

Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Vacancy Assisted Climb in Continuum Dislocation Dynamics

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Cornell University — Using a mesoscale continuum theory of dislocation dynamics, we study the physical effects of vacancy assisted climb. New physics emerges at high temperatures where dislocations are also able to move in the climb direction due to the absorption and emission of vacancies. We investigate this high temperature behavior using our minimal continuum dislocation dynamics model, which produces fractal cell structures in 2 and 3 dimensions. By coupling the dislocation density to a vacancy field we are able to study the effects of vacancies on diffusion-limited dislocation motion. We calibrate our model using measurements of climb velocities for straight, parallel dislocations and check the limit of no climb by freezing out vacancy motion. We use our model to explore applications of vacancy assisted climb, including dislocation creep and absorption of dislocations at grain boundaries.

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Date submitted: 11 Nov 2011

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