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Microstructure charactization of structured magnetorheological elastomers

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Magnetorheological elastomers (MREs) are composite materials consisting of an elastomeric matrix and magnetizable particles. If a magnetic field is applied during curing, the particles form chain-like structures, resulting in a structured MRE. The effective macroscopic behavior of such materials is strongly influenced by this particle arrangement. To characterize it, purely geometric microstructure descriptors can be employed.

This work assesses the ability of different descriptors to characterize microstructures with respect to their effective properties. A given reference microstructure is characterized using several descriptors, including the two-point correlation function [1], its Fourier coefficients, and the H-tensor. Based on these descriptors, alternative microstructures of potentially different size are generated via optimization to match the reference descriptor.

To compare the effective properties of both reference and reconstruction, magneto-mechanical loadings are applied to the microstructures. The resulting boundary value problems are solved with the Finite Element Method and macroscopic quantities are determined with homogenization [2]. Comparing the responses of the reference and reconstructed microstructures enables a systematic assessment of how well each descriptor captures structure-property relationships.

References

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