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Preface

The EUROMECH Colloquium 478 “Non-equilibrium Dynamical Phenomena in Inhomogeneous Solids” was organized by the Centre for Nonlinear Studies (CENS), Institute of Cybernetics at Tallinn University of Technology, 13–16 June 2006. We have somewhat become used to such a scientific gathering in the attractive city of Tallinn, Estonia, both a historical centre with traces of an unforgotten past and a lively, rapidly developing new metropolis. Indeed, this is but the third EUROMECH colloquium in a series that started with the EUROMECH Colloquium 348 “Nonlinear Dynamics of Heterogeneous and Microstructured Solids“ (Tallinn, 1996) and then complemented by EUROMECH 436 “Nonlinear Waves in Microstructured Solids” (Tallinn, 2002). Of course, “nonlinearity” has been the word recurring in all titles, but the emphasis has evolved in time from pure theory and analysis (in the 1990s) to material heterogeneity effects in 2002 and a voluntary move to dissipative effects and more numerical simulations for the present colloquium. This follows the necessary evolution trends over a period of some ten years. This evolution is also marked by an increase in the number of participants and of represented countries. While only 8 countries were represented in 2002 together with 24 contributions, Colloquium 478 welcomed 40 scientists from 16 different countries, resulting in a total of 32 oral contributions.

The subject matter of the colloquium is more precisely illustrated by the following 16 written contributions, all of which have passed the normal refereeing procedure. We remind the reader that the primary objective of the colloquium was to present and critically discuss the state of the art, various mathematical formulations, constitutive modelling, and numerical simulations in the prediction of the response of materials exhibiting to some degree nonlinearity, heterogeneity, and dissipation, under various types of dynamic loading. Few materials are used solely in their ideal equilibrium state. Non-equilibrium phases can be associated with inherent abilities to undergo structural changes, which are manifested in rearrangements of particles, crack propagation, phase transformation, and inhomogeneities of various kinds. Pure theory, numerical simulations and experiments combine in such a wide viewpoint to favour apprehending physical reality to its best. Accordingly, the main goal of the colloquium was to promote advances in the formulation and solution of real-life problems, with an emphasis on dynamic aspects, and with a multidisciplinary vision accounting for all the complex dynamics involved in the physical description.

In this framework, *nonlinear waves* certainly provide the first section of papers emphasizing the combined or competitive roles of dissipation, microstructure, and heterogeneity on the propagation of waves in solids. The influence of modern *general continuum mechanics and thermodynamics* is reported in the second section, with the introduction of configurational forces and their application in a thermodynamic background, the dynamics of discontinuity surfaces, and the remarkable behaviour of some biological materials. Finally, *applications and experiments* are mostly reported in the third section, where phase transformations as occurring in martensitic materials and shape memory alloys have naturally emerged as spot-on objects. This division that may appear to be somewhat arbitrary reflects well in a balanced manner which came out from the vivid discussions in which the key words were: material forces, thermodynamic considerations, phase transformations, phenomenology and applications, and wave propagation in inhomogeneous materials.

Indeed, *material forces* and material description of continuum mechanics offer efficient tools for analysing and describing various phenomena in inhomogeneous materials. *Thermodynamic considerations* and constraints provide another general approach to analyse the thermomechanical behaviour of materials. It was emphasized that the thermodynamic description of non-equilibrium states and irreversible processes is highly important in the understanding of phenomena, development of new models, and even in the construction of algorithms for numerical simulations. *Phase transformations* under applied thermal or mechanical loading provide many examples of complex material behaviour. Experimental results, theoretical models, and numerical simulations of martensitic transformations in solids and the corresponding microstructure formation were discussed intensively. *Phenomenology* and various applications of thermomechanical methods to crack and damage problems, hole growth, transforming nanoparticles, growing of biological materials, etc. show the power of the phenomenological description and its applicability in distinct areas. Finally, various aspects of linear and nonlinear wave propagation in microstructured solids were presented and discussed. Both theoretical considerations and numerical simulations demonstrated the richness of dynamic phenomena in materials behaviour.

In conclusion of an active and busy colloquium, the attending community proposed to establish a Network of Excellence to keep up and develop further the level of mutual understanding reached at this colloquium.

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