

Preface

Quickly developing theoretical, experimental and computational methods, directed to study and creation of numerous processing techniques, searching optimal compositions to process promising materials and composites are in the centre of modern Material Sciences and related areas of science and technology. Specific applications of materials and devices, manufactured on their base required quietly definite physical-mechanical and other structure-sensitive properties. Modern studies in this direction are found by very complex and fine fabrication techniques and constant searching of novel material compositions. A great attention is devoted to ecologically friendly material (for example, without lead ceramics). Industrial needs require devices and goods demonstrating very high accuracy, reliability, longevity and extended possibilities to operate under temperatures and pressures, changing into wide ranges. Characteristics of prepared devices are directly defined by the properties of materials and composites. Any movement in creation of optimal samples of materials and devices opens new possibilities in study of various physical processes and technologies.

This collection of 50 papers presents selected reports of the 2016 International Conference on “Physics, Mechanics of New Materials and Their Applications” (PHENMA-2016), which has taken place in Surabaya, Indonesia, during 19–22 July 2016 (<http://phenma2016.math.sfedu.ru>) The conference was sponsored the Ministry of Education and Science of the Russian Federation, South Scientific Center of the Russian Academy of Science, Russian Foundation for Basic Research, Ministry of Science and Technology of Taiwan, International Association of Certified Practicing Engineers (Indonesia), Ikatan Nasional Konsultan Indonesia, East Java Region (Indonesia), New Century Education Foundation (Taiwan), Ocean & Underwater Technology Association (Taiwan), Unity Opto Technology Co. (Taiwan), Fair Well Fishery Co. (Taiwan), Woen Jinn Harbor Engineering Co. (Taiwan), Lorom Group (Taiwan), Longwell Co. (Taiwan), Institute Technology of Bandung (Indonesia), Institute Technology of Sepuluh Nopember (Indonesia), University of 45, Surabaya (Indonesia), University of Islam Kadiri (Indonesia), Khon Kaen University (Thailand), Don State Technical University (Russia), South Russian Regional Centre for Preparation and Implementation of International Projects, Ltd.

The thematic of the PHENMA-2016 continued ideas of previous international symposia and conferences: PMNM-2012 (<http://pmnm.math.rsu.ru>), PHENMA-2013 (<http://phenma.math.sfedu.ru>), PHENMA-2014 (<http://phenma2014.math.sfedu.ru>), and PHENMA-2015 (<http://phenma2015.math.sfedu.ru>), whose results have been published in the following edited books “Physics and Mechanics of New Materials and Their Applications”, Ivan A. Parinov, Shun Hsyung-Chang (Eds.), Nova Science Publishers, New York, 2013, 444, p. ISBN: 978-1-62618-535-7, “Advanced Materials – Physics, Mechanics and Applications”, Springer Proceedings in Physics. Vol. 152. Shun-Hsyung Chang, Ivan A. Parinov, Vitaly Yu. Topolov (Eds.), Springer, Heidelberg, New York, Dordrecht, London, 2014, 380 p. ISBN: 978-3319037486, “Advanced Materials – Studies and Applications”, Ivan A. Parinov, Shun-Hsyung Chang, Somnuk Theerakulpisut (Eds.), Nova Science Publishers, New York, 2015, 527 p. ISBN: 978-1-63463-749-7, and “Advanced Materials – Manufacturing, Physics, Mechanics and Applications”, Springer Proceedings in Physics, Vol. 175, Ivan A. Parinov, Shun-Hsyung Chang, Vitaly Yu. Topolov (Eds.). Heidelberg, New York, Dordrecht, London: Springer Cham. 2016, 707 p. ISBN: 978-3319263229, respectively.

The presented papers are divided into four scientific directions: (i) processing techniques of advanced materials, (ii) physics of advanced materials, (iii) mechanics of advanced materials, and (iv) applications of advanced materials.

Into framework of the first theme are considered, in particular, the structural modification of sulfide minerals irradiated by high-power nanosecond pulses; the magnetic nanoparticles and heterogeneous persulfate oxidation of the nanoparticles and organic compounds. Then there are present the microstructure optimization of Pt/C catalysts for PEMFC; the synthesis of titanium dioxide, polyacrylonitrile-based materials, and also features of phase formation in bismuth ferrite. Moreover, this section contains investigations of growth of the strongly doped LiNbO_3 ; Zn single crystals and features of crystallization of sapphire melt. The first section is finished by considering the lignin degradation and production of slow release fertilizer from waste materials.

The second direction is opened by the numerical study of dielectric resonant gratings; the method of equilibrium density matrix in theory of superconductivity; new investigations of 1–3-type composites based on relaxor-ferroelectrics single crystals and ZTS-19/clay composite. Novel results are present at the modeling and characterization of advanced functional materials. In this section, in particular are studied diffusion of ferroelectric phase transition and glass-dipole state in the PZT-based solid solutions; the electromagnetic microwave radiation absorption by ferroelectric complex niobium oxides; the structural ordering in ceramic ferroelectromagnets. Special attention is devoted to physical properties of the graphene materials; morphology, atomic and electronic structure of metal oxide (CuO_x , SnO_x) nanocomposites and thin films; dispersion characteristics of zinc oxide nanorods organized in two-dimensional uniform arrays. Finally, new technical and technological solutions for measurement of displacements of the control object surfaces by laser interferometer and contactless method of temperature measurements are presented.

From viewpoint of mechanics, the models for nanosized magnetoelectric bodies with surface effects and general theory of polarization of the ferroelectric materials are presented. Moreover, there are studied the surface SH-waves in the weakly inhomogeneous pre-stressed piezoelectric structures; elastic waves in layered phononic crystals with strip-like cracks; ultrasonic guided waves in laminate fiber-reinforced composite plates; low-frequency elastic waves penetrating the triple periodic array of cracks and ultrasonic torsional guided waves in pipes with defects. Then why and how residual stress affects metal fatigue is discussed and also the mathematical modeling dynamics of prismatic body of two- and three-component materials and numerical study of three-dimensional anisotropic viscoelastic solids are presented. The third section is finished by investigations of the thermo-physical processes in boundary layers of metal-polymeric systems; the antifriction fillers influencing the characteristics of the metal polymer tribosystems and carbon brake discs with frictionally induced thermoelastic instability.

On the whole, the presented applications are devoted to lot of modern devices based on novel approaches. In particular, the developments of new metamaterials for advanced element base of micro- and nanoelectronics; the radiation detector with sensitive elements on the base of array of multi-walled carbon nanotubes and the magnetic field sensor with nanosized elements are discussed. Then the transducer designs for ultrasonic diagnostics and therapy, and also the electric power harvesting system based on the piezoelectric stack transducer and non-uniform polarization of multi-layered piezoelectric transducer are considered. Moreover, the multifrequency sonar equipment based on the self-action nonlinear effect is regarded. Finally, the singular nullor and mirror elements for circuit design; the usage of Markov chain model for wireless local area networks, and also the time-frequency features in the Berardius Baird whistles are discussed.

The book is addressed to students, postgraduate students, scientists and engineers, taking part in investigation of ferro-piezoelectrics, nano-structures and other advanced materials and composites. The book also covers many theoretical and experimental problems, connected with R&D of modern devices based on novel materials, which demonstrate wide applications in various scientific, technological and technical areas. The book includes new studies and results in the fields of Materials Science, Condensed Matter Physics, Physical and Mechanical Theory and Experiment, Processing Techniques and Engineering of Advanced Materials and Composites, Numerical Methods and numerous applications.

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