Preface

Variational calculus has been the basis of a variety of powerful methods in the field of mechanics of materials for a long time. Examples range from numerical schemes like the finite element method to the determination of effective material properties via homogenization and multiscale approaches. In recent years, however, a broad range of novel applications of variational concepts has been developed. This comprises the modeling of the evolution of internal variables in inelastic materials as well as the initiation and development of material patterns and microstructures.

The IUTAM Symposium on "Variational Concepts with Applications to the Mechanics of Materials" took place at the Ruhr-University of Bochum, Germany, on September 22–26, 2008. The symposium was attended by 55 delegates from 10 countries. Altogether 31 lectures were presented.

The objective of the symposium was to give an overview of the new developments sketched above, to bring together leading experts in these fields, and to provide a forum for discussing recent advances and identifying open problems to work on in the future. The symposium focused on the development of new material models as well as the advancement of the corresponding computational techniques. Specific emphasis is put on the treatment of materials possessing an inherent microstructure and thus exhibiting a behavior which fundamentally involves multiple scales. Among the topics addressed at the symposium were:

1. Energy-based modeling of material microstructures via envelopes of non-quasiconvex potentials and applications to plastic behavior and phase-transformations.
2. Modeling of the evolution of material microstructures in time and the associated thermodynamics using suitable variational principles.
3. Micromechanical modeling of shape-memory alloys and the evolution of martensitic microstructures.
4. Variational multiscale methods and associated numerical procedures.
5. Micromechanics of multifield and multiphysics problems.

A variety of novel results and methods were presented, especially in the realm of applying energy-based concepts to complex materials and structures. It was shown that the topic of the symposium is undergoing a rapid development boosted by the advancement of mathematical techniques in conjunction with new experimental findings concerning material microstructures.

The contributions in this volume have undergone a full peer-review. I would like to thank the reviewers involved for their valuable comments which certainly led to improvements in the papers contained in this book. Finally, thanks are due to Jolanda Karada of Karada Publishing Services for her professional preparation of the volume prior to its submission to Springer.

It is my hope that it will give the reader an insight into the exciting new developments of the field of variational methods and contribute to its popularity within the mechanics and physics communities.

Klaus Hackl
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