Preface

Functional materials play a key role in many modern technical devices ranging from consumer market items to applications in high-end equipment for automotive, aircraft and spacecraft, medical, and information technologies. Among functional materials, smart materials represent a class that transforms one basic physical property into another. The development of devices utilizing smart materials, as well as their testing, is generally very expensive. Therefore, considerable effort has been made to develop modeling tools that allow bypassing many of the experimental steps previously required in design. Important smart materials are ferroelectrics (coupling between electric polarization and strain), ferromagnets (coupling between magnetization and strain), shape-memory alloys (coupling between temperature and strain), and magnetoelectric multiferroics (coupling between electric polarization and magnetization). The latter ones combine the mutual controllability of magnetic and electric state variables. They are of great interest in the development of multifunctional devices. In single-phase multiferroics, the magnetoelectric interaction is generally very weak and mostly occurs at cryogenic temperatures. Therefore, the experimental preparation and characterization of composite materials, as well as their constitutive description based on homogenization strategies, are key challenges for the optimization of such magnetoelectric composites. The development of such composites made from two different ferroics is based on a comprehensive understanding of both the experimental and theoretical details of these materials. Thus, this CISM course covers the modeling of ferroelectric materials, ferromagnetic materials and shape-memory alloys, the formation of ferroic microstructures and their continuum-mechanical modeling, the experimental preparation and characterization of magnetoelectric multiferroics, computational homogenization, and the algorithmic treatment in the framework of numerical solution strategies.

The CISM course on "Ferroic Functional Materials: Experiment, Modeling, and Simulation," held in Udine from September 8 to 12, 2014, was addressing doctoral students and postdoctoral researchers in civil and mechanical engineering, materials science, physics and applied mathematics, and industrial researchers who wished to broaden their knowledge in experiments and theory of ferroic materials. The main focus was on the state-of-the-art experimental methods and advanced modeling

techniques, which are essential to qualify young scientists for high-quality research, and the development of innovative products and applications.

It is our pleasure to thank the lecturers of the CISM course Kaushik Bhattacharya (Pasadena, USA), Manfred Fiebig (Zurich, Switzerland), John Huber (Oxford, UK), Christopher Lynch (Los Angeles, USA), Marc-André Keip (Stuttgart, Germany) as well as the additional contributors to these CISM lecture notes Dorinamaria Carka (Old Westbury, USA), Irina Anusca (Essen, Germany), Morad Etier (Essen, Germany), Yanling Gao (Essen, Germany), Gerhard Lackner (Essen, Germany), Ahmadshah Nazrabi (Essen, Germany), Mehmet Sanlialp (Essen, Germany), Harshkumar Trivedi (Essen, Germany), Matthias Labusch (Essen, Germany), and Naveed Ul-Haq (Essen, Germany). We furthermore thank the participants who made the course a success. Finally, we extend our thanks to the Rectors, the Board, and the staff of CISM for the excellent support and kind help.

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http://www.springer.com/978-3-319-68881-7

Ferroic Functional Materials
Experiment, Modeling and Simulation
Schröder, J.; C. Lupascu, D. (Eds.)
2018, VII, 285 p. 99 illus., 49 illus. in color., Hardcover
ISBN: 978-3-319-68881-7