip systems [2]. The networks have been analyzed within the framework of Low-Energy-Dislocation-Structures (LEDS) and it is found that to a large extent the dislocations screen each other's elastic stress fields [3].

The present contribution aims at advancing the previous theoretical analysis of a boundary on a *known* crystallographic plane to actual *prediction* of this plane as well as other boundary characteristics, such as the dislocation content and misorientation. The prediction is based on the expected active slip systems and assumptions of mutual stress screening. In general, networks of dislocations with three linearly independent Burgers vectors fulfilling the criterion of mutual stress screening may form on any plane. Crystal plasticity calculations combined with the hypothesis that these boundaries separate domains with local differences in the slip system activity are introduced to address precise prediction of the experimentally observed boundaries. The presentation will focus on two cases from fcc metals: boundaries aligned with a {111} slip plane and boundaries, which bisect the angle between two slip planes. Finally, the effect of long-range plastic strain gradients is also discussed.

[1] X. Huang, G. Winther, Dislocation structures. Part I. Grain orientation dependence, Phil. Mag., **87**, 5189 (2007)

[2] C. S. Hong, X. Huang, G. Winther, Dislocation content of geometrically necessary boundaries aligned with slip planes in rolled aluminum, Phil. Mag, **93**, 3118 (2013)

[3] G. Winther, C. S. Hong, X. Huang, Low-Energy Dislocation Structure (LEDS) character of dislocation boundaries aligned with slip planes in rolled aluminium, Phil.Mag., **95**, 1471 (2015)