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SIMULATING THE BRITTLE-DUCTILE TRANSITION USING DISCRETE DISLOCATION PLASTICITY

Edmund Tarleton[1], Daniel S. Balint[2]

[1] Department of Materials, University of Oxford, Parks Road, Oxford, OX1 3PH, UK,
edmund.tarleton@materials.ox.ac.uk
[2] Department of Mechanical Engineering, Imperial College London, London, SW7 2AZ, UK,
d.balint@imperial.ac.uk

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At a given strain rate, metals fracture at low temperatures in a brittle manner characterised by little or no plasticity. As the temperature is raised dislocation nucleation and motion occurs in the highly stressed region surrounding the crack-tip and the material exhibits a more ductile fracture behaviour. The dislocations generate a back stress on the crack-tip which acts to shield the crack causing an increase in the fracture toughness. The temperature at which this brittle-ductile transition occurs increases with increasing strain rate. We have studied the relation between applied deformation, governed by the applied loading rate, and dislocation plasticity and crack tip shielding, where the time scale is determined by Frank-Read source nucleation time and dislocation drag coefficient. Micro-cantilever bending was simulated in plane strain with a discrete dislocation plasticity (DDP) model utilising cohesive elements to model the crack propagation. The micro-cantilever DDP simulations will be presented and compared to corresponding experiments to investigate rate and size effects in the brittle-ductile transition.