A Splitting Scheme for Solving Reaction-Diffusion Equations Modeling Dislocation Dynamics in Materiasl Subjected to Cyclic Loading

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Strain localization and dislocation pattern formation are typical features of plastic deformation in metals and alloys. Glide and climb dislocation motion along with accompanying production/annihilation processes of dislocations lead to the occurrence of of instabilities of initially uniform dislocation distributions. These instabilities result into the development of various types of dislocation microstructures, such as dislocation cells, slip and kink bands, persistent slip bands, labyrinth structures, etc., depending on the externally applied loading and the intrinsic lattice constraints. The Walgraef-Aifantis (WA) model is an example of a reaction-diffusion model of coupled nonlinear equations which describe microstructure formation of forest (immobile) and gliding (mobile) dislocation densities in the presence of cyclic loading. This paper briefly discusses two versions of the WA model and focus on a finite differences, second order in time Cranck-Nicholson semi-implicit scheme, with internal iterations at each time step, for solving the model evolution equations in two dimensions.

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