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THREE-DIMENSIONAL MODELING AND FINITE ELEMENT SIMULATION OF MAGNETORHEOLOGICAL ELASTOMERS

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Magnetorheological elastomers (MREs) are a class of active composites which consist of a polymer matrix with embedded micron-sized magnetizable particles. Due to strongly magneto-mechanical interactions of the individual constituents on the microstructure, MREs are able to alter their effective behavior if subjected to an external magnetic field.
In this contribution, we present a microscopically motivated modeling approach [1, 2]. Starting from the properties of the magnetizable particles and the elastomer matrix, a magneto-mechanical continuum formulation is applied. The governing equations of this strongly coupled field problem are solved by a nonlinear finite element formulation [2]. In order to validate our modeling strategy, we compare our simulations to experimental results of samples with a small number of particles [3]. In these experiments, the relative particle position is measured in dependence of an external magnetic field. Furthermore, basic microstructural interactions in MREs are investigated by the example of simplified chain-like structures with varying geometric arrangement.
By performing computational homogenizations [1] of different random microstructures, the microscopic model is used to predict the macroscopic behavior of MREs numerically. The results of our approach are used to identify parameters of available macroscopic models which allow for an efficient prediction of the effective behavior of realistic MRE samples.

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