

# Homogenisation of a Row of Dislocation Dipoles from Discrete Dislocation Dynamics

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Permanent deformations of crystalline materials are known to be carried out by a large number of atomistic line defects, i.e. dislocations, and a good understanding of the collective behavior of dislocation systems can boost the discovery of high-end materials. Conventional discrete-to-continuum approaches, however, have seen their limitation in fulfilling this task. The reason is that dislocation dipoles, which play an important role in determining the mechanical properties of crystals, often get smeared out when traditional homogenisation methods are applied. To address such difficulties, the collective behaviour of a row of dislocation dipoles is studied by using matched asymptotic techniques. The discrete-to-continuum transition is facilitated by introducing two field variables respectively describing the dislocation pair density potential and the dislocation pair width. It is found that the dislocation pair width evolves much faster than the pair density. Such hierarchy in evolution time scales enables us to describe the dislocation dynamics at the coarse-grained level by an evolution equation for the slowly varying variable (the pair density) coupled with an equilibrium equation for the fast varying variable (the pair width). The time-scale separation method adopted here paves a way for properly incorporating dipole-like (zero net Burgers vector but non-vanishing) dislocation structures, known as the statistically stored dislocations (SSDs) into macroscopic models of crystal plasticity in three dimensions.