2D dislocations modelled by interior discontinuities in a Discontinuous Galerkin method

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Abstract

Dislocation interactions with domain boundaries and material interfaces strongly govern the inelastic behaviour of micro/nano scale systems. A recently developed 2D dislocation model, Gracie et al. (2007) and Belytschko and Gracie (2007), is presented which is applicable to both isotropic and anisotropic materials, linear and nonlinear elastic materials and arbitrary material interfaces. The model is an application of the extended finite element method of Moës et al. (1999). The interior discontinuities, either sharp (Volterra) or smooth (Peierls-Nabarro), are introduced through an enrichment of the classical finite element approximation space.

We present a reformulation of our previous method in a Discontinuous Galerkin (DG) framework for the specific case of linear elastic isotropic materials. The stiffness matrix of the resulting discrete equations is independent of the number and location of the dislocations, so in dynamic simulations it need only be triangularized once. The DG formulation will be shown to yield more accurate results than the original method. The calculation of the Peach-Koehler force is described and shown to not directly depend on the number of dislocations in the domain. Finally, several examples will be presented to illustrate the applicability of this new method.

References:

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