07

Mechanism of Implementation of High Ductility in Ultrafine-Grained Aluminum after Annealing and Subsequent Deformation

© N.V. Skiba[1,2], T.S. Orlova[3], M.Yu. Gutkin[1,2]

[1] Institute for Problems in Mechanical Engineering, Russian Academy of Sciences,
St. Petersburg, Russia
[2] Peter the Great St. Petersburg State Polytechnic University,
St. Petersburg, Russia
[3] Ioffe Institute,
St. Petersburg, Russia

E-mail: nikolay.skiba@gmail.com

Received: July 19, 2020
Revised: July 19, 2020
Accepted for publication: July 19, 2020

A theoretical model that describes the implementation of high ductility in high-pressure torsion (HPT) processed ultrafine-grained aluminum subjected to annealing and additional HPT deformation, is suggested. In the framework of the model, the plastic deformation is realized through the successive emission of lattice dislocations from triple junctions of grain boundaries due to splitting of head dislocations in pile-ups of grain boundary dislocations, which are pressed by an external shear stress against these triple junctions, and their subsequent glide in grain interior and climb along surrounding grain boundaries. The energy characteristics and the critical stresses of dislocation emission have been determined for ultrafine-grained aluminum subjected to annealing with small additional HPT deformation. The theoretical stress–strain curves demonstrate good agreement with experimental data available in the literature.

Keywords: lattice dislocations, grain boundaries, ductility, annealing, high pressure torsion.