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On the effective mobility of BCC dislocations in 2D-Discrete Dislocation Plasticity

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Two-dimensional discrete dislocation plasticity (2D-DDP) has shown to be a powerful tool for studying micro-plasticity problems such as fatigue crack growth, fracture of bimaterial inter- faces, delamination of thin films, size effects in single crystals etc. Though widely applied, the existing 2D-DDP framework is limited to FCC crystals and needs to be extended before it can be used to study micro-plasticity in BCC materials. One of the key challenges in extending the method to BCC materials is that, contrary to FCC, the mobilities of edge and screw dislocations in BCC crystals differ vastly from each other, with the screw segments being much slower. As a result, the motion of screw segments governs the rate of plastic deformation and hence, accounts for many of the features of the low-temperature plasticity in BCC crystals. However, in 2D-DDP, only edge dislocations exist. Thus, a method is required to map the edge and screw mobilities in a dislocation loop into an effective mobility to be used in 2D. Here we consider three analytical methods to calculate the effective mobility of a 2D dislocation, and determine the best one by comparison of 2D-DDP predictions of the rate sensitivity in polycrystalline iron with experimental results [1]. We find that the best effective mobility in 2D is controlled by the in-plane shear strain rate averaged around the loop in 3D.

REFERENCES

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