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Olena Fesenko • Leonid Yatsenko  
Editors

# Nanocomposites, Nanophotonics, Nanobiotechnology, and Applications

Selected Proceedings of the Second FP7  
Conference and International Summer School  
Nanotechnology: From Fundamental  
Research to Innovations, August  
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# Preface

This book presents a selection of the latest developments in nanotechnology and nanomaterials. It features articles written by lecturers and young scientists from Europe, in particular from Ukraine, who participated in the Second International Summer School “Nanotechnology: From Fundamental Research to Innovations,” held in Bukovel, Ukraine from August 25 to September 1, 2013 within the framework of the FP7 project Nanotwinning. This International Summer School provided early-career scientists the opportunity to participate in a series of lectures on the emerging fields of nanoscience and nanotechnology. The goal of the Second International Summer School was to familiarize young scientists with actual research and problems of application in this area and to promote the future implementation of nanotechnology in innovative development to meet public needs. The First Summer School, held in 2012, received positive feedback from international experts and sparked interest in the media, with mentions on the Ukrainian Channel 5 programs “Window to Europe” and “Intellect.UA,” the TBi Ukrainian TV program “Today,” and on the Tonis national TV Channel program “Social Pulse,” as well as in Viche magazine and the scientific journal World of Physics. International Summer School was hosted by the Institute of Physics of NAS of Ukraine in conjunction with its Nanotwinning project partners: University of Tartu (Estonia), European Profiles A.E. (Greece), University of Turin (Italy), and Pierre and Marie Curie University (France).

The beginning of the twenty-first century witnessed tremendous breakthroughs in nanoscience and nanotechnology. Today, nanotechnology is used in computer technology and electronics; the aerospace, chemical, and construction industries; medicine and pharmacology; and in the manufacture of new unprecedented materials. The present volume surveys some of the latest advances in the field and points the way to exciting future investigations and applications. The book chapters cover such currently important topics as microscopy of nanostructures; nanocomposites; nanostructured interfaces and surfaces; nanooptics; nanoplasmonics; and enhanced vibrational spectroscopy. The book demonstrates that researching nanocarbons, nanosilicon, biomolecular nanostructures, and their applications is a very interesting and exciting area of modern science, which will certainly attract the attention of scientists and engineers for many years to come.

The book is divided into four sections: Part I: Nanocomposites and Nanostructures; Part II: Nanophotonics; Part III: Nanobiotechnology; and Part IV: Application.

An overview of the chapters is provided below. The reader is recommended to read the following descriptions first, as they provide insights into the book's contents and the results presented.

## **Part I: Nanocomposites and Nanostructures**

In Chap. 1 (Dodziuk) endohedral fullerene complexes involving  $C_{60}$ ,  $C_{70}$ , and  $C_{50}H_{10}$  nanotubes, especially those containing small molecular guests, are reviewed and calculations of their stability presented. Chapter 2 (Nykyforchyn) focuses on the improvement of certain physical and mechanical properties of surface layers of engineering steels by severe thermal–plastic deformation treatment using high-speed friction and simultaneous rapid cooling in a special medium. The authors of Chap. 3 (Korol) consider a gapped graphene superlattice (SL) constructed in accordance with the Fibonacci rule. Chapter 4 (Cravanzola) focuses on the characteristics and electrical conductivity mechanisms of carbon nanotubes and expanded graphite. Chapter 5 (Beresnev) presents nanocomposite (Zr–Ti–Cr–Nb)N coatings with high hardness and thickness around  $8.5\ \mu\text{m}$  which allows their use as protective coatings for cutting tools. In Chap. 6 (Savchenko), the luminescent spectra of obtained metallocomplexes in solid state are investigated and analyzed. In Chap. 7 (Vretik) possible morphological changes on a poly(methacrylamidoaryl methacrylate) surface before and after irradiation with polarized UV-light were investigated. Chapter 8 (Orel) presents research into the nonlinear magnetic properties magneto-mechano-chemical nanocomplex synthesized from magnetite and antitumor antibiotic doxorubicin. Chapter 9 (Bellel) describes the electrochemical preparation process of magnesium-based nanocomposites on a metallic cathode. Chapter 10 (Ulyanova) focuses on preparation processes of  $\text{SiO}_2\text{--Al}_2\text{O}_3\text{--TiO}_2$  composite materials doped with nanostructured fibrous powders  $\gamma$ - and  $\alpha$ - $\text{Al}_2\text{O}_3$ .

## **Part II: Nanophotonics**

Chapter 11 (Donets) presents technological aspects of corrosion resistant steels surfacing by intense relativistic electron beams. Chapter 12 (Chrzanowska) reviews the consequences of the presence and amount of water on the silicon based parts of nanodevices such as AFM tips. Chapter 13 (Uklein) examines the structural and optical characterization of the ( $\text{Y}_3\text{Al}_5\text{O}_{12}$ , YAG) ceramics prepared by high-pressure low-temperature technique. The authors of Chap. 14 (Raczyński) interpret the behavior of homocysteine molecules in the pure clusters and in the clusters with carbon nanotube, by qualitative interpretation of physical observables and snapshots of instantaneous configurations. Chapter 15 (Sumarokov) examines the heat capacity of 1D chains of atom/molecule adsorbates in the grooves of c-SWNT bundles.

### **Part III: Nanobiotechnology**

Chapter 16 (Martseniuk) is devoted to the analysis of properties of water, diffused in the layered compounds  $\text{SrFe}_2\text{As}_2$  and  $\text{FeTe}_{0.8}\text{S}_{0.2}$ . The aim of Chap. 17 (Pavlovich) is to study the effect of gold nanoparticles on morphological and functional characteristics of SPEV cells. Chapter 18 (Shcherbak) focuses applications of nanomaterials in rational gene pool preservation technology. In Chap. 19 (Christophorov) the author describes the basis and development of the concept of dynamic molecular self-organization, a model he first introduced more than 20 years ago when searching the most adequate approach to analyzing the functioning of biomolecules, in particular, proteins–enzymes. Chapter 20 (Burlaka) presents applications of CNT-based strategies for improved efficacy, reproducibility, accuracy, and speed in gene transfer in plants. In Chap. 21 (Chevichalova) the authors present the result of investigations on the effect of platinum nanoparticle aggregations on the vital activity of a variety of cancer cells.

### **Part IV: Applications**

Chapter 22 (Kucherenko) describes urease-based conductometric biosensors that were created using a non-typical method of urease immobilization via adsorption on micro- and nanoporous particles. Chapter 23 (Bažela) presents the results of investigations into the effect of particle size on the magnetic properties of  $\text{RMnO}_3$  ( $R = \text{Pr, Nd and Tb}$ ) using magnetometric and X-ray and neutron diffraction methods. Chapter 24 (Nichkalo) reviews investigations of silicon nanowire formation via a combination of LPCVD and wet etching methods on Si substrate using gold films as mask. In Chap. 25 (Draidi) the authors develop a precision MESFET model for transconductance variation based on gate length and voltage and resistance and voltage. Chapter 26 (Shalaeva) discusses the nanocrystalline structure formation mechanism of quasi-one-dimensional nanostructured aggregates  $\text{ZnO}$  and  $\text{Zn–O–C}$  used as photocatalysts and the effect of thermolysis condition on the formation of textured structure in these aggregates. Chapter 27 (Boudine) focuses on the study of spin-polarized transport in semiconductors as new type of current transmission in semiconductor devices. In the chapter, the authors present a two-degree model for a so-called SPINFET transistor. Chapter 28 (Protsenko) is devoted to the strain properties of multilayer thin-film materials based on metals. Chapter 29 (Gudyma) is devoted to an analysis of spin-crossover system dynamics using both an Ising-like mechanoelastic model and a macroscopic phenomenological model.

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