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Continuum Dislocation Dynamics Modeling in Two Dimensions

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Continuum Dislocation Dynamics (CDD) is a promising method for a physically motivated, continuum description of crystal plasticity on microscopic scales [1]. By utilizing a higher order dislocation density tensor and considering the action of the density of statistically stored dislocations in addition to the geometrically necessary density, CDD is able to replicate complex features of the dislocation microsctructure. The CDD method has previously been shown to accurately replicate the results of both classical dislocation theory and Discrete Dislocation Dynamics in the idealized one dimensional case [2]. In order to be a useful tool for the modeling of plasticity in real structures however, extensions to more complicated two and three dimensional systems must be realized.

Recent work on dislocation ensembles has predicted additional stress terms acting on the dislocation density for the idealized two dimensional case due to the correlation between dislocations on length scales of the order of the mean dislocation spacing. In order to test the validity of these stress components for CDD, we have attempted to recreate the dislocation correlation function, examining the relaxed density in the vicinity of a single, stationary dislocation. In addition, the stress field calculated here can be used to determine the equilibrium configuration of dislocations in a number of different systems, including dislocation configurations in a narrow 2D channel and in the vicinity of an impenetrable inclusion. We present here the results of our two dimensional continuum model and compare it to results from DDD for these sample systems.

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