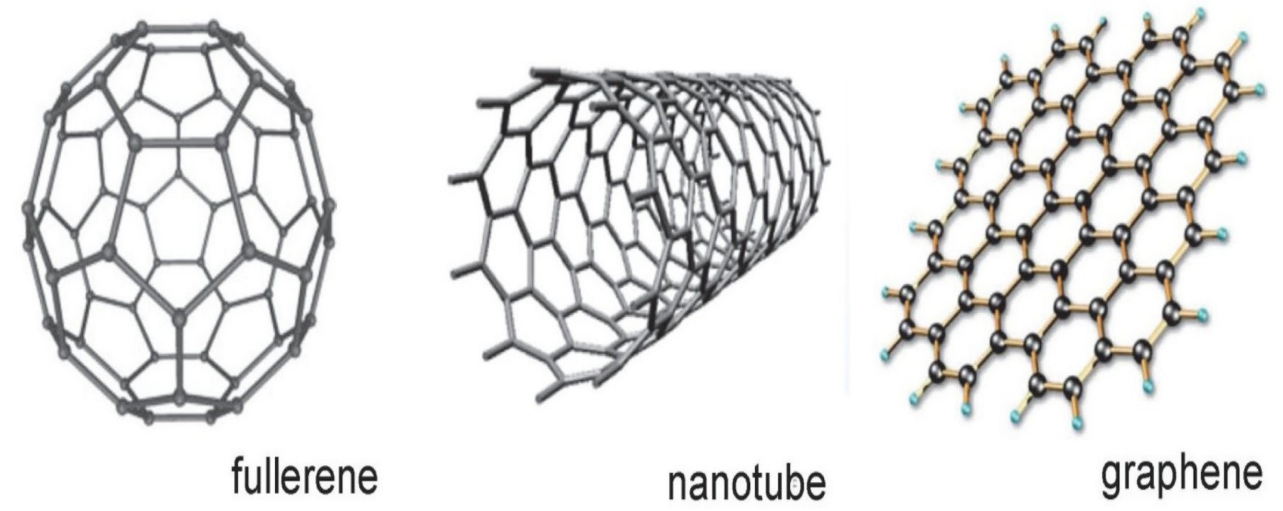
National Research Saratov State University

Department of English and Intercultural Communication

Department of Semiconductor Physics



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

Friday, April 19, 2019

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) Live-Cell Imaging by Confocal Raman and Fluorescence Microscopy Recognizes the Crystal Structure of Calcium Carbonate Particles in HeLa Cells
Abalymov Anatolii — Gent University, Belgium
Porous calcium carbonate (CaCO3) vaterite particles are very attractive templates for the encapsulation of pharmaceuticals and for the construction of hollow polyelectrolyte capsules, sensors, and enzyme-catalyzed reactors. Although CaCO3 is biocompatible and biodegradable, little is known about the intercellular behavior and properties of vaterite particles in the cytoplasm of cells. In this study we combined confocal Raman and fluorescent microscopy for the imaging of porous CaCO3 vaterite particles in HeLa cells to study the uptake and status of the particles inside the cells in real time. The results indicate that our imaging approach to examining inorganic particles in living cells may have theranostic applications.

2) United Tiny Fabrics as the Future For New Metabolic Pathways
Rybkin Iaroslav, Lapanje Aleš — Jozef Stefan University, Slovenia
Obtaining new valuable products by using the biotechnological processes has tremendous potential due to the possibility of the involvement of various microorganisms and formation of new joint metabolic pathways. To maintain such a complex system cells should share decomposed products within developed pathways, where one of the key factor is cell to cell interaction depending on the activity of the bacterial surface. Modifying the latter allows us to affect the process of attachment to different surfaces, that in its turn can induce formation of homo- or heterocellular aggregates, attachment of enzymes for faster start-up of bioreactor processes or keeping the desired surface charge. In our study we investigated the way different cells survived

the encapsulation process and proved that such modified cells showed tremendous ability to attach to different surfaces or control intercellular interactions between different bacteria.

3) Graphene Langmuir Layers: Specificity of Formation on the Water Subphase and Transfer on the Solid Substrate
A.J. Al-Alwani — Babylon University, Iraq, SSU
Graphene layers were studied on the water subphase in different conditions. Subphase pH and temperature were changed. Behavior of surface pressure (compression isotherms) and potential *vs* unique molecule surface were presented. Graphene films prepared on the solid substrate by Langmuir-Blodgett (LB) technique were investigated by scanning electron and atomic force microscopy. Experimental data have demonstrated the successful deposition of single graphene layer on the silicon substrate by Langmuir technique.
Instructor — Glukhovskoi E. G.

4) Voltage Dependence of MOS Capacitance at High Frequency
Olope Olumide Innocent — Faculty of Nano- and Biomedical Technologies, SSU
The report examines the operation modes of MOS capacitor. It investigates the variation of surface volume charge density with surface potential. Gate to bulk capacitance is calculated as a function of surface potential. The method for determining the doping density is considered. C-V measurements are performed using capacitance-voltage meter.
Instructor — Kalinkin M. Iu.

5) MOS Capacitance vs Bias Voltage at Low Frequencies
Novikov Aleksandr — Faculty of Nano- and Biomedical Technologies, SSU
The report examines the cross-section and potential band diagram of the MOS capacitor. The capacitance is investigated under various bias voltage conditions. Gate to bulk capacitance is calculated as a function of surface potential. Low frequency C-V measurements are performed using an LCR meter.
Instructor — Kalinkin M. Iu.

6) Estimating Arterial Resistance and Compliance
Ilicheva Mariia — Faculty of Nano- and Biomedical Technologies, SSU
A two-element windkessel model is introduced. The human arterial tree is modeled as an elastic chamber. The governing equations in the frequency and time domains are given. An electromechanical analogy of the cardiovascular system parameters was introduced. The human bioimpedance signal in the Multisim system is simulated. Vascular resistance and elasticity were determined by calculating the area under the rheosignal for two parts of the cardiac cycle
Instructor — Kalinkin M. Iu.

7) Controlled Decomposition of Porous Calcium Carbonate Particles
Shamsutdinova Elizaveta — Faculty of Nano- and Biomedical Technologies, SSU
The report proposes a model of controlled decomposition of porous calcium carbonate particles to determine the possibilities of further practical application of the existing synthesis methods, while ensuring both safety and high quality of the resulting product.
Instructors — Mitin A. V., Matyashevskaya A. I.

8) The Effect of Ethanol on the Transport of Methylene
Basko Elizaveta — Faculty of Physics, SSU
The main goal of the report is to investigate the effect of ethanol in aqueous solutions with 30, 40, and 50% volume concentrations on the transport of Methylene Blue (MB) in rat skin *ex vivo*. The

study has shown that the diffusion rate gets higher with the increase of ethanol concentration in the solutions. Ror 50%-ethanol solution the rate is 1.6 folds higher compared to aqueous solution.
Instructors — Mitin A. V., Matyashevskaya A. I.

9) Analysis of the Conduction Mechanism through InSb Nanoparticle by Tunnelling CVC Method
Gavrikov Maksim — Faculty of Nano- and Biomedical Technologies, SSU
The model representations of electronic conductivity mechanism through *InSb* nanoparticle was formulated and analyzed in accordance with the theory of field emission. Based on the analysis of tunneling current-voltage characteristics by various calculation methods a consistent value of InSb QD in the size range of 18-22 nm was obtained. Qualitative and quantitative agreement of the results for the sample illumination by a source of "white" light confirms the validity of the formulated model representations.
Instructors — Kabanov V. F., Matyashevskaya A. I.

10) Correlation between the Autonomic Regulation of Microcirculation and Large Arteries Blood Flow
Skazkina Victoria — Faculty of Nano- and Biomedical Technologies, SSU
The report examines the photoplethysmogram of the microvasculature and invasive pressure of patients after coronary bypass grafting. The data concerning the correlation between the autonomic circuits of the microcirculation regulation and the main blood flow is obtained.
Instructors — Mitin A. V., Matyashevskaya A. I.

11) The Temperature and Hemodynamic Response to Multiple Occlusion of Peripheral Blood Flow
Leschenko Alyona — Faculty of Nano- and Biomedical Technologies, SSU
A violation of the blood supply in the limbs is often a precursor of various diseases that reduce health-related quality of life and make the person more vulnerable to a cascade of life-threatening ills. It is common knowledge that nowadays diseases of the cardiovascular system, in particular coronary artery disease, are the leading causes of death globally. The extensive study of ischemic myocardial damage during cardiac operations led to the discovery of the phenomenon now known as ischemic preconditioning that is considered in the report.
Instructors — Mitin A. V., Matyashevskaya A. I.

PART 2

1) Obtaining Porous Anodic Aluminum Oxide (PAAO) and Ivestigating the Effect of the Physical and Chemical Parameters on its Properties
Mikhailov Ilya — 4 year; Faculty of Chemical Technologies, SSTU
The report examines the synthesis of porous anodic aluminium oxide, focusing on its basic parameters: type of electrolyte, anodizing voltage, anodizing temperature and aluminum purity.
Instructors — Mitin A. V., Matyashevskaya A. I.

2) Digital Methods of Speckle Images Analysis to Characterize the Flow of Objects
Kozinceva Nataliya — 3 year, Faculty of Physics, SSU
Nowadays methods of non-invasive analysis are widely used in medicine, biology and other sciences. One of the most accurate and relatively easy-to-use methods is laser speckle imaging. The purpose of this report is to determine the period of decorrelation, to study the phase correlation method and digital methods of processing speckle images to characterize the flow of

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

3) Modeling of Carrier Separation in CdSe-CdS Core-Shell Nanocrystals
Vetrintcev Maksim — 3 year, Faculty of Nano- and Biomedical Technologies, SSU
The colloidal CdSe-CdS core-shell nanocrystals were modeled using Comsol Multiphysics.The carrier distribution within the nanodot and nanorod is calculated using a numerical model based on Comsol Multiphysics. Using spherical geometry, the dependence of carrier separation on the core radius / shell thickness ratio was investigated. The obtained values are not much different from the experimental ones. Based on the results, it can be concluded that the higher probability of population inversion in CdSe / CdS core-shell nanocrystals can be reached in a spherical quantum dot with the core radius of 1.2 nm and the shell thickness of 1 nm.
Instructors — Mitin A. V., Matyashevskaya A. I.

4) The Effect of Illumination on the Current-Voltage Characteristics of GaAs Planar-Epitaxial Mesa-Structures
Kobzev Eugene — 3 year, Faculty of Nano- and Biomedical Technologies, SSU
The presentation provides an overview of the planar-epitaxial mesa-structure based on the epitaxial wafer of gallium arsenide and its current-voltage characteristics changes. The changes in the negative differential resistance area under illumination and the electrochemical physical behavior of analogous semiconductors semiconductor devices, such as photodiode, photoresistor are also considered.
Instructors — Mitin A. V., Matyashevskaya A. I.

5) Graphene Electronic Properties in Relation to its Structure
Levitckii Semion — 3 year, Faculty of Physics, SSU
The report provides the theoretical calculation results of graphene electronic and magnetic properties. Structure modeling and calculations are performed using software “Kvazar”.
Instructors — Mitin A. V., Matyashevskaya A. I.

6) Pillared Graphene: Modeling, Optimization and Calculations
Petrunin Aleksandr — 2 year, Faculty of Physics, SSU
Hybrid structure of graphene sheets supported by carbon nanotubes (CNTs) sustains unique properties of both graphene and CNTs. The superior multi-dimensional functionality of the VACNT-graphene structure provides many potential applications such as energy storage and gas separation membranes.
Instructors — Mitin A. V., Matyashevskaya A. I.

7) Everlast: Long-life, Supercapacitor-operated Wireless Sensor Node
Semionov Vladislav — 2 year, Faculty of Physics, SSU
The report provides an overview of a supercapacitor-operated, solar-powered wireless sensor node Everlast. Unlike traditional wireless sensors that store energy in batteries, Everlast's use of supercapacitors enables the system to operate for an estimated lifetime of 20 years without any maintenance. The novelty of this system lies in the feedforward, PFM (pulse frequency modulated) converter and open-circuit solar voltage method for maximum power point tracking, enabling the solar cell to efficiently charge the supercapacitor and power the node. Experimental results show that Everlast can achieve low power consumption, long operational lifetime, and high transmission rates, something that traditional sensor nodes cannot achieve simultaneously.
Instructors — Mitin A. V., Matyashevskaya A. I.

8) Synthesis and Investigation $CaCO_3$ Microparticles Grown on Inorganic Nanofibers
Sultanova Kamila — 2 year, Faculty of Nano- and Biomedical Technologies, SSU
The paper describes the synthesis of electrospun polycaprolactone fibers (PCL), modified by calcium carbonate nuclei ($CaCO_3$) and magnetite nanoparticles. The optimal concentration of calcium chloride and sodium carbonate solutions and optimum stabilization time of calcium carbonate were identified.
Instructors — Sergeev S. A., Matyashevskaya A. I.

9) Review of Atomic Force Microscopy Imaging Systems: the Operation Modes
Palnov Georgii — 1 year, Faculty of Physics, SSU
The atomic force microscope (AFM) system has evolved into a useful tool for direct measurements of micro-structural parameters and unraveling the intermolecular forces at nanoscale level with atomic-resolution characterization. The report provides an overview of different AFM operation modes.
Instructors — Mitin A. V., Matyashevskaya A. I.

10) Graphene and Carbon Nanotubes in MEMS/NEMS Applications
Nosov Kirill — 1 year, Faculty of Physics, SSU
Recently carbon based nanomaterials, including one-dimensional carbon nanotubes (CNTs) and two-dimensional graphene, have attracted considerable interest for various potential applications. The presentation reviews the key electrical and mechanical properties of graphene with the focus on their applications in sensors and actuators.
Instructors — Mitin A. V., Matyashevskaya A. I.

11) Working Principle of HEMT
Seleznev Mikhail — 1 year, Faculty of Nano- and Biomedical Technologies, SSU
In recent years, high electron mobility transistors (HEMTs) have attracted much attention in high-speed and high-power applications. One of the most interesting properties of these devices is the formation of the two-dimensional electron gas with a very high electron mobility at the hetero interface. The report describes the working principle of HEMT.
Instructors — Mitin A. V., Matyashevskaya A. I.

12) Porous Aluminum Oxide
Malcev Dmitrii — 1 year, Faculty of Nano- and Biomedical Technologies, SSU
The anodization of aluminum is an electro-chemical process that changes the surface chemistry of the metal via oxidation, to produce an anodic oxide layer. During this process a self organized, highly ordered array of cylindrical shaped pores can be produced with controllable pore diameters, periodicity and density distribution. This enables anodic aluminum oxide (AAO) membranes to be used as templates in a variety of nanotechnology applications without the need for expensive lithographical techniques. This presentation provides an overview of the current state of research on AAO membranes and the various applications of nanotechnology that use them in the manufacture of nano-materials and devices or incorporate them into specific applications such as biological/chemical sensors, nano-electronic devices, filter membranes and medical scaffolds for tissue engineering.
Instructors — Mitin A. V., Matyashevskaya A. I.