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Structural phase transformations and dislocations within the Landau theory ROMAN GRÖGER, TURAB LOOKMAN, AVADH SAXENA, Los Alamos National Laboratory — We propose a two-dimensional model (Gröger et al., PRB78:184101, 2008) that demonstrates how the Landau theory of first order phase transitions can be coupled with plasticity. It is based on Kröner's continuum theory of dislocations that views each dislocation as a source of incompatibility between the components of the elastic strain tensor. This incompatibility then couples to the order parameter that is a local representation of the space group of the crystalline lattice. The order parameter field is obtained by minimizing the free energy and this provides both the stress fields and the Peach-Koehler forces on individual dislocations. The evolution of the dislocation density is then obtained by a Fokker-Planck equation. Updating the dislocation density results in a new estimate of the distribution of strain incompatibilities and this serves as an input to the subsequent minimization of the free energy. This self-consistent procedure thus allows for a simultaneous evolution of the order parameter texture and the density of dislocations. To develop a clear link between the microscopic and mesoscopic dislocation density, the crystal dislocations in individual discrete slip systems are restricted to glide in their well-defined slip planes. Upon cooling, the finite dislocation density gives rise to heterogeneous nucleation of the martensite and thus results in a shift of the transformation temperature.

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