EFFECTIVE RESPONSE OF CLASSICAL, AUXETIC AND CHIRAL MAGNETOELASTIC MATERIALS

Kostas Danas[1]

[1] LMS, CNRS, Ecole Polytechnique, Palaiseau, France, konstantinos.danas@polytecnique.edu and http://www.kostasdanas.com

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This work provides a rigorous analysis of the effective response, i.e., average magnetization and magnetostriction, of magnetoelastic composites that are subjected to overall magnetic and mechanical loads [1]. It clarifies the differences between a coupled magnetomechanical analysis in which one applies a Eulerian (current) magnetic field and an electroactive one where the Lagrangian (reference) electric field is usually applied. For this, we propose an augmented vector potential variational formulation to carry out numerical periodic homogenization studies of magnetoelastic solids at finite strains and magnetic fields. We show that the developed variational principle can be used for bottom-up design of microstructures with desired magnetomechanical coupling by properly canceling out the macro-geometry and specimen shape effects. To achieve that we properly treat the average Maxwell stresses arising from the medium surrounding the magnetoelastic representative volume element (RVE) while at the same time we impose a uniform average Eulerian--and not Lagrangian--magnetic field. The developed variational principle is then used to study a large number of ideal as well as more realistic two-dimensional microstructures [2]. We study the effect of particle volume fraction, particle distribution and particle shape and orientation upon the effective magnetoelastic response at finite strains. We consider also unstructured isotropic microstructures based on random adsorption algorithms and we carry out a convergence study of the representativity of the proposed unit cells. Finally, three-phase two-dimensional auxetic microstructures are analyzed [3]. The first consists of a periodic distribution of voids and particle chains in a polymer matrix, while the second takes advantage of particle shape and chirality to produce negative and positive swelling by proper change of the chirality and the applied magnetic field.

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