Anomalous slip in BCC metals

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Crystal strength and plastic flow are controlled by the motion and interaction of dislocations, the line defects carrying atomic shear increments. While, in most crystals, deformation develops in the crystallographic planes where the glide force acting on dislocations is maximum, plasticity in body-centred cubic (BCC) metals is more complex. Slip systems where the resolved shear stress is not the highest can dominate at low temperature, leading to anomalous slip [1, 2]. Using in situ tensile tests in a transmission electron microscope we show that anomalous slip arises from the high mobility of multi-junctions, i.e. junctions between more than two dislocations, which glide at a velocity several orders of magnitude larger than single dislocations. These multi-junctions result from the interaction of a simple binary junction with a gliding dislocation. Although elasticity theory predicts that these binary junctions should be unstable in crystals with a weak elastic anisotropy like tungsten, both experiments and atomistic simulations reveal that such junctions can be created under dynamic conditions, in agreement with the existence of anomalous slip in almost all BCC metals, including tungsten.

Keywords: dislocations, anomalous slip, niobium, tungsten.

References:

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