

Research Institute “Nanotechnology and nanomaterials” at G. R. Derzhavin Tambov State University

The Tambov region of the Russian Federation has 2 centers of excellence in nanoscience and nanotechnology. One of them is aimed at fundamental and exploratory research as well as R&D in nanometrological equipment. It is part of the G. R. Derzhavin Tambov State University. The second center is engaged mainly in applied and technological developments and subordinate to Tambov State Technical University. They loosely cooperate, in particular, in the field of development of new nanocarbon materials and products made of them.

Further information concerns the Research Institute “Nanotechnology and nanomaterials” of G. R. Derzhavin Tambov State University which was created in 2015 on the basis of the Scientific- Educational Center having the same name. The latter was organized in 2007 in the framework of the National Priority Project “Education” and was further developed in 2010–2011 at the expense of the federal budget in accordance with the federal target program “Development of infrastructure of the nano-industry in the Russian Federation” and the University assets. The Scientific-Educational Center is a structural unit of the National Nanotechnology Network of the Russian Federation.

The main strategic goals of the Research Institute “Nanotechnologies and nanomaterials” include:

- fundamental studies in the field of physico-chemical properties of nanostructures and nanomaterials (in particular, nano-carbon, ceramic, metallic, polymeric, composite and nano-porous ones);
- R&D work, the creation of innovative technologies, products and services and bringing them to the stage of commercialization (including nanodiagnostic equipment, new structural and functional nanomaterials);
- creation of start-ups and their development up to the level of stably operating hi-tech companies;
- transfer of nanotechnologies, production of nano-products, scientific and technical support for hi-tech projects in industry;
- training the staff at Masters and postgraduate courses;
- involvement of talented youth into the sphere of science, innovation and high technology;
- popularization of knowledge in the field of NANO-.

At present, the Research Institute “Nanotechnologies and nanomaterials” includes scientific-educational centers “Nanotechnology and nanomaterials” and “Nanobiotechnology”, Students’ Design Bureau “Nanobioinformatics” and 5 innovative small businesses (LLC) created with participation of the University according to Federal Law No. 217

The research laboratories of SEC “Nanotechnology and Nanomaterials” carry out fundamental and applied studies in the following areas:

1. New types of zirconium ceramics.

Our scientists, independently or in collaboration with specialists from Zircoa Inc. OH, USA are developing new types of zirconium dioxide-based ceramics for different functional purposes with improved performance characteristics from natural raw material, namely, baddeleyite, the large deposits of which are located in Russia. The stabilized nanostructured zirconium ceramics has the unique combination of properties, including high wear and fire resistance, chemical inertia, ion conductivity. Up to date there have been obtained test samples of high-strength zirconium ceramics on the basis of natural mineral baddeleyite, which are not inferior in their operating parameters (e.g. hardness and fracture toughness) to traditional ceramics from much more expensive (5 – 8 times as much) chemically synthesized precipitated zirconium dioxide.

2. Nanodiagnostic nanotechnological equipment.

This block is being developed by our scientists in collaboration with experts from LLC “Nanodiagnostics Ltd” (Tambov) and includes:



Photo 1. Students Training in the electron microscopy laboratory



Photo 2. The study of nanostructured matrix tensile strength in the laboratory of micro- and macromechanical testing



Photo 3. The staff at work in the laboratory of micro-Raman spectroscopy

a) universal dynamic nanotesters to study physico-mechanical properties of materials and coatings in the nanoscale;

b) the instruments for characterization of powders and other loosely coupled systems (they are patented and unprecedented);

c) equipment sets for magnetic pulse processing of iron ore in order to increase its concentrability during subsequent extraction of useful components (have no analogues).

3. Technologies and equipment for controlling biochemical processes using low-frequency magnetic fields in the presence of magnetic nanoparticles.

The scientists from SEC “Nanotechnology and Nanomaterials” together with the specialists from LLC “Nanomaterials Ltd” (Tambov), scientists from Chemistry Department of M. V. Lomonosov Moscow State University and nano-medicine centers of Nebraska and North Carolina State Universities (USA) have developed and commercialized an original line of equipment for innovative nano-medicine platform, which is designed for targeted drug delivery, their controlled release and remote activity control, as well as drug-free treatment of cancer using magnetic nanoparticles activated by non-heating magnetic field.

Trial deliveries of the developed equipment have been made to various research centers and industrial enterprises located both in Russia and abroad.

SEC “Nanobiotechnology” was founded in 2015 on the basis of medical ecology and nanotoxicology laboratory which has been functioning since 2008. The main areas of research and applied activities of SEC “Nanobiotechnology” are:

- research in the field of nanobiotechnology, nanomedicine, nano- and ecotoxicology;
- creation of innovative agricultural fertilizers;
- development of methods for the detection of technogenic nanoparticles in biological objects;
- evaluation of biocompatibility of nanomaterials;
- research and methodology support for the developments in the field of nanobiotechnology and nanomedicine.

SDB “Nanobioinformatics” was organized in 2012 with the purpose of developing students’ creative abilities, supporting their research activities and training specialists familiarized with the latest achievements of science and technology. To date, SDB “Nanobioinformatics” is actively developing and highly demanded subdivision of the Research Institute “Nanotechnology and nanomaterials” in which the students under the supervision of highly qualified specialists perform research and design projects at a high professional level.

All the above listed structural subdivisions of the RI “Nanotechnologies and Nanomaterials” are successfully operating on the principles of self-financing and achieving world-renowned theoretical and applied outcomes, published in top-rated international journals, such as *Angewandte Chemie International Edition*, *Journal of Controlled Release*, *Colloids and Surfaces*, *Journal of Magnetism and Magnetic Materials*, *Journal of Material Research*, *Philosophical Magazine*, *Scripta Materialia*, *Molecular Physics*, *Solid State Physics*, *Crystal Growth*, *Physics of the Solid State*, etc.

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