Microstructure evolution in nanotwinned copper under mechanical deformation

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Metals with high density of nanotwins have attracted considerable interest over the past years attributed to their remarkable mechanical properties including high strength and good ductility. Recent study shows that the mechanical properties arise from the interplay between lattice dislocations and twin boundaries, including coherent and incoherent twin boundaries. Twin boundaries with {111} and {112} planes in face centered cubic structured metals are often designated as coherent and incoherent twin boundaries, respectively. The structure and energy of the twin boundaries have been extensively studied in both experiments and simulations. Coherent twin boundaries, serving as strong barriers to dislocation movement and as dislocation emission sources, play a significant role in strengthening and maintaining the ductility. Meanwhile, incoherent twin boundaries are important to the detwinning mechanism and mechanical behavior of nanotwinned materials. This presentation will focus on deformation behaviors of these boundaries and the interaction between twin boundaries and grain boundaries during fatigue deformation. Twin-assisted grain boundary migration was observed, which is carried out by partial dislocations in the incoherent twin boundaries reacting with grain boundaries. Additionally, the responses of twin lamellae to the propagation of fatigue cracks are illustrated and explained in details. The precession electron diffraction was employed to analyze quantitatively grain orientation and boundaries in nanometer-scale, in order to determine the microstructure evolution under mechanical deformation. The effects of these deformation behaviors on mechanical properties of the material are also addressed.

References:

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