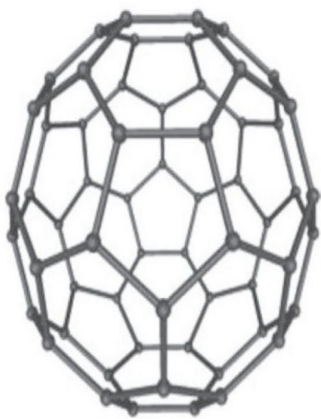


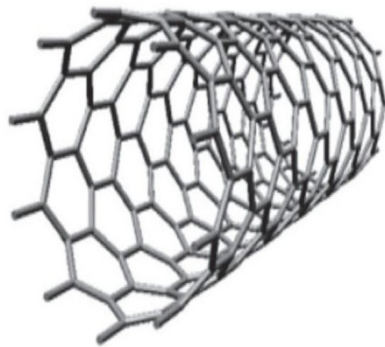
National Research Saratov State University

Department of English and Intercultural Communication

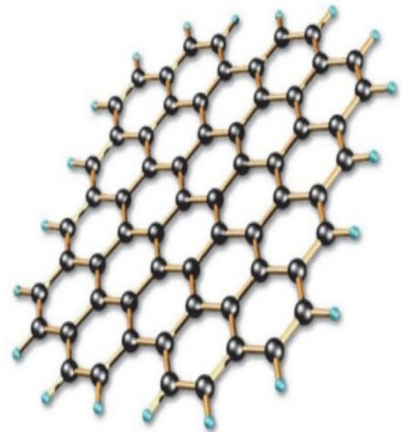
Department of Semiconductor Physics



fullerene



nanotube



graphene

**MICRO- & NANOTECHNOLOGY: RESEARCH &  
APPLICATIONS. THE SCIENCE FESTIVAL FOR  
YOUNG SCHOLARS**

Thursday, April 20, 2018

**Saratov**

**Convenor: Angelina I. Matyashevskaya** (Ph.D. in Linguistics, Associate Professor, Department of English and Intercultural Communication, SSU)

**Chairman: Anton V. Mitin** (Senior Lecturer, Department of Semiconductor Physics, SSU)

**Chairpersons:**

**Aleksandr G. Rokakh** (Doctor of Physics and Mathematics, Professor, Department of Semiconductor Physics, SSU)

**Sergey A. Sergeev** (Ph.D. in Physics and Mathematics, Associate Professor, Department of Semiconductor Physics, SSU)

**Vladimir F. Kabanov** (Ph.D. in Physics and Mathematics, Associate Professor, Department of Semiconductor Physics, SSU)

**Evgenii G. Glukhovskoi** (Ph.D. in Physics and Mathematics, Associate Professor, Department of Material Sciences and Technologies and Quality Management, SSU)

**Mikhail Iu. Kalinkin** (Ph.D. in Physics and Mathematics, Associate Professor, Department of Medical Physics, SSU)

**Executive Secretary: Elena V. Tiden** (Senior Lecturer, Department of English and Intercultural Communication, SSU)

## **PART 1**

### **1) Successes in the Cell Imaging by Confocal Raman and Fluorescence Microscopy**

**Abalymov Anatolii — Gent University, Belgium**

Porous calcium carbonate ( $\text{CaCO}_3$ ) vaterite particles are particularly attractive templates for the encapsulation of pharmaceuticals and construction of hollow polyelectrolyte capsules, sensors, and enzyme-catalyzed reactors. Despite the biocompatibility and the biodegradability of  $\text{CaCO}_3$ , little is known about the intercellular behavior and properties of vaterite particles in the cytoplasm of cells. We combine confocal Raman and fluorescent microscopy for imaging of porous  $\text{CaCO}_3$  vaterite particles in HeLa cells to study the uptake and the status of the particles inside the cells in real-time.

### **2) Control of Cell Behaviour Through Development of Alive Bacteria-Polyelectrolyte Composites**

**Rybkin Iaroslav, Lapanje Aleš — Jozef Stefan Institute, Slovenia**

Surface charge modification of the bacterial cells can increase their biotechnological potential tremendously since it affects their attachment to different surfaces, may induce formation of homo- or heterocellular aggregates. This paper proposes a highly efficient approach to polyelectrolyte multilayer deposition: the evidence suggests that bacterial cells entrapped in polyelectrolyte shells show delayed growth and slow down their division rate.

### **3) Self-Assembly of Quantum Dots under the Influence of Liquid Crystal Phase Transition**

**A.J. Al-Alwani — Babylon University, Iraq, SSU**

In this paper the liquid crystal monolayer of 4-octyl-4'-cyanobiphenyl (LC) at air-water interface was studied at different subphase temperatures. Upon varying surface pressure of liquid crystal monolayer, the surface potential per molecular area was recorded. The monolayer alignment was obtained from the surface potential measurements under different experimental conditions. The monolayer formation of quantum dots at the air-water interface was investigated. The phase-induced changes in liquid crystal could be used to create organized assemblies of quantum dots.

### **4) The Material of the Future. Synthesis and Characterization of CaCO<sub>3</sub> Microparticles Grown on Inorganic Nanofibers**

**Koronevsky Nikita — Faculty of Nano- and Biomedical Technologies, SSU**

Two different methods for growing the microparticles of calcium carbonate with polymer nanofibers with and without including of magnetite nanoparticles were used in this investigation. The optimum concentrations of solutions of calcium chloride and sodium carbonate and the optimum time for stabilization of calcium carbonate were investigated.

*Instructors — Sergeev S. A., Matyashevskaya A. I.*

### **5) Synchronization of Low-Frequency Processes in the Circulatory Regulation and Spectral Estimates of Heart Rate Variability in Newborns**

**Skazkina Victoria — Faculty of Nano- and Biomedical Technologies, SSU**

The paper investigates low-frequency processes of blood circulation regulation in newborns. 15 subjects took part in the experiment. Electrocardiogram and photoplethysmogram were recorded on the third day after birth. Spectral assessments of the state of autonomic regulation of blood circulation and the index of synchronization between low-frequency rhythms were calculated. Significant differences were found in the functioning of autonomic regulation of blood circulation in newborns and adults.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **6) The Temperature and Hemodynamic Response to Multiple Occlusion of Peripheral Blood Flow**

**Leschenko Alyona — Faculty of Nano- and Biomedical Technologies, SSU**

The reaction of the cardiovascular system to the occlusal test is used to detect endothelial dysfunction and to identify remote ischemic preconditioning of the myocardium. The usage of moderate hypoxia or repeated short-term hypoxic exposure is pathogenetically grounded and clinically promising method, that improves adaptive abilities of the body, thus enabling the treatment and prevention of oxygen-deficiency-related conditions.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **7) Methodology for Analyzing the A2B6 Semiconductor Quantum Dot Parameters**

**Gavrikov Maksim — Faculty of Nano- and Biomedical Technologies, SSU**

Direct methods (using a laser particle size analyzer) and indirect (the analysis of spectral characteristics and differential normalized tunnel CVC) methods allowed us to estimate the size of CdSe QD (4 - 5 nm) and shown good qualitative and quantitative agreement of the results (with the error of less than 10%). Thus, the tunnel differential CVC analysis is proved to be an effective tool of express analysis, that might be successfully implemented in the

investigations of quantum-size objects.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **8) The Effects of Size Quantization on the Protuberances of A3B5 Semiconductors**

**Ruhlov Nikita — Faculty of Nano- and Biomedical Technologies, SSU**

The effects of size quantization on the protuberances of A3B5 semiconductors are considered. Based on experimental data, conclusions are drawn about the characteristic dimensions of the quantum dots in materials of the A3B5 group

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **9) Synthesis and Properties of Conducting Metal-Ceramic Porous Structures Based on Anodic Aluminum Oxide**

**Shaturnyi Vladislav — Faculty of Nano- and Biomedical Technologies**

The paper examines the effect of the anodizing parameters on the spectral characteristics and geometric parameters of the structures obtained. The new method for additional expansion of pores was proposed. Moreover, this method might also improve the optical properties of structures based on anodic alumina.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **10) Creation of Electron-Positron Plasma in Strong Electric Field**

**Pirogov Stanislav — Faculty of Physics**

This paper investigates the issue that is related to one of the Quantum Electrodynamics effect and its theoretical description. A closed system of kinetic equations is used to describe the vacuum creation of an electron-positron plasma and secondary photons due to a strong electric field. The mathematical expressions are given physical interpretation.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **11) Brain-computer interface**

**Stepanenko Elizaveta — Faculty of Physics, SSU**

This paper provides a review of recent studies that are related to the use of brain-computer interfaces. Multiple training programs for BCI have been recently developed. They enable people, who naturally can't type, to successfully do it, by mentally choosing the right letter at the intersection of character strings and rows. The programs for posttraumatic rehab make use of biofeedback to restore the brain functions.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **PART 2**

### **1) Evaluation of Fe<sub>3</sub>O<sub>4</sub> nanoparticles loading efficiency into (sub)microcapsules of different structure by colorimetric titration method**

**Kozlova Anastasiya — 4 year; Faculty of Nano- and Biomedical Technologies, SSU**

In this study magnetite nanoparticles were synthesized by chemical precipitation. Microcapsules with Alginate/Ag shell and polyelectrolyte Parg/DS submicron capsules were formed as well. Obtained structures were functionalized with Fe<sub>3</sub>O<sub>4</sub> nanoparticles by freezing them into an inner volume or/and adsorption on a shell. Colorimetric titration method was used to determine ferrum oxide (III) nanoparticles concentration to evaluate the efficiency of loading by different methods.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **2) Computer Modeling of Schottky Diode C-V Curves for the Dopping Profile Controlling**

**Pyrev Sergei — 4 year; Faculty of Nano- and Biomedical Technologies, SSU**

In this paper the C-V characteristic of the Schottky diode has been investigated. The Poisson equation has been solved for the reverse voltage bias in metal-semiconductor junction. Modelling for different doping concentrations of ND was carried out.

*Instructors — Kalinkin M. I., Tiden E. V.*

## **3) The Dielectric Permittivity of Composites Based on the Polymeric Matrix with Polar Fluid Inclusions**

**Trifonova Maria — 3 year, Faculty of Nano- and Biomedical Technologies, SSU**

Nowadays the study of composites' properties finds promising application in telecommunication systems and construction of antennas, radars, and measuring equipment. This is due to the fact that adding various microinclusions to artificial dielectrics allows making deliberate changes to the electrophysical properties of composite materials. The paper examines frequency dependences of the real and imaginary part in composite complex permittivity based on the polymeric matrix with polar fluid inclusions.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **4) High Voltage Source as Lab Power Supply**

**Kolesov German — 3 year, Faculty of Physics, SSU**

This article characterizes the high voltage source and some experiments that the method claimed allows to perform. It is possible to tailor the device for a wide range of applications.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **5) Modern Methods of DNA Sequencing and Features of Their Application**

**Kovylin Igor — 2 year, Faculty of Physics, SSU**

The paper provides an overview of the modern methods of DNA sequencing, their working principles and differences, as well as practical application in genomics and bioinformatics.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **6) Digital Methods of Speckle Pattern Analysis**

**Kozinceva Nataliya — 2 year, Faculty of Physics, SSU**

Speckles carry information about the structure and movement of the biological objects and its components. Speckle-visualization proves to be a very effective method of studying and diagnosing biological objects. Using laser speckle-visualization, it is possible to obtain a full-field velocity map with respect to a large area of the object without scanning, with high temporal and spatial resolutions.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

## **7) Modeling Fluorescent Quantum Dots Using Comsol Multiphysics**

**Vetrincev Maksim — 2 year, Faculty of Nano- and Biomedical Technologies, SSU**

The paper considers some modelling methods at the nano- and micro-scales using Comsol Multiphysics. With the development of nanotechnology and the improvement of QD marking technology, they have promising application in optical and biological research, due to their unique physical and chemical properties. QDs are the most promising fluorescent markers. In particular, QDs have made great progress in the cellular imaging in recent years, showing far

more advantages than the traditional organic dyes.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **8) Analog-to-Digital Converters**

**Kobzev Eugene — 2 year, Faculty of Nano- and Biomedical Technologies, SSU**

The paper examines the types of ADCs and outlines their practical application. The main block diagrams are described. The article suggests that the single-chip light-to-frequency converter based on high-resistivity gallium arsenide has the comparative advantages of ease of use and affordability.

*Instructors — Mitin A. V., Tiden E.V.*

### **9) Magnetic Field Influence on CVCs of High-Resistivity GaAs Structure**

**Baranov Vladimir — 2 year, Faculty of Nano- and Biomedical Technologies, SSU**

The paper investigates the effect of a magnetic field on the I-V characteristics of the high-resistivity gallium arsenide structures with two "flat" contacts. The experimental setup and details of the methodology are described.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **10) 1D-Periodic Ewald Summation**

**Levitckii Semion — 2 year, Faculty of Physics, SSU**

In molecular dynamics simulations, a crucial and time consuming task is to compute the long-range interactions or particularly the electrostatic potential (or force) between charged particles. For systems that are subject to periodic boundary conditions, Ewald summation is a technique to evaluate these interactions. The paper presents a fast and spectrally accurate method for efficient computation of the three dimensional Coulomb potential with periodicity in one direction.

*Instructors — Mitin A. V., Matyashevskaya A. I.*

### **11) Investigation of hemodynamics using Windkessel Model ( electrical analog)**

**Kuznetsov Anton — 2 year, Faculty of Nano- and Biomedical Technologies, SSU**

To carry out hemodynamics simulations the mathematical models were used. The Windkessel model consists of eight subsystems, that allow to estimate the mechanical properties of the bloodflow. The differential equation is derived for systemic arterial blood pressure. Electronics Workbench was chosen as a simulation platform.

*Instructors — Kalinkin M. I., Tiden E. V.*

### **12) Graphene. The Breakthrough of the 21st Century.**

**Petrinin Aleksandr — 1 year, Faculty of Physics, SSU**

The aim of this paper is to provide a review of recent studies that are related to the use of graphene. It describes monocrystalline graphitic films, which are a few atoms thick but are nonetheless stable under ambient conditions, metallic, and of remarkably high quality.

*Instructors — Mitin A. V., Matyashevskaya A. I.*