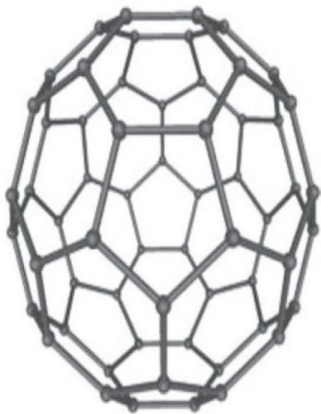


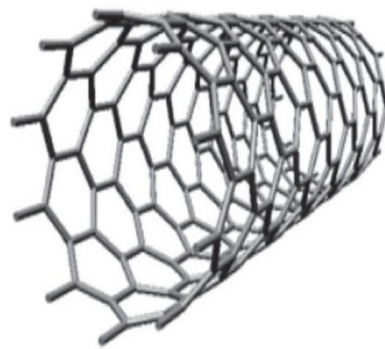
National Research Saratov State University

Department of English and Intercultural Communication

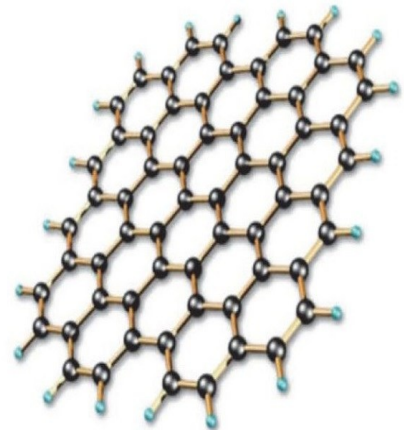
Department of Semiconductor Physics



fullerene



nanotube



graphene

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

April 28, 2021

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)

**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) A Special Technique for Studying the Electrophysical Properties of Liquid Media, Colloidal Solutions and Suspensions**

**Shamsutdinova Elizaveta — Kotelnikov Institute of Radioengineering & Electronics of RAS**

Recently researchers have shown an increased interest in various new materials based on polar and non-polar liquids which can be colloidal solutions, emulsions, suspensions, and other mixtures. We have created a cell that has the properties of universalism, performance, compatibility, making it possible to investigate the electrophysical properties of liquid media using various experimental equipment.

*Scientific advisors — Kuznetsova I.E., Fionov A.S.*

**2) PWM Controller as the Pulse Oscillator**

**Kolesov German, Vasin Konstantin — Institute of Physics, SSU**

The PWM controller models were considered in this report. With the help of LT-spice program we considered the scheme work simulation. We've focused on some characteristics of PWM controllers: the rise and fall time in different modes (active and complex loads) and also maximum/minimum repetition and duty cycle range. We've created the pulse PWM controller oscillator and experimentally proved that the duty cycle range and pulse amplitude variation depend on repetition rate (for the frequency variation from 9 KHz to 510 KHz the duty cycle range changes from 25% to 7%). This device can be applied in cross-disciplinary research such as geology, chemistry, pulse technique and electronics.

*Scientific advisors — Andrianov V.G., Kolosov D.A.*

**3) Response to External GHz and THz Radiation of  $K^+@C60$  Endohedral Complex in Cavity of Carbon Nanotube Containing Polymerized Fullerenes**

**Levitckii Semion — Institute of Physics, SSU**

We investigate how the electrical conductivity of a functionalized nanotube affects its absorption of THz radiation. The nanotube is a periodic structure made from C60 fullerenes that are regularly polymerized with each other and with a nanotube wall with a step of several nanometers. A  $K^+ @C60$  complex, where  $K^+$  is a positive potassium ion, oscillates freely in the THz range in a potential well in the nanospace between polymerized fullerenes.

*Scientific advisor — Shunaev V.V.*

#### **4) Influence of Acid Electrolyte Concentration on the Synthesis of Nanostructured Porous Anodic Aluminum Oxide (PAAO)**

**Mikhailov Ilya** — Faculty of Chemical Technologies, SSTU

Nowadays researchers are showing an increased interest in nanostructured materials. Porous anodic aluminum oxide (PAAO) is a self-organized material with honeycomb-like structure formed by high density arrays of uniform and parallel pores. It possesses unique physical and optical properties and ensures a high mechanical strength. Membranes based on nanoporous alumina are used in nanotechnology, microbiology, nuclear physics, and instrumentation.

*Scientific advisor* — Kosobudsky I.D.

#### **5) Method for Analyzing the Electrophysical Properties of Semiconductor Quantum Dots**

**Gavrikov Maksim** — Institute of Physics, SSU

Some important properties of the InSb and CdSe quantum dots, such as size and energy spectrum, were studied by method of normalized differential tunneling current-voltage characteristics. The results of size evaluation are qualitatively and quantitatively consistent with the results obtained by TEM and analysis of spectral dependence of absorption coefficient and luminescence with an error less than 15%. During the study it was also shown, that method of normalized differential tunnelling current-voltage characteristics also allows us to analyze the energy spectrum of semiconductor quantum dots (position of the first three energy levels).

*Scientific advisor* — Kabanov V. F.

#### **6) Electronic Spectrum Analysis of Indium Antimonide Quantum Dots Using Comsol Multiphysics**

**Vetrintcev Maksim** — Institute of Physics, SSU

Changing the periodical potential inside the quantum dots by the impurity alloying has a significant effect on the spectrum of charge carriers. Two cases of alloying are considered: 1. the impurity is in the center of the quantum dot and is located in the center of the quantum well, respectively. 2. the impurity is near the surface of the quantum dot and is located at the quantum well barrier. The findings suggest that the impurity insignificantly affects the electrons spectrum in QDs, but this indicates the resistance of this material to defects resulting from technological production.

*Scientific advisor* — Kabanov V.F.

#### **7) Investigation of the Production Methods and Properties of a New Composite Material**

**Kildisheva Veronika** — Institute of Physics, SSU

Three methods of obtaining a new composite material based on polycaprolactone fibers, calcium carbonate microparticles and magnetite nanoparticles are presented, as the release time of the substance loaded into the microparticles is determined.

*Scientific advisor* — Sergeev S.A.

## **PART 2**

#### **1) Conductivity and Band Structure of 2D Composites Based on Graphene Sheets and Nanotubes**

**Petrinin Aleksandr** — 4 year, Institute of Physics, SSU

Being a single sheet of graphitic carbon, graphite offers us great advantages owing to its high surface area, good conductivity, and excellent mechanical properties. Models of four different types of nanostructures were studied: monolayer CNT, Monolayer CNT/graphite – carbon nanotube on a graphite monolayer substrate, Bilayer CNT – cross-lying nanotubes, and Bilayer CNT/graphite – substrate-cross-lying carbon nanotubes on graphite. The report investigates the stability, zone structure and Fermi energy, conductivity and transmission function of the 2D composite.

*Scientific advisor* — Glukhova O.E.

**2) A Modified Apparatus for Measuring VSWR Spectra and Transmission of Liquid Dielectrics**  
**Shchiptsov Roman, Andreev Anton — 2 year, Institute of Physics, SSU**

To reduce the experiment time and ensure automation of the measurement process of reflection and transmittance spectra of microwave radiation in the 3-cm range, we've developed an apparatus consisting of a panoramic VSWR, attenuation meter R2-61 and Arduino Mega.

*Scientific advisor — Sergeev S.A.*

**3) Electromagnetic Radiation of the Terahertz Range**

**Velikanov Iliia — 1 year, Institute of Physics, SSU**

One of the promising areas of fundamental science is the research of the terahertz spectrum of electromagnetic waves (the range of 0.1-10 THz). Since this radiation is yet to be fully investigated, new devices operating in the terahertz range are being actively developed, and its new properties are discovered.

*Scientific advisor — Sergeev S.A.*

**4) Means of Targeted Drug Delivery**

**Kalinova Aleksandra — 1 year, Institute of Physics, SSU**

Nowadays the formation of polyelectrolyte capsules and their properties are attracting considerable attention due to the wide range of their practical applications. The report focuses on the issue of targeted drug delivery and its applications, provides an overview of some changes in the properties of the polyethylene capsules and shows how the temperature range affects the capsule solubility.

*Scientific advisor — Lomova M.V.*

**5) Field-Effect Integrated Circuits**

**Korobko Mikhail — 1 year, Institute of Physics, SSU**

We review the main features and applications of Field-Effect Transistors. They are widely used in electronics today. Field-Effect Transistors are relevant now, and will be relevant in the near future.

*Scientific advisor — Mitin A.V.*

**6) The Influence of Water Dispersions of Metal Nanoparticles on the Development of Insect Larvae**

**Nikelshparg Matvei — MAOU «Gymnasium №3»**

One of the important tasks of enterprises synthesizing nanoparticles is the study of their effects on living organisms. For example, there is an active search for new antibacterial drugs using metal nanoparticles. The aim of our work was to study the effect of aqueous dispersions of silver and gold nanoparticles on insects, starting from the larval stage. We have established the negative effect of aqueous dispersions of nanoparticles of metals of gold and silver on insects: *Aulacidea hieracii* and *Eurytoma cynipsea*.

*Scientific advisors — Glinskaya E. V., Anikin V. V.*