ACE-X2018

12th International Conference on Advanced Computational Engineering and Experimenting
AMSTERDAM (The Netherlands) from 1-5 July, 2018

Modeling of Micro-Heterogeneous Magneto-Electric Composites: An Algorithmic Scale-Bridging Scheme

J. Schröder, M. Labusch

University Duisburg-Essen, Essen, Germany.

Materials which combine two or more ferroic characteristics are known as multiferroics and can exhibit an interaction between electric and magnetic fields. This magneto-electric (ME) coupling can find applications in sensor technology or in electric field-controlled magnetic data storage devices. Since most ME single-phase materials show an interaction between electric polarization and magnetization far below room temperature and therefore outside of a technical relevant temperature range, the manufacturing of composites, consisting of a ferroelectric matrix with magnetostrictive inclusions, becomes important. They generate the ME coupling at room temperature as a result of the interaction of their constituents. We distinguish between the direct and converse ME effect, whereas the direct effect characterizes magnetically induced polarization, where an applied magnetic field yields a deformation of the magneto-active phase which is transferred to the electric phase. On the other hand, the converse effect characterizes electrically activated magnetization. Hence, the ME coupling of composite materials significantly depends on the material behavior of both phases as well as on the morphology of the composite's microstructure. In order to determine the effective properties with respect to both aspects, a finite element based homogenization approach is performed, which combines via a scale bridging the macro- and microscopic level, in which the microscopic morphology is captured by a representative volume element, see e.g. [1,2].

[1] J. Schröder, M. Labusch and M.-A. Keip, Computer Methods in Applied Mechanics and Engineering, 302, 253-280 (2016).

[2] M. Labusch, M. Etier, D.C. Lupascu, J. Schröder and M.-A. Keip, Computational Mechanics, 54, 71-83 (2014).