Eulerian rates of elastic incompatibilities in finite crystal elastoplasticity

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Abstract

The measures of rates of elastic incompatibilities developed in (Rubin and Bardella, 2024, "Eulerian rates of elastic incompatibilities applied to size-dependent hardening in finite torsion", J. Mech. Phys. Solids 193, 105905) are adopted to study the incompatibility in crystals undergoing finite deformations within an Eulerian framework for anisotropic elastoplastic materials. Such framework relies on the evolution of microstructural vectors. It is emphasized that the rates of incompatibilities depend on the constitutive equation for the rate of plasticity. For small strains and rotations, such rates are equal to the negative of the components of the rate of Nye-Kroner's dislocation density tensor. The application to the finite-deformation bending of a single crystal allows isolating and discussing the contributions to incompatibility of pure densities of geometrically necessary dislocations and of the deformation of the crystal lattice. These contributions can be used to enhance the hardening with a size-dependent term that can increase or decrease during loading history, modeling the generation and annihilation of defects.

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