学术报告 Seminar

北京大学力学与工程科学学院
School of Mechanics and Engineering Science

Product properties of magnetic-electrical composites: an FE² algorithmic scale-bridging scheme

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报告摘要 Abstract

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 two-phase 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. Furthermore, 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 this contribution we discuss the modeling of micro-heterogeneous composites with electrically and magnetically active phases, which exhibit as a product property an effective (macroscopic) magneto-electric coupling. In order to determine the effective properties a homogenization approach, the so-called FE²-method, is performed, which combines via a scale bridging the macro- and microscopic level. In order to predict a realistic coupling behavior we implemented suitable material models on the microscopic level for the individual phases to depict the characteristic hysteresis loops.

报告人简介 Speaker Bio

Jörg Schröder is Professor of Mechanics at the University of Duisburg-Essen and twice served as Vice-Rector for Research. He was President of the International Association of Applied Mathematics and Mechanics (GAMM) from 2020 to 2023 and Vice-President until 2025. He is a member of the Academy of Sciences and Literature Mainz and the German Academy of Science and Engineering (acatech). He served as spokesperson of DFG Research Unit 1509 (“Functional Materials at Multiple Scales”) and led DFG Priority Program 1748 (“Reliable Simulation Techniques in Solid Mechanics”). From 2017 to 2025 he was a member of the DFG Senate and, since 2017, of its Committee for the Investigation of Allegations of Scientific Misconduct. He also served on the Alexander von Humboldt Foundation’s selection committee for research fellowships (2016–2026). Since May 2024, he coordinates a DAAD project with Bethlehem University, TU Darmstadt, and FAU Erlangen–Nürnberg to establish a degree programme in Computer Simulation in Science and Engineering at Bethlehem University. He received the IACM Fellows Award (2022), honorary membership of the Croatian Society of Mechanics, and the European Mechanics Society's Fellow Award (2025).

His research interests lie in computational and continuum mechanics, constitutive modelling, and multiscale methods (FE²), with recent work on electromagnetic-mechanical coupling, statistically similar RVEs, scale transitions in micromagnetics, and generalized continua. He also investigates polyconvexity in hyperelasticity, mixed finite element formulations, phase-field regularization of fiber-reinforced concretes, and phenomenological material models. He has co-authored over 300 papers and 15 books, serves as Editor-in-Chief of the *Archive of Applied Mechanics*, and is on the editorial boards of several international journals.