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XFEM MODELING AND MULTISCALE ANALYSIS OF MAGNETOACTIVE COMPOSITES

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ABSTRACT

In this contribution we present two- and three-dimensional updated Lagrangian XFEM formulations with linear and quadratic shape functions for modeling weak discontinuities in mechanical, magnetic and weakly coupled magneto-mechanical boundary value problems.

For properly resolving the location of curved interfaces and the discontinuous physical behavior, methods for the level set representation of curved interfaces and numerical integration of the weak form in higher-order XFEM formulations are developed. In order to reduce the complexity of the representation of curved interfaces, an element local approach is proposed which allows for an automated computation of the level set values and also improves the compatibility between the level set representation and the integration subdomains. Integration rules for polygons and strain smoothing are applied in conjunction with quadratic elements and compared to curved integration subdomains. The methods are outlined for the two-dimensional case in [1]. They are suitable for application in image-based (CT-based) analysis of heterogeneous media and have recently been generalized to three-dimensional problems.

Eventually, the developed methods are utilized to predict the effective material behavior of a magnetorheological elastomer consisting of a polymeric matrix with embedded magnetizable particles in the framework of a staggered multiscale analysis. In order to account for large deformations of the elastomer, the XFEM procedures are applied in an updated Lagrangian frame work. The scale transition process is based on the energy equivalence condition which is satisfied by using periodic boundary conditions. The homogenization scheme in the context of small strains is presented in [2] and currently generalized to finite deformations. Results for the effective mechanical, magnetic and coupled behavior are presented in terms of macroscopic stress-strain and magnetization curves as well as effective actuation stresses and magnetostrictive effects.

REFERENCES

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