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Atomistic simulations of initial yield mechanism in ultrafine-grained metals

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Abstract

Ultrafine-grained metals (UFGMs) produced by warm- or cold-rolling under severe plastic deformation have attracted interest as high-strength structural materials. UFGMs with a grain size less than 1□m exhibits remarkable material and mechanical properties, and a computational model predicting these properties is desired in the field of materials science and engineering. To reveal the fundamental yield process of UFGMs, huge-scale atomistic simulations of the aluminum polycrystalline thin film containing the Frank-Read source are performed to elucidate the relationship between the inter- and intragranular plastic deformation processes and the mechanical properties of ultrafine-grained metals. Two-types of polycrystalline models, which consist of several grain boundaries reproducing easy and hard slip transfer, respectively, are prepared to investigate the effect of grain boundary on flow stress. While the first plastic deformation occurs by the dislocation bow-out motion within the grain region for both models, the subsequent plastic deformation is strongly influenced by the resistance of the slip transfer by dislocation transmission through grain boundaries. The influence of the competition between the intragranular dislocation nucleation and intergranular slip transfer on the material strength is considered. The nanostructured material's strength depending on local defect structures associated with grain size and dislocation source length is assessed quantitatively.

Biography

Tomohito Tsuru has completed his PhD in 2007 from the Department of Mechanical Science and Engineering, Osaka University. He is currently the research associate of Japan Atomic Energy Agency and a visiting scholar at University of California, Berkeley. He has published more than 40 papers in reputed journals and has been serving as an editorial board member of The Japan Society of Mechanical Engineers.