

## Preface

This volume contains the proceedings of the international workshop *Variational Problems in Materials Science*, which was jointly organized by the International School for Advanced Studies (SISSA) of Trieste and by the Dipartimento di Matematica “Francesco Brioschi” of the Politecnico di Milano. The conference took place at SISSA from September 6 to 10, 2004.

The study of variational problems in materials science has a long history, and it has contributed a lot in shaping our understanding on how materials work and perform. There is, however, a recent renewed interest in this subject as a consequence of the fruitful interaction between mathematical analysis and the modelling of new, technologically advanced materials. On one hand, a sizable group of analysts has found in materials science a valuable source of inspiration for new variational theories and interesting problems. On the other hand, workers in the fields of theoretical, applied, and computational mechanics are increasingly using innovative variational techniques. The workshop intended to review some of the recent advances stemming from the successful interaction between the two communities, and to identify promising areas for further cooperation.

Talks were devoted to a wide spectrum of analytical techniques and of physical systems and phenomena. They included the study of BV vector fields, path functionals over Wasserstein spaces, variational approaches to quasi-static evolution, free-discontinuity problems with applications to fracture and plasticity, systems with hysteresis or with interfacial energies, evolution of interfaces, multi-scale analysis in ferromagnetism and ferroelectricity, variational techniques for the study of crystal plasticity, of dislocations, and of concentrations in Ginzburg–Landau functionals, concentrated contact interactions, and phase transitions in biaxial liquid crystals.

This volume collects contributions authored or co-authored by 11 out of the 20 speakers invited to deliver lectures at the workshop. They all contain original results in fields which are at the forefront of current research, and in rapid evolution.

More than sixty researchers with quite different disciplinary expertise (calculus of variations, computational mechanics, continuum mechanics, geometric measure theory, materials science) attended the workshop. The list of participants appears at the end of the volume. We thank them all for their lively and friendly contributions to the scientific discussions, and to the pleasant atmosphere of the event.

The meeting enjoyed the financial support of SISSA, Politecnico di Milano, MIUR (through the National Research Group “Calculus of Variations”), and of the Istituto Nazionale di Alta Matematica “Francesco Severi” through the groups GNAMPA and GNFM. We are grateful to all these Institutions for their contributions.

Most of the burden of organizing the logistics fell on Andrea Brunetta. We wish to warmly thank him for his excellent job.

Finally, it is our pleasure to thank once again all the lecturers, and we are especially grateful to those who contributed to this volume.

Milano and Trieste, November 15, 2005

Gianni Dal Maso  
Antonio DeSimone  
Franco Tomarelli

## Invited Lectures

*Luigi Ambrosio* (Scuola Normale Superiore, Pisa)

On the Cauchy problem for BV vector fields

*Kaushik Bhattacharya* (Caltech)

Ferroelectric ceramics

*Andrea Braides* (Università di Roma Tor Vergata)

Surface energies in discrete systems

*Giuseppe Buttazzo* (Università di Pisa)

Path functionals over Wasserstein spaces

*Antonin Chambolle* (École Polytechnique)

On the initiation of cracks in Griffith's model

*Gianpietro Del Piero* (Università di Ferrara)

Bi-modal cohesive energies

*Irene Fonseca* (Carnegie Mellon University)

Variational methods in materials science: the study of foams and quantum dots

*Ilaria Fragalà* (Politecnico di Milano)

Concentration of Ginzburg-Landau energies with “supercritical” growth

*Gilles Francfort* (Université Paris XIII)

A variational approach to brittle damage evolution

*Adriana Garroni* (Università di Roma La Sapienza)

Gamma-convergence of a phase field model for dislocations

*Richard D. James* (University of Minnesota)

Hysteresis and geometry: a way to search for new materials with “unlikely” physical properties

*David Kinderlehrer* (Carnegie Mellon University)

Approaches to understanding interface evolution in polycrystals

*Stefan Müller* (Max Planck Institute for Mathematics in the Sciences, Leipzig)

A hierarchy of plate and shell theories derived from three-dimensional nonlinear elasticity by Gamma-convergence

*Michael Ortiz* (Caltech)

Discrete crystal plasticity

*Felix Otto* (University of Bonn)

Multiscale analysis in micromagnetics

*Daniilo Percivale* (Università di Genova)

Regular and non regular solutions for elastic plastic beams and plates

*Paolo Podio-Guidugli* (Università di Roma Tor Vergata)

Phenomenology of concentrated contact interactions in simple continuous bodies

*Lev Truskinovsky* (École Polytechnique)

Quasi-static deformation of a system with nonconvex energy from a perspective of dynamics

*Epifanio Virga* (Università di Pavia)

Phase transitions in biaxial nematic liquid crystals

*Augusto Visintin* (Università di Trento)

Quasilinear hyperbolic equations with hysteresis

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