Revealing the Maximum Strength in Nanotwinned Copper

The strength of polycrystalline materials increases with decreasing grain size. Below a critical size, smaller grains might lead to softening, as suggested by atomistic simulations. The strongest size should arise at a transition in deformation mechanism from lattice dislocation activities to grain boundary-related processes. We investigated the maximum strength of nanotwinned copper samples with different twin thicknesses. We found that the strength increases with decreasing twin thickness, reaching a maximum at 15 nanometers, followed by a softening at smaller values that is accompanied by enhanced strain hardening and tensile ductility. The strongest twin thickness originates from a transition in the yielding mechanism from the slip transfer across twin boundaries to the activity of preexisting easy dislocation sources.