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Plasticity in ultra fine polycrystalline materials

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ABSTRACT

Technological applications of materials and devices with nanoscale and microscale features commonly involve metals and alloys in their polycrystalline form. Plastic deformation in crystalline materials is carried by the nucleation and propagation of dislocations and the intricate structures they form. Grain boundaries interact strongly with dislocations and affect the mechanical properties; this is particularly important in samples with micro or sub-micron characteristic grain size when phenomena like grain sliding, grain boundary diffusion and migration as well as the interaction of dislocations with grain boundaries play a prominent role.

We will present a theory that describes the interaction of dislocations with grain boundaries through a set of continuum field equations. The resulting theory and simulations model explicitly the interaction of dislocations with grain boundaries and its effect on the macroscopic response of polycrystalline materials. These simulations show the fundamental mechanisms behind grain size dependency.