

Preface

This book highlights the most recent advances in nanoscience from leading researchers in Ukraine, Europe, and beyond. It features contributions from participants of the 3rd International Research and Practice Conference “Nanotechnology and Nanomaterials” (NANO-2015), held in Lviv, Ukraine, on August 26–29, 2015. This event was organized jointly by the Institute of Physics of the National Academy of Sciences of Ukraine, University of Tartu (Estonia), University of Turin (Italy), and Pierre and Marie Curie University (France). Internationally recognized experts from a wide range of universities and research institutes shared their knowledge and key results in the areas of nanocomposites and nanomaterials, nanostructured surfaces, microscopy of nano-objects, nano-optics and nanophotonics, nanoplasmonics, nanochemistry, nanobiotechnology, and surface-enhanced spectroscopy.

The book is divided into five sections: Part I is on *Nanoscale Physics*; Part II is on *Nanooptics and Photonics*; Part III is on *Nanostructured Interfaces and Surfaces*; Part IV is on *Nanochemistry and Biotechnology*; and Part V is on *Nanocomposites and Nanomaterials*.

Part I: Nanoscale Physics

In Chap. 1 (Gburski), the ultrathin one-atom-thick krypton layer between graphite surfaces has been studied using the molecular dynamics simulation method. Chapter 2 (Raczyński) focuses on the properties of 4-*n*-pentyl-4'-cyanobiphenyl molecules placed over a wall made of fullerene molecules. The authors of Chap. 3 (Raczyńska) present the results of a study of the nanoindentation of a phospholipid layer by carbon nanotubes of different diameters. In Chap. 4 (Raczyńska), the behavior of paracetamol molecules in clusters composed of 30 and 80 molecules was investigated over a wide range of temperatures. Chap. 5 (Krupa) focuses on the current-driven spin-orbit-mediated spin torque for the case of an arbitrary

magnetization orientation and a linear in momentum. In Chap. 6 (Gudyma), the authors examined the kinetics of transition in the light-induced spin-crossover system in contact with thermostat.

Part II: Nanooptics and Photonics

A study of the dynamics of pattern formation in a class of adsorption/desorption systems described by the reaction-Cattaneo model (with memory effects of the diffusion flux) is presented in Chap. 7 (Kharchenko). The authors of Chap. 8 (Los) apply their approach to the solution of the time-dependent Schrödinger equation in the case when a particle moves toward a rectangular, generally asymmetric well/barrier potential, which changes in the x (perpendicular to interfaces) direction and models the spin-dependent potential profile in magnetic nanostructures. Chapter 9 (Bulavinets) is devoted to modeling of absorption and scattering by multilayer nanoparticles of the form metal/semiconductor/metal and semiconductor/metal/semiconductor. The goal of the work described in Chap. 10 (Sartinska) is to synthesize and research the properties of boron nitride powder produced under the effect of concentrated light in a flow of nitrogen in a xenon high-flux optical furnace. In Chap. 11 (Smirnova), the authors investigated the dynamics of electron excitations in a plasmonic nanocomposite based on a polymer matrix with a periodic substructure of ordered silver nanoparticles.

Part III: Nanostructured Interfaces and Surfaces

In Chap. 12 (Stetsko), the complex method of chemical treatment and diffusive chrome plating is proposed as a novel approach to surface hardening, providing the required quality characteristics for machine parts and tools. Dispersion kinetics research on niobium and hafnium nanofilms of 100 nm of thickness deposited on the surface of samples from alumina ceramics, sapphire, and ZrO_2 -based ceramics at vacuum annealing at 1300–1600 °C and different pauses in the range of 2–20 min is described in Chap. 13 (Gab). The aim of the investigations presented in Chap. 14 (Panko) is to reveal the colloid-chemical mechanisms and features of geomechanical and microbiologic processes aided by nanoparticles and nanostructures in carbonate-clay peloids and, relatedly, the establishment of biocolloid and colloid-chemical transformations with variations of colloid-chemical properties and biological activity of bottom sediments. The authors of Chap. 15 (Galaktionov) investigate the morphology of nanostructural anodic titanium. Chapter 16 (Martseniuk) is devoted to theoretical research into the properties in vacancies and divacancies of silicon. A few interesting examples emerging from the density functional theories for two-dimensional discorectangles are discussed in

Chap. 17 (Chrzanowska) together with the factors responsible for their structure. In Chap. 18 (Frolova), the authors present their study on the influence of ultrasonic treatment and contact non-equilibrium plasma on the ferritization process in Fe^{2+} – Ni^{2+} – SO_4^{2-} – OH^- system. Chapter 19 (Nasiedkin) presents a quantum chemical simulation of the formation of mono-vacancy defects on the single graphite sheet (graphene) as a result of carbon atom removal due to reaction with molecular oxygen in both basal-plane and edge positions, as well as clarification as to whether the defects at the graphite basal plane are associated with the original defect sites or can be formed as a result of oxidative removal of carbon atoms. In Chap. 20 (Nedolya), the effect of the position of impurity carbon atom and substitutional atoms of nickel on energy changes of iron subnanoclusters of face-centered cubic type was evaluated via molecular mechanics. Chapter 21 (Raks) focuses on obtaining robust superhydrophobic coatings based on conventional materials for the paint industry. The aim of Chap. 22 (Wiśniewska) is to determine the adsorption and stability mechanism in a colloidal system in which mesoporous zirconia nanoparticles are dispersed in the aqueous biopolymer solution.

Part IV: Nanochemistry and Biotechnology

Evolution of derma porosity during pre-tanning, tanning, retanning, and modifications with inorganic particles was investigated in Chap. 23 (Dzyazko) with techniques of standard contact porosimetry, transmission, and scanning electron microscopy. The authors of Chap. 24 (Savkina) focus on the cavitation process at a silicon surface. In Chap. 25 (Gburski), the authors embedded paracetamol molecules in high-density lipoprotein aggregate. The authors of Chap. 26 (Gburski) report the dynamics of homocysteine molecules embedded in high-density lipoprotein aggregate and compare the results with the free sample, where the homocysteine molecules were not surrounded by water. In Chap. 27 (Shevchenko), the authors present the result of their study of the physical properties of magnetic nanocomplexes consisting of ferromagnetic iron oxide nanoparticles or superparamagnetic iron oxide nanoparticles loaded with the antitumor drug doxorubicin. Chapter 28 (Nagirnyak) considers the influence of a range of parameters (process temperature, treatment duration, and type of precursor) on the composition and morphology of obtained tin(IV) oxide powders. Chapter 29 (Liapina) evaluates the possibility of using the additional reagents in preparation of a feedwater for extraction of sucrose from the beet slices. In Chap. 30 (Burlaka), the background and recent achievements of using carbon nanotubes as gene delivery vehicles are discussed. The authors of Chap. 31 (Nadtoka) investigate the photocatalytic properties of semiconductor dye-polymer films. The authors of Chap. 32 (Chumachenko) present the results of a study using previously characterized polymers as carrier/stabilization systems in experiments on antitumor photodynamic therapy in vitro and in vivo with chlorin e6 as a photosensitizing agent. The

gasification of an aqueous suspension of lignite from the Alexandria coalfield (Ukraine) under supercritical pressure was studied in Chap. 33 (Korzh). The problem of understanding genetic information coding is discussed from the perspective of the influence of amino acids and proline physical and structural properties in Chap. 34 (Shmeleva). In Chap. 35 (Stolyarchuk), amino-containing spherical particles were synthesized based on 1,2-bis(triethoxysilyl)ethane and 3-aminopropyltriethoxysilane using the modified Stöber method. The aim of Chap. 36 (Talankova-Sereda) is to investigate the influence of copper and cobalt nanoparticles on clonal microreproduction of *Mentha longifolia* plants received by method of isolated cells and tissue culture.

Part V: Nanocomposites and Nanomaterials

Chapter 37 (Kalinichenko) presents the authors' investigation into the formation of nanocomposites on a base of sludge biosolids and pH-sensitive acrylic hydrogel with immobilized bioelements as well as estimates for their efficacy for plant growth. Nanocomposites based on polyurethane/poly(2-hydroxyethyl methacrylate) multicomponent polymer matrix and nanofiller densil were created, and structure, thermodynamic miscibility, dynamic mechanical and physical-mechanical properties have been investigated in Chap. 38 (Karabanova). Chapter 39 (Perets) reveals how liquid dispersive media affect the degree of graphite nanoplatelet (GNP) surface modification and electric properties of GNP/epoxy nanocomposites depending on ultrasonic dispersion and ultraviolet/ozone treatment time. The influence of components on optical and photovoltaic properties of polymer nanocomposite films made of polymethine dyes at high concentrations is analyzed in Chap. 40 (Vertsimakha). Chapter 41 (Barbash) presents the determination of a suitable nanostructuring approach for the bleached softwood sulfate pulp by mechanochemical treatment, followed by a study of the optical characteristics (transparency in the visible spectrum range) and physical-mechanical properties (Young's modulus, tensile strength) of the obtained films. Chapter 42 (Galstyan) addresses the electrical and thermoelectrical properties of carbon nanotubes and their nanocomposite with polytetrafluorethylene and the relationship between the electrical conductivity and Seebeck coefficient. Chapter 43 (Gdula) is dedicated to iron oxides and their composites at the nanometer scale as biocompatible systems for biomedical applications. Chapter 44 (Gorban) considers the influence of modification by copper-containing complexes at a stage of hydrogel synthesis on surface state of nanoparticles and their organization in the structure of amorphous xerogel. Chapter 45 (Ivasyshyn) presents the results of a study of Ti_3AlC_2 -based materials oxidized at 600 °C. The authors of Chap. 46 (Huczko) show how the self-propagating high-temperature synthesis route can be used to produce different carbon-related nanomaterials: silicon carbide

nanowires and few-layered graphene. Chapter 47 (Podhurska) is aimed at studying the physical and mechanical behavior of solid oxide fuel cell anode material during cyclic redox treatment depending on the treatment temperature as well as determining the responsible microstructural changes.

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