How materials deform when dislocation activity is suppressed

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Dislocations are the primary drivers of plasticity in polycrystalline materials and they can drive microstructural evolution during mechanical deformation. When dislocation nucleation and propagation are suppressed, a material either becomes brittle or other mechanisms need to be activated to accommodate plastic strain and deformation. In this talk, I will first discuss our discovery of amorphous shear bands in crystalline intermetallics. These shear bands accommodate plastic strain in the absence of dislocations, they do not require pre-existing damage, and they can be nucleated in pristine crystalline grains. Such shear bands can be utilized to increase toughness of nominally brittle materials. I will also present our study on the role of dislocations in stress-induced microstructural evolution of nanocrystalline metals. I will discuss how dislocation suppression by dopants or by pre-existing twins can be beneficial to microstructural evolution of nanocrystalline metals and to their wear resistance.