Abstract. All up-to-date engineering applications of advanced multi-phase materials necessitate a concurrent design of materials (including composition, processing routes, microstructures and properties) with structural components. Simulation-based material design requires an intensive interaction of solid state physics, material physics and chemistry, mathematics and information technology. Since mechanics of materials fuses many of the above fields, there is a pressing need for well founded quantitative analytical and numerical approaches to predict microstructure-process-property relationships taking into account hierarchical stationary or evolving microstructures. Owing to this hierarchy of length and time scales, novel approaches for describing/modelling non-equilibrium material evolution with various degrees of resolution are crucial to linking solid mechanics with realistic material behavior. For example, approaches such as atomistic to continuum transitions (scale coupling), multiresolution numerics, and handshaking algorithms that pass information to models with different degrees of freedom are highly relevant in this context. Many of the topics addressed were dealt with in depth in this workshop.

Mathematics Subject Classification (2000): 74-XX.

Introduction by the Organisers

The workshop Mechanics of Materials, organised by Reinhold Kienzler (Bremen), David L. McDowell (Atlanta) and Ewald A. Werner (München) was held January 22nd–January 28th, 2006. The workshop attracted some 40 participants with a wide geographic spread. Special attention was devoted to increasing the participation of younger members of the related research community. Mechanics of Materials is a broad, interdisciplinary subject that focusses on the intersection of Applied Mathematics, Continuum Mechanics, Material Physics and
applications. To address important, emerging topics related to these interdisciplinary areas, several themes were pursued in distinct sessions, each with keynote addresses and extended discussions. The following main topics were treated:

- Emerging topics at the interface of Mechanics of Materials and Materials Science
- Inhomogeneous materials and phase transformations
- Configurational Mechanics
- Atomistic and discrete modelling approaches to defects and defect structures
- Mathematical modelling new materials and engineering applications
- Elasticity, Plasticity and time dependent material behavior

Although these fields appear to be quite unconnected, certain physical properties and numerous mathematical approaches were identified as common structures. This includes basic balance and conservation laws as well as variational principles for establishing and solving the evolving partial differential equations. Bridging scales from electrons to macroscopic structures by various consistent methods we were able to arrive at a more complete picture of modelling material behavior and the associated mathematical challenges.

The unique atmosphere at the Institute offered an extraordinary opportunity for intense, amiable exchange of currently emerging, detailed and conceptual ideas. The significant amount of time devoted to fruitful discussion is certainly an element that made this meeting in Oberwolfach distinct from other outstanding technical venues. Many new collaborative relationships were initiated.

The following abstracts very well summarize both the keynote lectures and the additional contributions to the discussion.

It was our great pleasure to celebrate during an informal gathering the 50th anniversary of Horst Lippmann as participant, organizer and long-term intellectual contributor to many Oberwolfach workshops.