2015 International Conference on

"Physics and Mechanics of New Materials and Their Applications" (PHENMA 2015)

devoted to 100-year Anniversary of the Southern Federal University

Azov, Russia, May 19-22, 2015

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Advanced materials and composites, including piezoelectrics, nanomaterials, nanostructures, functional materials, polymeric composites and so on, have very importance for modern sciences, technologies and techniques. The success of the Russian-Taiwanese Symposium "Physics and Mechanics of New Materials and Their Applications", PMNM-2012 (Russia, 2012, http://pmnm.math.rsu.ru/), 2013 International Symposium "Physics and Mechanics of New Materials and Underwater Applications", PHENMA 2013 (Taiwan, 2013, http://phenma.math.sfedu.ru) and 2014 International Symposium "Physics and Mechanics of New Materials and Underwater Applications", PHENMA 2014 (Thailand, 2014, http://phenma2014.math.sfedu.ru) predefined objectives and scientific directions of the new conference PHENMA 2015, devoted to 100-year Anniversary of the Southern Federal University (Russia). The following PHENMA abstracts are divided into four scientific directions: (i) processing techniques of new materials, (ii) physics of new materials, (iii) mechanics of new materials, and (iv) applications of new materials. These are present by scientists from 20 countries, demonstrating strong scientific collaboration, formed for last years.

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PREFACE

Advanced materials and composites, including piezoelectrics, nanomaterials, nanostructures, functional materials, polymeric composites and so on, have very importance for modern sciences, technologies and techniques. Their properties improve difficultly without intense chemical, physical, mechanical researches and development of modern numerical approaches and methods of mathematical modeling. Tremendous interest to similar investigations grows constantly, caused numerous applications and due to fast development of theoretical, experimental and numerical methods, requiring improvement of experimental equipment, theoretical and numerical approaches, computer hard- and software. These achievements create a new scientific knowledge. They allow one to understand and estimate very fine processes and transformations, occurring during processing, loading and operation of modern materials and devices under intense internal and external influences that lead to arising critical conditions and states. The modern devices and goods with sizes, changing from nano- up to macroscale ranges, possess very high accuracy, longevity and extended possibilities to operate in wide temperature and pressure ranges.

The success of the Russian-Taiwanese Symposium "Physics and Mechanics of New Materials and Their Applications", PMNM-2012 (Russia, 2012, http://pmnm.math.rsu.ru/), 2013 International Symposium "Physics and Mechanics of New Materials and Underwater Applications", PHENMA 2013 (Taiwan, 2013, http://phenma.math.sfedu.ru) and 2014 International Symposium "Physics and Mechanics of New Materials and Underwater Applications", PHENMA 2014 (Thailand, 2014, http://phenma2014.math.sfedu.ru) predefined objectives and scientific directions of the new conference PHENMA 2015, devoted to 100-year Anniversary of the Southern Federal University (Russia).

A significant interest to the PHENMA 2015 has led to the great sponsor support from 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, New Century Education Foundation, Ocean & Underwater Technology Association, Unity Opto Technology Co., EPOCH Energy Technology Co., Fair Well Fishery Co., Formosa Plastics Co., Woen Jinn Harbor Engineering Co., Lorom Group, Longwell Co., Taiwan International Ports Co. (Taiwan), University of 17 Agustus 1945 Surabaya (Indonesia). Khon Kaen University (Thailand), Don State Technical University (Russia), South Russian Regional Centre for Preparation and Implementation of International Projects, Ltd.

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of corresponding bonds" dependencies (containing differential equations).
A calculation algorithm was formed for a case of uniaxial strain to evaluate (under known longitudinal strain) bonds' deformations and thus the deformations of the elementary volume. Then the numerical solution of nonlinear equations allows us to calculate the extending force. The S-shape of the "force-elongation" diagram (with hysteresis loop), which is specific for a rubberlike materials, is reproduced through the parameters' selection. The analysis of the effect of these parameters upon the stress-strain relationship was carried out. The equations take the form of the simple relations of linear theory of elasticity with four different relaxation times for a case of infinitesimal deformations.
The problem of model's development is discussed for a case, when the changing of the mechanical properties under large deformations takes place due to the structural modifications (not mentioning the reological effects). Then the "internal forces - extensions of corresponding bonds" dependences should be selected as non-linear functions.

Investigation of Mechanical Properties of Aluminum Alloys with Carbon Nanotubes

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Carbon nanotubes (CNT) and their mechanical properties were intensively investigated since the early 1990s. The main research was focused on using of CNT to reinforce polymer and ceramic matrices but the interest in metallic-CNT composites was grown considerably in the last decade. Such composites could have the potential applications in aerospace, automotive and sport industries where the light weight combined with high stiffness and strength properties is desired.
Unfortunately, the material data provided by manufacturers very often do not contain all necessary information to predict the behaviour of nanocomposite materials using different analyses tools. Additionally, due to high costs of nanocomposites, their experimental testing with conventional fracture methods suffers from high expenses too. On this reason different non-destructive techniques developed for the characterisation of advanced composite material properties is adapted for the testing of nanocomposite samples with small geometrical dimensions. Static approach using a three-point-bending test and two dynamic methods: impulse excitation method and inverse technique based on vibration tests were successfully applied for the non-destructive material properties characterisation of aluminum alloys with different CNT volume content. The dissipative material properties were characterised by a structural loss factor obtained by the peak-picking method analysing the frequency response functions of specimens in the points of resonance.
Nanocomposites used in the present investigation were made by adding CNT to molten aluminum alloy via gravity casting into a mould. An addition of CNT to the aluminum alloys did not yield a visible increase in their elastic properties. However, instability in the elastic

properties through the thickness of billet was observed. This could be explained by a gradient of CNT distribution and presence of pores due to the limitations of the gravity casting process. The experimental results show that addition of CNT to this aluminium alloy decreases their dissipative material properties for bending and twisting modes. It is necessary to note that investigated material contains pores and therefore it was not possible to obtain a clear dependence of the material loss factors on frequency for the specimens with different CNT volume content. The problem of a gradient of CNT distribution throughout the aluminium alloy and porosity of material could be probably overcome producing CNT-reinforced aluminum alloys using die casting.

Synthesis of Titanium Dioxide: The Influence of Process Parameters on the Structural, Size and Photocatalytic Properties

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Due to its low toxicity, chemical stability, low cost, high efficiency in the oxidation of organic and biological objects nanosized titanium dioxide is the most promising material for photocatalysis. Parameters affecting the properties of catalysts are specific surface area, the degree of crystallinity and the ratio of the TiO_2-crystalline modifications (anatase, rutile, etc.). Among these modifications of titanium dioxide, anatase is considered to be the most effective photocatalytic phase.

The main objective of this study was to prepare nanosized titanium dioxide characterized by higher photocatalytic properties compared with existing analogues via gel technology and sonochemistry from different precursor such as titanium chloride and titanyl nitrate. Different physical properties and photocatalytic activity of the synthesized materials were compared.

Materials have been investigated by the following methods: X-ray powder diffraction (ARL X'TRA diffractometer), sedimentation analysis (CPS Disk Centrifuge Model DC24000), Thermogravimetry and Differential Thermal Analysis (thermal analyzer STA 449^0S/4 G Jupiter Jupted) and transmission electron microscopy (TEM Tecnai G^2 Spirit Bio TWIN). The photocatalytic activity of the prepared materials in the aqueous media was evaluated through monitoring of the discoloration of organic azo dye methylene blue and methyl orange.

The influence of various factors on the photocatalytic activity of TiO_2 produced from different precursors by a gel and sonochemical methods was analyzed.

TiO_2 synthesized via the gel-precipitation from titanium chloride consisted of particles with anatase sizes of 9–18 nm depending on the calcination temperature. The size of detected particles for the gel-precipitation samples obtained from titanyl nitrate solutions equals 8–23 nm. The smallest TiO_2 particles of 6–11 nm were prepared by the sonochemical method from titanyl nitrate solutions.

The samples prepared by the sonochemical method are characterized by far better photocatalytic activities. The samples synthesized from the aqueous solution of titanium

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