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Editors

Surface Effects in Solid Mechanics

Models, Simulations and Applications

Springer

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Preface

The collection of papers "*Surface Effects in Solid Mechanics*: *Models, Simulations and Applications*" is devoted to the modeling of non-traditional effects in material behavior which are related to surface phenomena. In the classical mechanics as usual the properties of the bulk material are the focus of researchers. The problem solution is based on the following elements:

- geometrical relations presenting, for example, the displacements, strains, strain rates, etc.,
- equilibrium equation or equations of motion,
- constitutive equations (stress–strain relations among others), and
- evolution equations describing the evolution of inner processes like hardening or damage.

The problem statement is finished, if the boundary and initial conditions are fixed. After that using analytical, semi-analytical, or numerical methods problems of the engineering practice can be solved.

With the miniaturizing of structures it is not enough to present only the bulk properties of the materials. It is well known from the physics of materials or material science that classical properties like the Young modulus changes dramatically if the size of the structure or specimen attains the nanometer range. For an adequate description of such behavior several approaches are suggested. All of them are based on the surface properties of the interface behavior or the lattice properties, etc., which should be taken into account.

Various approaches are discussed within this book. Most of the contributions were selected from lectures presented during the mini-symposium "*Surface Effects in Nano-Mechanics*" at the European Solid Mechanics Conference, which was held in Graz (Austria) in July 2012. The book contains 14 papers, which are presented in alphabetical order. In the first paper some mathematical aspects of initial-boundary and boundary-value problems for elastic bodies including surface stresses are present. The mechanical properties of materials considering surface effects are presented in the second paper. Graphene, which is a monolayer of carbon atoms packed into a two-dimensional honeycomb lattice, in the simplest

case can be modeled as an elastic material. The relevant properties are presented by Berinskii and Borodich. A comparison of atomistic and surface enhanced continuum approaches at finite temperature is given in the next paper. After that, in the next paper electro-elastic coupling is introduced and some special effects are investigated. Plane problems and their solution based on the Goursat–Kolosov complex potentials and Muskhelishvili's technique are introduced in two papers from Grekov's group in St. Petersburg. The paper by Kutelova et al. is devoted to some experimental observations related to surface effects. This contribution is close to applications. In the paper of Nasedkin and Eremeyev the problem of natural oscillations of piezoelectric bodies of nanosizes taking into account surface stresses and electric charges is discussed. The stability and structural transition in crystal lattices are studied in the paper of Podolskaya et al. An excellent survey on mathematical modeling of phenomena caused by surface stresses in solids is given by Povstenko. The buckling of a supported annular plate with a non-Euclidean metric and made of graphene is studied with an atomistic and a continuum mechanics approach in the paper of Schwartzbart and Steindl. The paper of Ustinov et al. is devoted to peculiarities in describing surface and interface effects in elasticity. Finally, the kinetics of chemical reaction fronts is presented in the last paper.

Magdeburg, St. Petersburg, August 2012

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Contents

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