SEMINAR

Dipartimento di Meccanica Strutturale - Università di Pavia

in collaboration with

Istituto di Matematica Applicata e Tecnologie Informatiche - IMATI (CNR)

Aspect of Computational Magnetomechanics for Nonlinear Multifunctional Materials

Active and multifunctional materials have drawn considerable interest in recent years, as they show great potential for enabling truly novel sensing, actuation, transduction, energy harvesting and biomimetic applications, to be employed, for example, in aerospace, the automotive industry, microelectronics and the biomedical field. In addition to the exploration, synthesis and characterization of new material systems, the accurate modeling and simulation of their constitutive response is of key importance in the endeavor to lead the application development process beyond purely conceptual ideas. We focus here on the modeling of a subclass of such materials exhibiting magneto-mechanical coupling, namely giant magnetostrictives, magnetic shape memory alloys and magneto-active polymers. From a modeling standpoint, great challenges stem from the complex coupled, nonlinear and inelastic nature of the material response. This macroscopic behavior is often driven by microstructural changes, such as phase transformations or twin-boundary and magnetic domain wall motion. On the other hand, strongly-coupled nonlinear boundary value problems must be solved for device analysis. Three particular modeling cases are discussed and illustrated with numerical examples. First, as an extension of classical approaches of computational inelasticity, a return-mapping-based algorithm for *magnetic shape memory* behavior is presented. Secondly, a new and rather general *variational-based modeling approach* and computational implementation of macroscopic continuum magneto-mechanics is presented with a special focus on *dissipative magnetostriction*. Finally, a brief overview is given on recent research activities related to computational magnetomechanics in the geometrically-nonlinear setting with an application to *magnetoactive polymers*.

REFERENCES:

[1] B. Kiefer and D. C. Lagoudas, Modeling the Coupled Strain and Magnetization Response of Magnetic Shape Memory Alloys under Magnetomechanical Loading, Journal of Intelligent Material Systems and Structures Vol. 20, 143–170, 2009.

[2] C. Miehe, B. Kiefer and D. Rosato, An Incremental Variational Formulation of Dissipative Magnetostriction at the Macroscopic Continuum Level, International Journal of Solids and Structures Vol. 48, 1846–1866, 2011.

[3] C. Miehe, D. Rosato and B. Kiefer, Variational Principles in Dissipative Electro-Magneto-Mechanics: A Framework for the Macro-Modeling of Functional Materials, International Journal for Numerical Methods in Engineering Vol. 86, 1225–1276, 2011.

Prof. Bjorn Kiefer
Institute of Mechanics,
Faculty of Mechanical Engineering,
TU Dortmunt

Tuesday 4 October, 14.00
MS1 Conference Room,
Department of Structural Mechanics,
Via Ferrata, 1 – Pavia

The support of the European Community through the ERC Starting Grant project “BioSMA: Mathematics for Shape Memory Technologies in Biomechanics” is gratefully acknowledged