Radiation Response of Nanotwinned Cu and the Stability of Stacking Fault Tetrahedron Under Shear

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Abstract: Multiple collision cascades (MCC) of nanotwinned (nt) Cu with three different twin spacings are performed to model the response of nt Cu upon a radiation dose of 1 displacement per atom (dpa). The microstructural evolutions during the radiation process shows that the main radiation defect in Cu is stacking fault tetrahedron (SFT). Smaller size of defect clusters and lower defect density are seen in the nt Cu with smaller twin spacing. Besides, the potential formation and elimination mechanisms of SF are found to be due to the climb of Frank partial dislocation and glide of Shockley partial dislocations. Furthermore, we present mechanism studies of the SFT in twin boundary (CTB) bicrystal copper under shear. It is found that CTB bicrystal and single crystal embedded with a larger size of SFT have a smaller critical stress at their incipient plasticity. Dislocation motion begins with the dissociation of two stair-rod dislocations on the SFT basal plane while the CTB migration direction with respect to SFT, resulting in the atomic diffusions, determines the final configuration of SFT. The continuous migrations of CTB towards and away SFT respectively lead to the collapse and flip over of SFT. This work may be helpful in revealing mechanical properties of irradiated metals.

Keywords: Stacking fault tetrahedron; twin boundary; dislocation; atomic diffusion; radiation