

Engineering Materials

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Finite Element Modeling of Nanotube Structures

Linear and Non-linear Models

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To our wives, children and parents

Preface

The purpose of this book is to explain the application of the finite element modeling or analysis (FEM or FEA) with special emphasis on the mechanics of carbon and inorganic nanotubes and related solids, such as nanocomposites. It is intended for those who require modeling and stress analysis of nanotubes using finite element modeling with specific explanations and the book is designed as a textbook or reference material for related graduate engineering courses.

Models of the nanotubes are made using *Nanotube Modeler*[®] and *Surface Builder* tool of *Material Studio*[®] package with application of the finite element method demonstrated using *ANSYS*[®]. Step-by-step instructions for the use of *ANSYS* Parametric Design Language (APDL) in relation to nanotubes are given under different structural and boundary conditions.

This book is not anticipated as an exhaustive reference book on the use of *ANSYS*, but as a guide for simulation of mechanical properties of nanotubes and nanocomposites that are carbon and inorganic based. Thus, Chaps. 1 and 2 give required information about the atomic structures of nanotubes and how the concept of interatomic potential energy functions are utilized in determining mechanical properties. In order to simplify the procedures to be followed in modeling and meshing of nanotubes, Chaps. 3 and 4 explain the geometrical structure of nanotubes and the options for the elements to be used. An overview of *ANSYS* is given in Chap. 5 with step-by-step guidelines on how to carry out linear FEA on nanotubes. Chapters 6–10 deal with some specific applications of *ANSYS* in determining mechanical properties of nanotubes, such as nonlinear analysis, effect of geometrical parameters, effect of defects and multi-walled structures and behaviour of nanocomposites. Most of the simulations presented in this book were made using Version 14.5 of *ANSYS*; however, many of the examples can be conducted using earlier versions.

During the preparation of this book, necessary attempts were made to cover only essentials of the subject and to provide required tools for understanding of some theoretical background and the skills for using related software. Therefore, apology is offered in advance to all those concerned whose materials are not referenced.

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