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Simulation studies of ductile yield at finite temperature ROBIN SELINGER, Catholic University, MATTHEW DAVIDSON, Catholic University, JULIE KAUFMAN, Montgomery Blair High School — At finite temperature, a ductile crack under even a small applied load can emit dislocations via thermal activation, but the relevant activation energy and its dependence on the stress state of the crack tip are not well understood. We investigate this process via a simulation study of crack-tip plasticity using an idealized model in two dimensions based on the XY rotor model. A subcritical shear load and prescribed temperature are applied to a sample containing a single crack which emits screw dislocations; these glide across the sample and annihilate on the opposite free surface. The activation energy is determined from an Arrhenius plot of the resulting strain rate vs temperature. We find that the activation energy is highly sensitive to the stress state of the crack tip and doubles when the stress intensity factor is reduced by 20%. We also find super-Arrhenius behavior at high temperature and identify its onset with activation of a secondary dislocation source away from the crack tip. These results, if replicated in three dimensional simulations, provide useful insight for construction of mesoscale models of ductile yield at finite temperature.

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