

Preface

This is the second volume in a series of books on selected topics in Nanoscale Science and Technology based on lectures given at the well-known INFN schools of the same name. The aim of this collection is to provide a reference corpus of suitable, introductory material to relevant subfields, as they mature over time, by gathering the significantly expanded and edited versions of tutorial lectures, given over the years by internationally known experts.

The Nanotechnology group at INFN – LNF organizes since 2000 a series of international meetings in the area of nanotechnology. The conferences in 2006 and 2008 were devoted to recent developments in nanoscience and its manifold technological applications. They included of a number of tutorial/keynote lectures, which are reflected in this volume, besides research talks presenting frontier nanoscience research developments and innovative nanotechnologies in the areas of biology, medicine, aerospace, optoelectronics, energy, materials and characterizations, low-dimensional nanostructures and devices. Selected papers, based on conference talks and related discussions, were published on dedicated issues of international journals.

Special poster and equipment session were devoted to the exhibit by various firms of their institutional activities in selected areas of application where nanoscience can have a deep impact. There was also the possibility for sample testing by the participants. *Tutorial lectures were delivered at the School, addressing general and basic questions about nanotechnology, such as what they are, how does one go about them, what purposes can they serve.* In tutorial sessions the nature of nanotechnology, the instruments of current use in its characterizations and the possible applicative uses were *described at an introductory level.*

The Conferences covered a large range of topics of current interest in nanoscience and nanotechnology, including aerospace, defence, national security, biology, medicine, electronics. This broad focus is reflected in the decision to publish different areas of application of these technologies in different volumes. The present set of notes results in particular from the participation and dedication of prestigious lecturers, such as Andrzej Huczko, Nicola Pugno Alexander Malesevic, Stefano Bellucci. All lectures were subsequently carefully edited and reworked, taking into account the extensive follow-up discussions at the Conferences.

A tutorial lecture by *Andrzej Huczko* and collaborators (Warsaw University, Poland) shows how different carbon and ceramic nanostructures (nanotubes,

nanowires, nanofibres, nanorods, and nanoencapsulates) have a great potential for improving our understanding of the fundamental concepts of the roles of both dimensionality and size on physical properties, as well as for many potential applications. *Stefano Bellucci* and *Pasquale Onorato* (INFN-LNF, Italy) engaged in an extensive review of the transport properties in carbon nanotubes, encompassing a description of the electronic structure from graphene to single-wall nanotubes, the quantum transport in such systems, as well as the description of experimental evidence of superconductivity in carbon nanotubes and the corresponding theoretical interpretation. *Nicola Pugno* (Turin Polytechnic University, Italy), in the first of his contributions, goes about new laws to design futuristic self-cleaning, super-adhesive and releasable hierarchical smart materials, as well as large invisible cables, based on carbon nanotube technology. He also reviewed the mechanical strength of nanotubes and megacables, with an eye to the challenging project of the carbon nanotube-based space elevator megacable. In this second contribution, he outlined the role on the fracture strength of thermodynamically unavoidable atomistic defects with different size and shape, both numerically (with *ad hoc* hierarchical simulations) and theoretically (with quantized fracture theories), for nanotubes and nanotube bundles. Focusing on graphitic allotropes, the chapter by *Stefano Bellucci* and *Alexander Malesev* tries to give a taste of the widespread implications carbon nanostructures have on research and applications, starting from an historical overview, followed by a discussion of the structure of carbon nanotubes and graphene, over viewing several different synthesis techniques and illustrating the physical properties of these innovative materials, before summarizing their broad range of applications.

In concluding this effort, I wish to thank all lecturers, and especially those who contributed to the present second volume in this series, as well as speakers and participants to the 2006 and 2008 Conferences, for having contributed to create a pleasant and productive atmosphere, fostering the settling of pervasive collaborative spirit and pedagogical drive. I am confident that this first set of lectures, in turn, will provide an opportunity for those who are just now beginning to get involved with nanoscience and nanotechnology, allowing them to get contacts and prime, up-to-date information from the experts. I also wish to acknowledge the enduring dedication and caring support of my wife Gloria and our great daughters Costanza, Eleonora, Annalisa, Erica and Maristella, which allowed me to put this volume together.

Frascati, Italy
May 2010

Stefano Bellucci

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