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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Abstracts & Schedule

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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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TABLE OF ABSTRACTS

Nonlinear Shear Properties of Colloidal Suspensions of Nanoparticles

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Suspensions of nanoparticles of yttrium aluminum garnet doped by neodium in ethylene glycol and silicon dioxide in polyethylsiloxane liquid were studied by the resonance acoustical method [1, 2]. The liquid investigated was placed between one end of horizontal surface of piezoquartz and rested cover. The piezoquartz have been performed tangential oscillates at the resonance frequency of 73 kHz. Thus, the liquid was subject to shear deformations. The shear viscoelastic measurements of these suspensions at various concentrations showed a nonlinear dependence of real and imaginary shear moduli on shear deformation angle. The study of the investigated liquid also revealed that shear viscoelastic properties depend on concentration and size of particles.

Acknowledgement
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Gas Sensitivity of Graphene Films on Silicon Carbide Surface to NH_3 and $(CH_3)_2CH(OH)$ Vapours

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Gas sensors that can operate in extreme conditions, are in demand in modern industry. In this report, graphene is used as a gas sensitive layer of a gas sensor, because graphene has several unique electrophysical parameters, giving it an important advantage over other materials used for gas sensitivity.

A graphene film grown by using the method for vacuum thermal degradation of silicon carbide (SiC) enables us to obtain the high-quality graphene film over the entire surface of the

substrate. The topological pattern of the gas sensor has been designed and produced by applying a mask from a dielectric Al_2O_3 film on SiC. Use of different temperature regimes of SiC vacuum thermal annealing makes it possible to state that the highest quality graphene films are produced at 1300 °C. The study of gas sensitivity, dynamic characteristics of the sensor was carried out, and the dependencies of NH_3 and $(CH_3)_2CH(OH)$ vapors desorption from the sensor temperature for graphene films prepared at different temperatures were found.
The response time, recovery time, sensitivity threshold of graphene films to NH_3 gas and $(CH_3)_2CH(OH)$ vapors and the effect of the annealing temperature of SiC on the gas sensitivity of the investigated sensors were found. It was shown that graphene films obtained at the annealing temperature 1300 °C have almost two times higher sensitivity to NH_3 at a concentration 100 ppm compared to the samples obtained at the annealing temperature 1400 °C.
Sensitivity of graphene films to $(CH_3)_2CH(OH)$ vapours at a concentration 100 ppm was almost four times higher as compared to the samples obtained at the annealing temperature 1400 °C. It was found that the annealing temperature does not significantly affect the response time and recovery time of the sensor gas sensitivity. The prospects of the developed sensor for the analysis of highly toxic environments were shown.
Acknowledgement
This work was supported by The Ministry of Education and Science of Russian Federation, the State Task in the Sphere of Scientific Activities (project no.16.1154.2014/K). The equipment of the Sharing Center and REC "Nanotechnologies" of Southern Federal University was used for this study.

Features of Technology of SAW Devices

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The most common general scheme of manufacturing the SAW devices includes the following basic operations: production of the piezoelectric acoustic line (substrate), making master drawing and mask, metallization of the substrate, formation of interdigital transducer structures and contact tires, installation, assembly and sealing of the filter. Recently, for the manufacture of a photo mask is usually used phototypesetting machine that eliminates the master drawing manufacturing operation.
For the manufacture of the SAW device, substrates can be both single-crystal and polycrystalline (piezoceramic) materials. Single crystals with structural perfection, providing a small loss on the SAW distribution (about 0.1 – 0.5 dB/cm at frequencies of 1.5 – 2 GHz). In addition, they are stable over time and have highly reproducible parameters in the serial production.
Among the number of single crystal materials promising for use in SAW filters, there are bismuth germanate $Bi_{12}GeO_{20}$, iodate, lithium silicate, bismuth paratellurid TeO_2, selenium Se, and also zinc oxide film ZnO, aluminum nitride AlN on sapphire and others. Some of them have already been successfully used for the development of SAW devices. Recently, there was

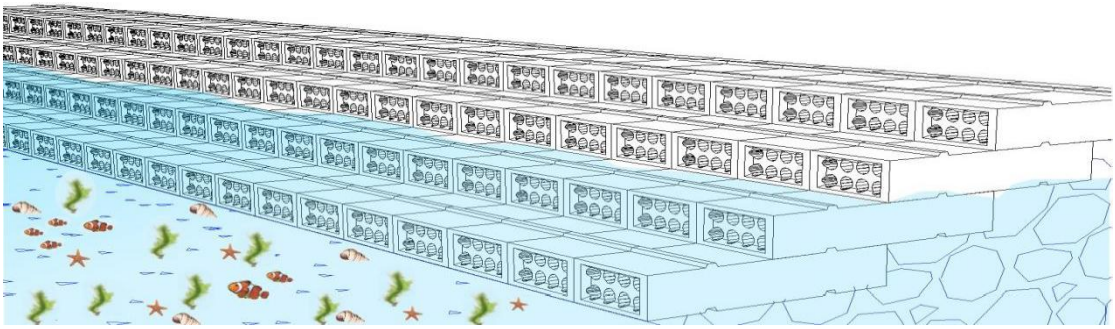

Fig. 3. Porous columnar armored blocks were arranged as decay wave revetment diagram (more clean than traditional type, more beautiful, more ecology, more hydrophilic)

Design Features of Rectangular Nanoscale Graphene/SiC Field Emission Cathodes

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Carbon nanomaterials are widely used in modern field emission electronics. Graphene is one of the promising carbon materials for vacuum field emission nanoelectronics. Structures based on graphene/silicon carbide have mechanical strength, high thermal conductivity, radiation resistance, performance and stability of film parameters. Stability of the parameters of field emission cathodes depends on homogeneity of the electric field between cathode and anode, which is mainly determined by optimal design of the emitter. A model of a rectangular nanoscale field emission cathode was considered to identify features of the emission characteristics of cathodes based on graphene films on SiC and effect of geometric parameters on electric field strength at an interelectrode distance 10–50 nm was studied.
The dependences of electric field strength on thickness, height of the field emission cathode and interelectrode spacing were graphically represented according to the simulation results and analytical calculation. The curves on the graphs from the analytical calculations and simulation results have similar character. The difference of the values of electric field strength is attributed to the fact that the analytical expression does not take into account local field amplification in the cathode ends, unlike the curves plotted are based on the simulation results. Reducing the width of the field emission cathode and interelectrode spacing promotes an increase of the electric field strength. Changing the height of a field emission cathode does not make a significant impact on the value of the electric field strength: there is a slight augmentation of the electric field strength with decreasing height. Local emission of the electrons from substrate begins at the height of cathode less than 100 nm. Inhomogeneity of the electric field along the field-emission cathode was established, which at its ends was 1.5–2 times higher than in the central part of the emitting surface. This augmentation of the electric field may be one of the reasons of emission current instability and premature degradation of

devices. It was proposed to optimize the design of rectangular emitter at its ends in order to reduce the gain of the electric field strength at this location. The results of studies are to be considered, when designing elements of field emission devices.

Acknowledgement

This work was supported by the Ministry of Education and Science of Russian Federation, the State Task in the Sphere of Scientific Activities (project no.16.1154.2014/K). The equipment of the Sharing Center and REC "Nanotechnologies" of Southern Federal University was used for this study.

Production of ZnO Based UV-Detector

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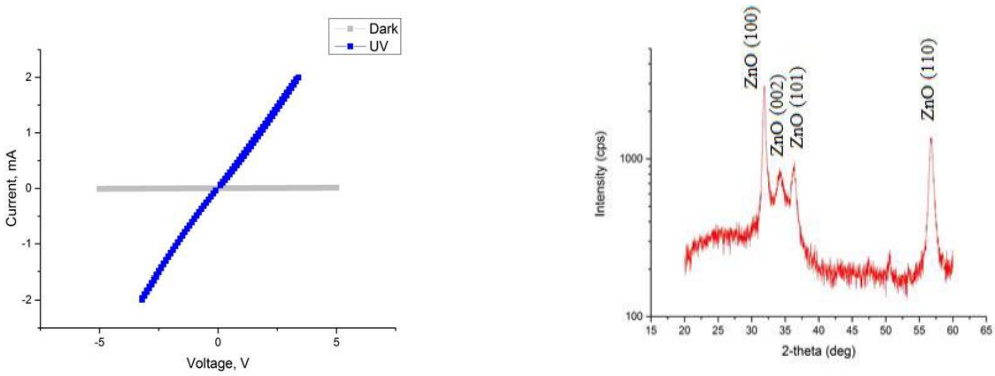
The implementation of zinc oxide thin films for detection of UV radiation has several advantages over the current technologies. The aim of the study was to investigate the influence of substrate and deposition process parameters on the film quality and the efficiency of UV detection. Samples were prepared on silicon, ITO covered glass and sapphire substrates. The optimal process parameters were determined experimentally: the concentration of zinc acetate of 0.045 mol, the amount of ethylene glycol monoethyl ether of 30 ml. The deposition temperature was varied in the range from 300°C to 450°C. On the ZnO films, grown on sapphire substrates, golden interdigital electrodes were deposited. The optimal growth temperature of 300°C was determined by analysis of XRD and current-voltage patterns. Fig. 1 shows the current-voltage characteristics and XRD-diffraction pattern of the film.



a) b)

Fig. 1. Current-voltage characteristics of the UV-detector based on ZnO film, grown on sapphire with golden interdigital electrode (a) and XRD-diffraction pattern of the ZnO film grown on ITO-covered glass at 300°C