Kinetic Relations for Dislocations and Twins from Somewhat Continuous to Rather Discrete Models

Phoebus Rosakis
Department of (Applied) Mathematics
University of Crete, Greece

I will describe past work of mine and coworkers B. Sharma, A. Vainchtein, V. Nosenko and G. Morfill, that tries to model the kinetic relation for a dislocation, which means the relation between remotely applied shear stress and the speed of a moving dislocation. A good motivation for this difficult problem, apart from its own sake, is that it has a bearing on the the kinetics of twin boundaries in a way I will describe in a simple setting. Since the dislocation is an inherently discrete object, it is necessary to take crystalline discreteness into account to some extent at least. I will describe a few models that do this in various degrees, as well as their shortcomings and predictions. These are an augmented dynamic Peierls model, and the dynamic Frenkel-Kontorowa, Ishioka and Celli-Flytzanis models. One remarkable byproduct of this is the unanimous debunking, by all the models considered, of the old but persistent myth that dislocations cannot move supersonically. This is the unfortunate legacy of a fully continuum (specificaly linear elastic) model of dislocations.

In order to drive the final nail into the coffin of that myth I will show the first movies ever made from actual experiments (not simulations) showing dislocatios moving faster than shear waves in some rather special crystals.