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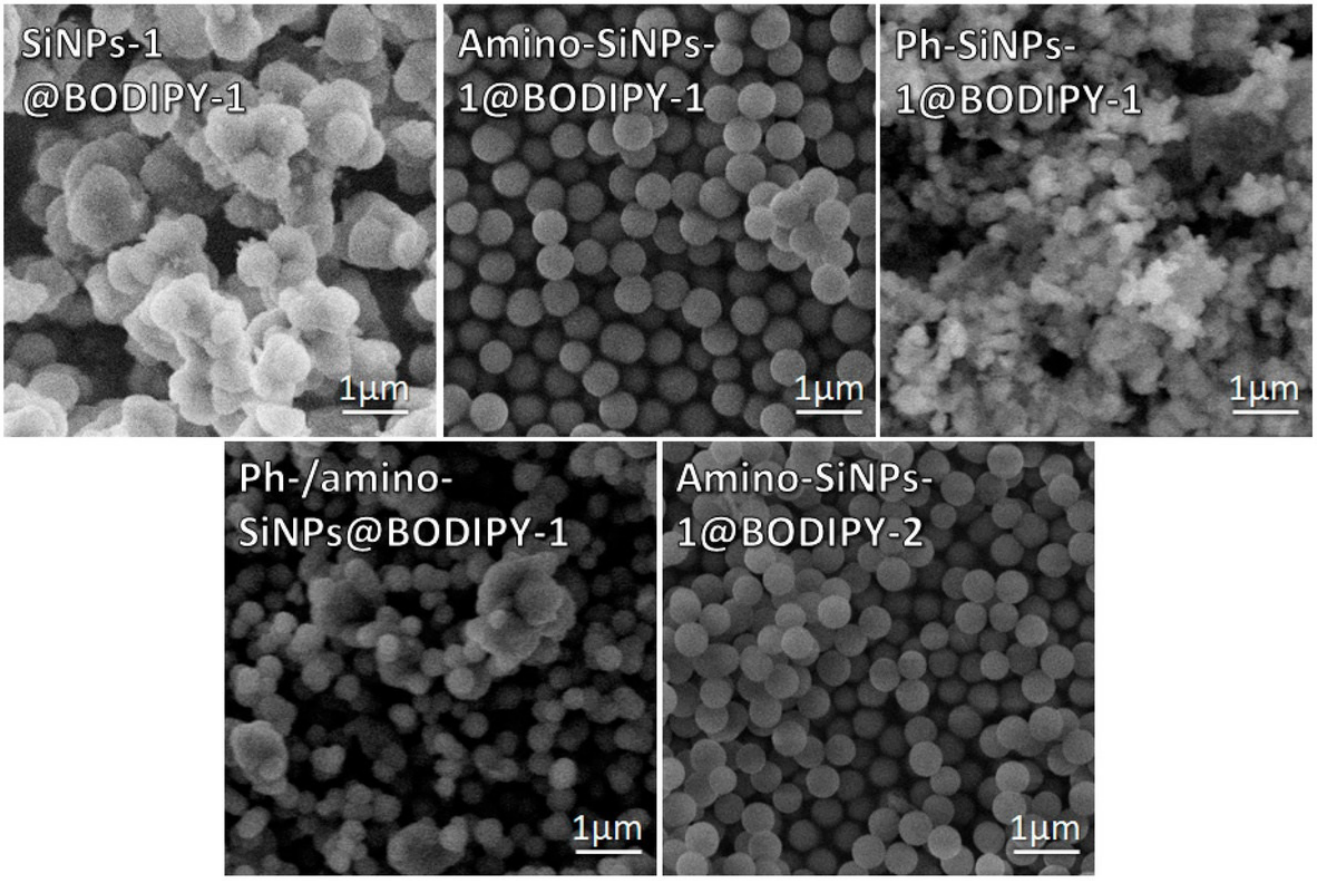


New approach for obtaining BODIPY-doped silica nanoparticles and study of their uptake by cancerous cells

The design of cargo carriers with high biocompatibility, unique morphological characteristics, and capability of strong bonding of fluorescent dye is highly important for the development of a platform for smart imaging and diagnostics.

In this study research group have successfully developed the new approach for obtaining BODIPY-doped silica nanoparticles via “one-pot” soft-template method. This method allows preparing silica-based materials with definite morphology, size, structure, and functional groups. Obtained particles have been shown to be non-cytotoxic and can be effectively internalized into the cervical cancer cell line (HeLa). The described method of synthesis allows scientist to obtain silica-based carriers with an immobilized fluorescent dye that provide the possibility for real-time imaging and detection of these carriers.

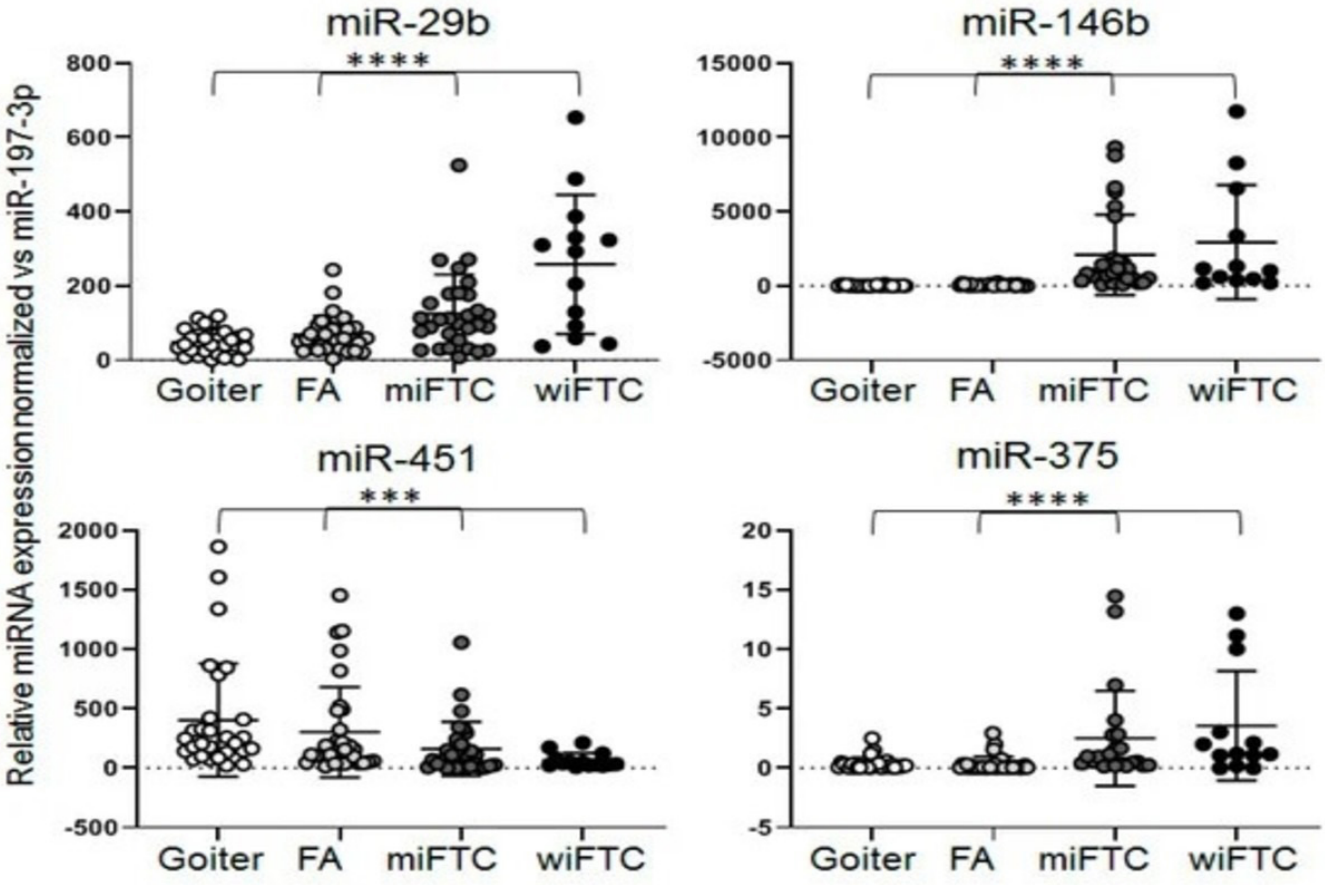
This paper is a result of collaboration with Ivanovo State University of Chemistry and Technology, Ural Federal University, Pavlov University, St. Petersburg State University, National Research Tomsk Polytechnic University and Ivanovo State Polytechnic University.

Key words: *silica nanoparticles, soft-template, oil-in-water, one-pot synthesis, BODIPY, biophysics*

SPbPU Department: Department of Biophysics

Publisher: Molecules

Link to the publication



Biologists studied dysregulation of miRNAs due to malignant phenotype of follicular thyroid tumor

Over the last few years, incidental thyroid nodules are being diagnosed with increasing frequency with the use of highly sensitive imaging techniques. The ultrasound thyroid gland examination, followed by the fine-needle aspiration cytology is the standard diagnostic approach. However, in cases of the follicular nature of nodules, cytological diagnosis is not enough. Analysis of miRNAs in the biopsy presents a promising approach. There is a need to increase knowledge of

miRNA’s role in follicular carcinogenesis and development of the appropriate miRNA analytical technologies are required to implement miRNA-based tests in clinical practice.

Scientists applied a new bioinformatics method (MiRImpact) to evaluate the biological significance of the observed expression alterations. The invasion-associated miRNAs expression alterations were assayed. Researchers suggest that the results can help to distinguish truly malignant follicular thyroid cancer from indolent follicular adenoma.

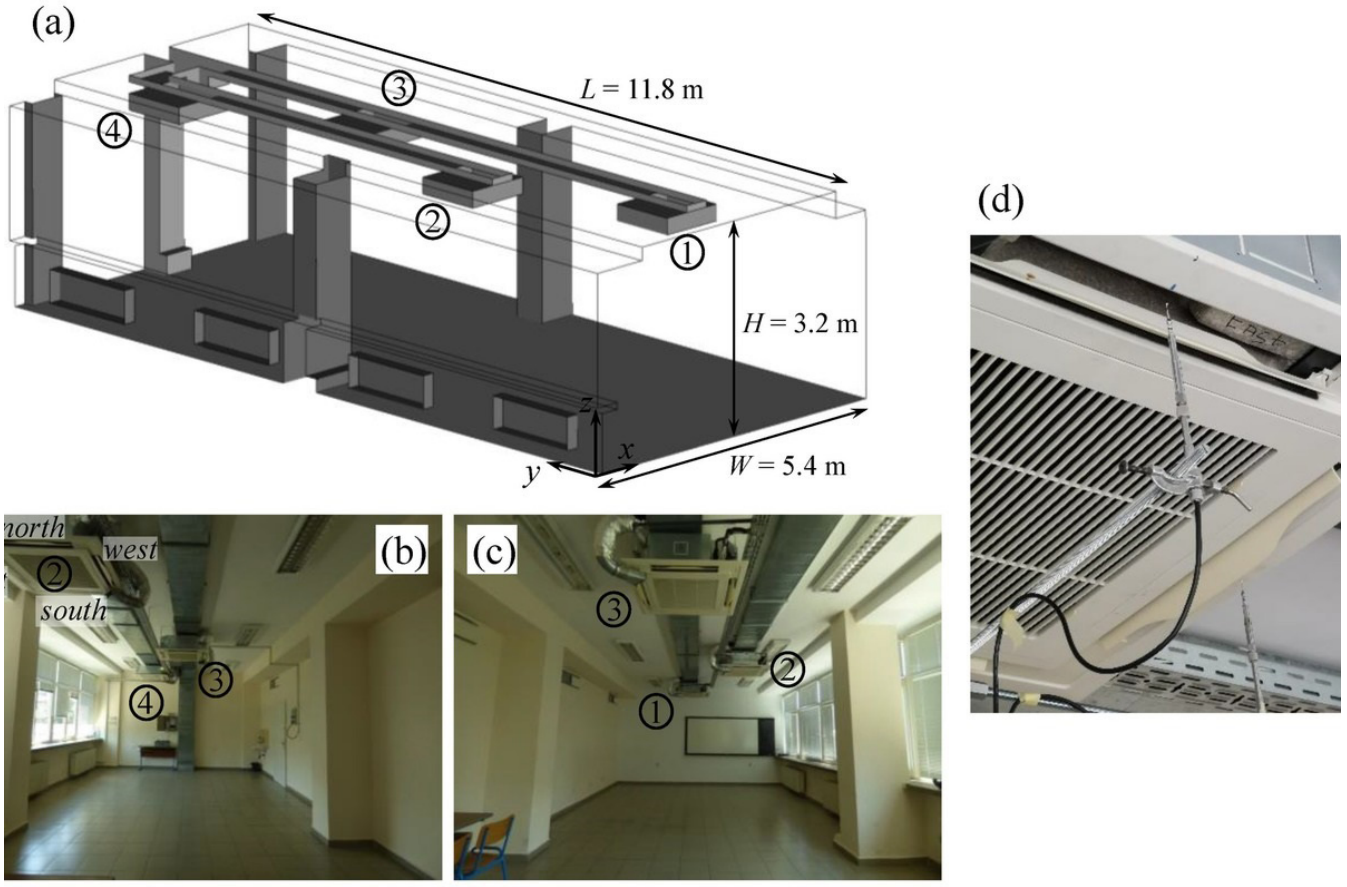
This study was conducted in collaboration with researchers from Petrov National Medical Center of Oncology, Oncosystem Company Limited, ITMO University, Sechenov First Moscow State Medical University, Omicsway Corporation (CA, USA), Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry and National Center of Clinical Morphological Diagnostics.

Key words: *follicular thyroid cancer, follicular adenoma, miRNA, RT-qPCR, reciprocal dysregulation, invasion, biotechnology, biological sciences*

SPbPU Department: Institute of Biomedical Systems and Biotechnologies

Publisher: International Journal of Molecular Sciences

Link to the publication



Study of draught rate assessment in indoor spaces

The indoor environmental quality (IEQ) depends on both indoor air quality and human comfort - thermal, visual, acoustic. A lack of IEQ could lead to different discomforts and health problems. The objective of the study was to demonstrate the importance of the unsteady Computational Fluid Dynamics (CFD) simulations and long-term measurements for the reliable assessment of thermal comfort indoors.

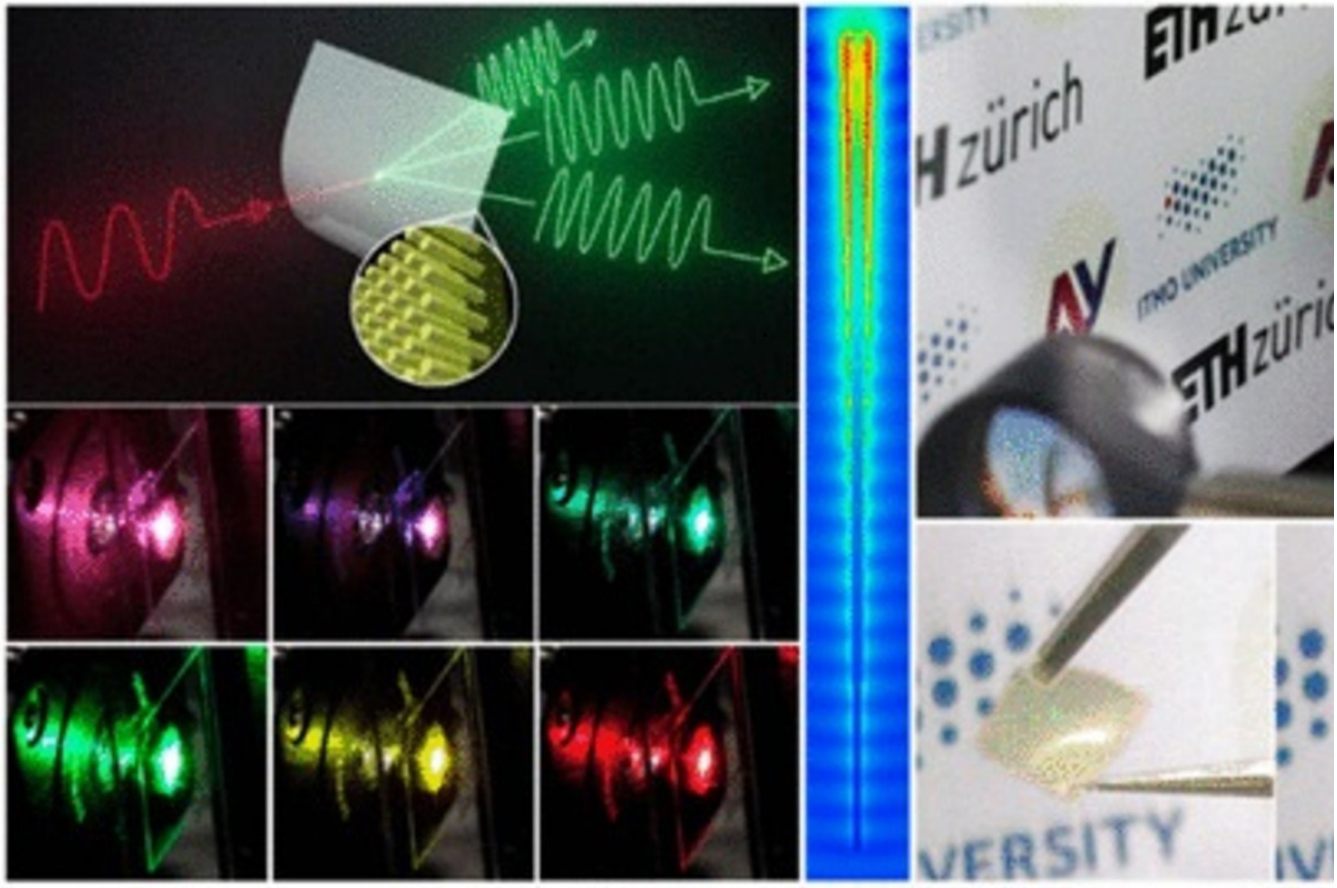
The paper presents the results of a combined numerical and experimental study of room air movement in a test university classroom with a controlled indoor environment. Both the 3D field results computed with the unsteady RANS technique and the real-scale long-term point velocity data measured with the thermo anemometer report about strong unsteadiness of the airflow. This study was conducted together with engineers from Technical University of Sofia.

Key words: *ventilation, thermal comfort, experimental measurement, numerical simulation, URANS modelling, CFD validation, draught discomfort, civil & structural engineering*

SPbPU Department: Department of Fluid Dynamics, Combustion and Heat Transfer

Publisher: Applied Sciences (Switzerland)

Link to the publication



Study of Gallium Phosphide Nanowires in a Free-Standing, Flexible, and Semitransparent Membrane for Large-Scale Infrared-to-Visible Light Conversion

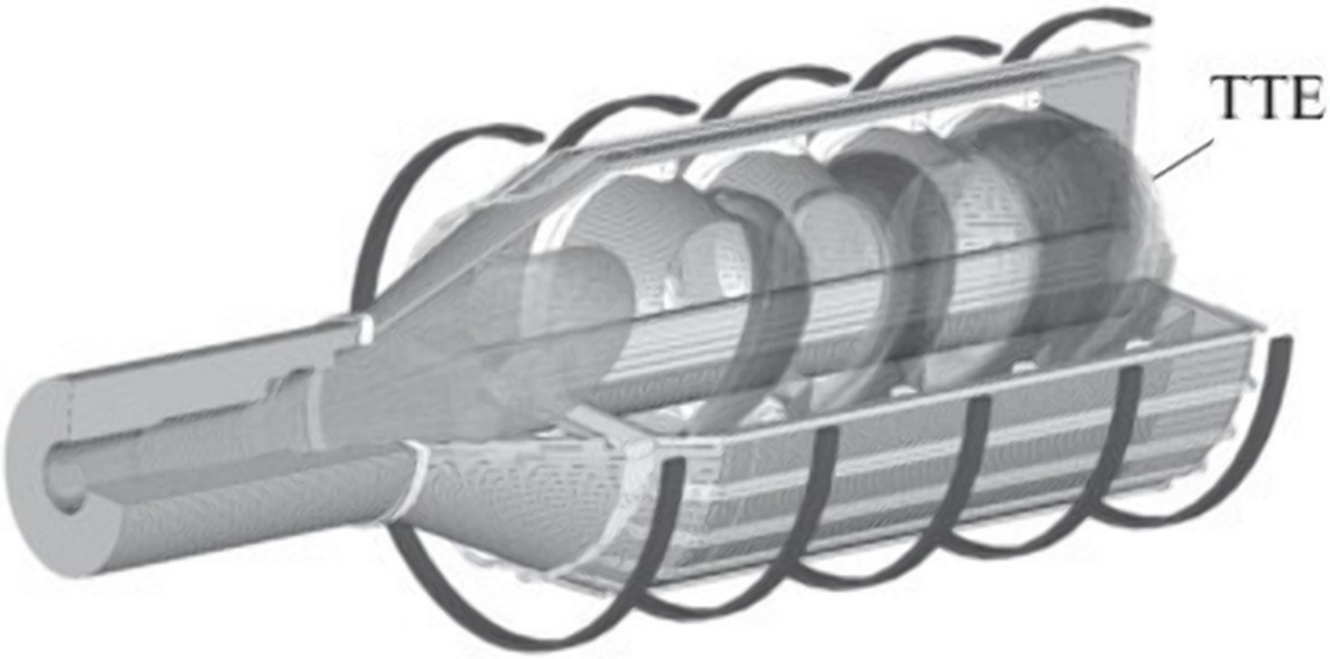
Engineering of nonlinear optical response in nanostructures is one of the key topics in nanophotonics, as it allows for broad frequency conversion at the nanoscale. Nevertheless, the application of the developed designs is limited by either high cost of their manufacturing or low conversion efficiencies.

This study reports on the efficient second-harmonic generation in a free-standing GaP nanowire array encapsulated in a polymer membrane. Light coupling with optical resonances and field confinement in the nanowires together with high nonlinearity of GaP material yield a strong second-harmonic signal and efficient near-infrared (800–1200 nm) to visible upconversion. The fabricated nanowire-based membranes demonstrate high flexibility and semitransparency for the incident infrared radiation, allowing utilizing them for infrared imaging, which can be easily integrated into different optical schemes without disturbing the visualized beam. The study was performed in collaboration with Alferov University and ITMO University.

Key words: *nonlinear nanophotonics, second harmonics, infrared imaging, flexible devices, nanowires, nanotechnology*

Publisher: ACS nano

Link to the publication



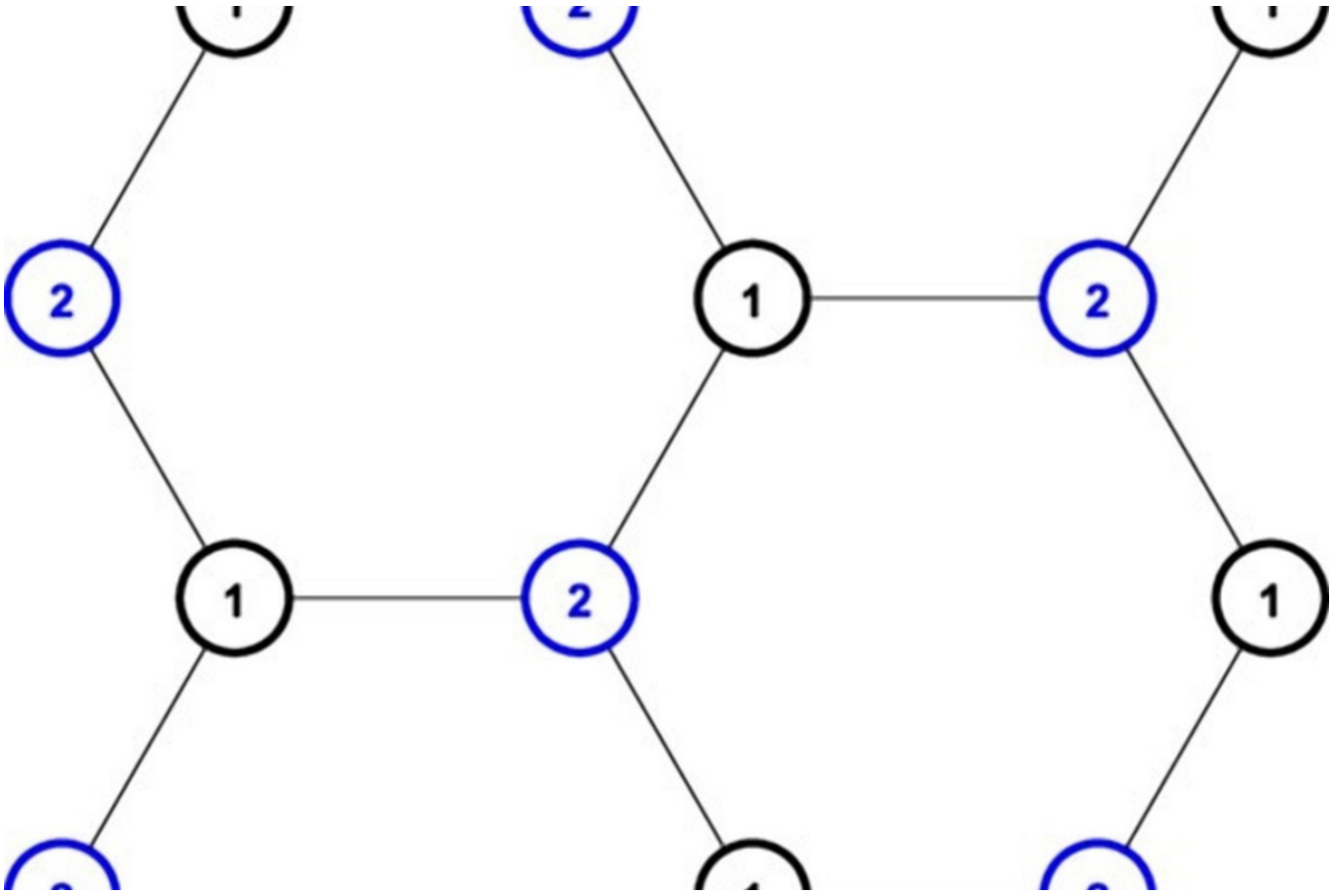
Development of a Collector with Multistage Recuperation for Gyrotron

A four-stage collector system is developed for the experimental gyrotron at the Peter the Great St. Petersburg Polytechnic University. It is based on spatial separation of electrons with different energies in crossed electric and magnetic fields. Researchers determined conditions of use of this system for the efficient recuperation of electron residual energy in a spent beam. The numerical simulation of the recuperator and the analysis of the electric and magnetic field distribution in the gyrotron collector region were accomplished. Theoretical estimations and trajectory analysis of the helical electron beam show that system provides the electron residual energy recuperation necessary to achieve total gyrotron efficiency over 70%.

Key words: *electrons, magnetic fields, gyrotrons, electrical & electronic egineering*

Publisher: Journal of Communications Technology and Electronics

Link to the publication



Geometrically nonlinear dynamic model for a hexagonal lattice

In this study it has been shown that angular stiffness in the hexagonal lattice model plays a significant role in the geometrical nonlinear terms in the equations of the continuum limit. Researchers developed a geometrically nonlinear discrete model for the hexagonal lattice by considering the interaction of two sublattices. An asymptotic procedure was developed in order to obtain the nonlinear coupled equations of motion in the continuum limit of the discrete model. An interaction of longitudinal and shear plane strain waves is studied by using the solutions of the obtained equations.

The localized strain waves may propagate keeping their shape and velocity. This is important for problems of nondestructive testing and durability of materials. It also might be useful for a development of the new heat conduction models based on the analysis of the nonlinear crystalline lattice.

This study was conducted together with scientists from Institute for Problems in Mechanical Engineering and Technische Universität Berlin

Key words: *crystal lattices, equations of motion, shear flow, strain, continuum mechanics, lattice dynamics, mechanics, physics*

Publisher: Physical Review E

Link to the publication

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