Sumy State University

Nanomaterials for medicine and environment

SUMY STATE UNIVERSITY
2, Rymskogo-Korsakova str.,
40007 Sumy, Ukraine
http://sumdu.edu.ua/int/

Sumy State University (SSU) is a higher education institution of the classical type, which offers a wide range of educational programs in engineering, IT, humanities and medicine from bachelor to post-doctoral degree. SSU trains over 16,000 students in different educational levels on 60 majors, 40 areas and 25 fields of knowledge. Currently about 1,400 foreign students from more than 50 countries are an immutable part of SSU student family. The languages of instruction are Ukrainian, Russian and English (for the list of majors, please, follow: http://sumdu.edu.ua/int/en/academics/academic-programs.html).

According to the global internet ranking WEBOMETRICS SSU is in TOP-5 universities of Ukraine. In the national ranking Sumy State University occupies the third position in the category "Classical Universities".

SSU constantly widens its geography of international partnerships. Today the number of partners is about 200 universities in the USA, Great Britain, Germany, Austria, Belgium, Sweden, France, Poland, Lithuania, Bulgaria, Czech Republic, Slovakia, Romania, Japan, South Korea, Japan, the Russian Federation and other countries of the world. (for more information about SSU partners, please, follow: http://sumdu.edu.ua/int/en/international-coorperation/partners/583.html).

Sumy State University is a reliable partner for international educational and research grant projects: Framework Programme, Horizon 2020, Tempus, Erasmus Mundus, Erasmus+ of the European Commission, intergovernmental bilateral research projects; grants of national academies of science of European countries, United Nations Development Programme, the World Bank, the Federal Ministry of Education and Research of Germany (BMBF), German Research Center (DFG) etc. (more information on: http://sumdu.edu.ua/int/en/international/academic-projects.html).

In accordance with the standards of European education, SSU actively implements academic mobility programmes of short-term and long-term studying, practical training and skills upgrading for students and academic staff.

Our best students have an opportunity to study on double degree programmes, provided by SSU together with universities in Germany, Poland and China.

SSU academics work in Polish, British, German, French and Russian universities as visiting staff.

Sumy State University welcomes researchers and professors from foreign universities, what is an important factor in providing high quality education and research.

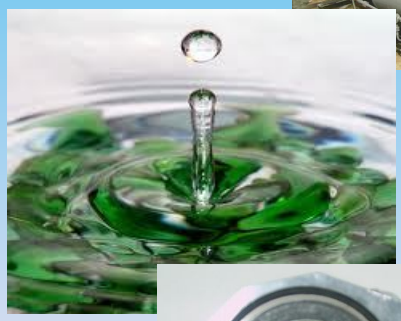
Sumy State University welcomes for international cooperation in a wide range of academic activities, research and innovation projects.

Sumy State University
RESEARCH ACTIVITY

ENERGY EFFICIENCY

- Heat-generating units;
- expansion turbine – electrical generator units;
- thermotransformers for heat and water supply systems;
- system of monitoring building's energy and resource consumption.

ECOLOGY AND ENVIRONMENTAL ECONOMICS

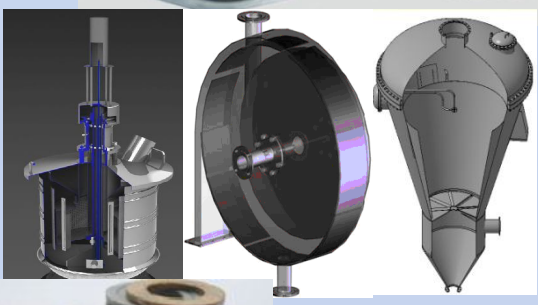


- Preparation of "climate projects";
- inventory of pollutant emissions;
- protection of the atmospheric air and a water basin;
- treatment of domestic and industrial wastes;
- ecological economic problems of heat power engineering;
- management of environmental quality;
- cross-border cooperation of ecological development;
- economic evaluation of ecological damage.

ENGINEERING

- Sealing mechanics and vibrodiagnostics;
- pumps and compressor equipment;
- milling technologies for non-uniform surfaces;
- processing technologies of composites and mixed packets.

CHEMICAL AND FOOD INDUSTRY



- Equipment for granulation of fertilizers and powdered food products;
- separators of the inertial-filtering type;
- vortex heat and mass transfer devices;
- homogenizer units;
- food bio additive technologies in stockbreeding.

NEW MATERIALS

- Film materials for nanoelectronics and sensor technologies;
- biocompatible medical materials;
- semiconductor materials for optoelectronics and solar power engineering;
- composite and powder materials;
- technologies of micro- and nanosized superhard coverings.

ELECTRONICS AND INFORMATION TECHNOLOGY

- Devices of microwave electronic technology;
- turbo mechanisms control systems;
- self-learning intellectual information systems of management;
- IT-systems of distance research;
- modern computer technologies of design;
- Integrated computer systems design;
- distance learning systems.

MEDICINE

- Molecular-genetic, chemico-toxicological and bacteriological research
- treatment and diagnostic research.

SOCIAL COMMUNICATIONS AND INNOVATIVE DEVELOPMENT

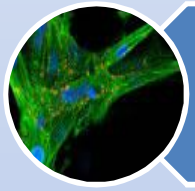
- Gender research;
- socio-political research;
- applied research on social communications and philology;
- sustainable development economics;
- management of enterprise innovative development;
- marketing and management of innovations.

More information on: http://sumdu.edu.ua/int/en/research/scientific-products.html

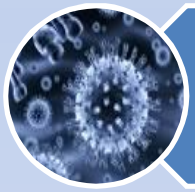
Nanomaterials for medicine and environment

Chitosan-hydroxyapatite for bone replacement

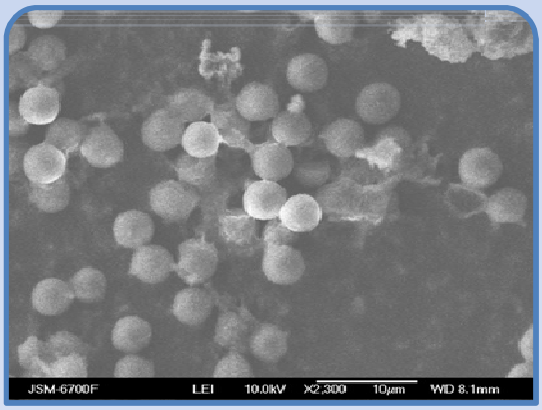
Chitosan-based sorbents for environment management



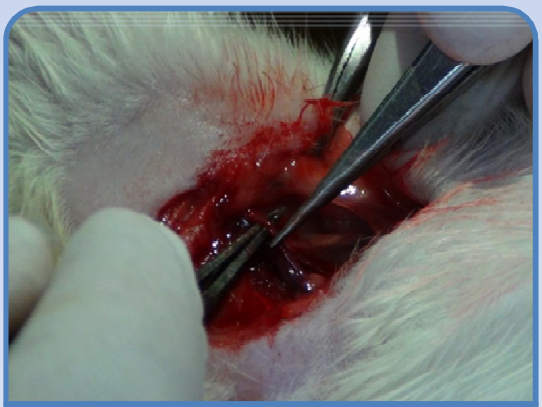
Chitosan-based materials for tissue regeneration



Chitosan based composites for nanoparticle release



Nanomaterials characterization

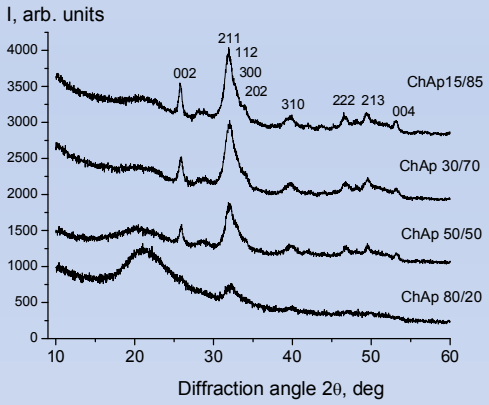


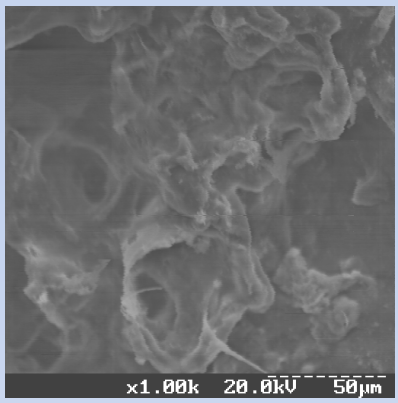
Animal Modeling Center

Chitosan- hydroxyapatite for bone replacement

Chitosan/hydroxyapatite composites has been synthesized in aqueous medium from chitosan solution and soluble precursor salts by a one step coprecipitation method.

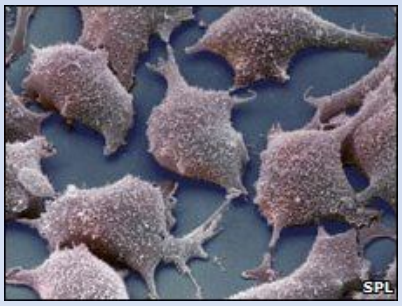
- The major absorbance bands of IR spectra correspond to hydroxyapatite, though their width increases significantly and the bands characteristic to chitosan appear as the chitosan content increases.
- XRD patterns suggest the presence of nanocrystalline apatite, its crystallinity decreases as content of chitosan increases





Properties of new materials:

1. Non-toxic
2. Non-allergenic
3. Osteoconductive
4. Osteoinductive
5. Absence of cell and general toxicity
6. Have antibacterial properties



Future research:

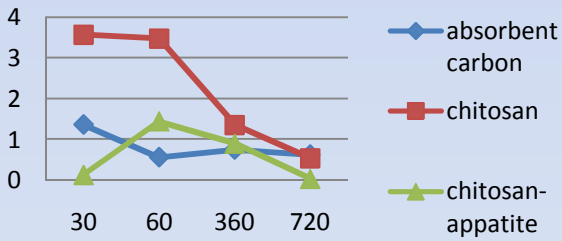
1. Combine materials with other nanoparticles to increase osteoinductive and antibacterial properties
2. Improve distribution of nano-apatite on chitosan matrix

Chitosan-based sorbents for environment management

- Environmental security is a major challenge in the development of society.
- Curently, one of common toxins are trace elements (TE), that enter the body in various ways, including nutritional. Most of the known sorbents exhibit high absorption properties for this type of toxicants, however, the development and research of new sorbents is an actual medical and ecological problem. Natural polymeric adsorbents are very promising for the concentration and removal of TE from aqueous solutions. These adsorbents can be used to clean the environment (pollution, industrial wastewater, drinking water, etc.), and for the elimination of trace elements from internal environment (chelators).

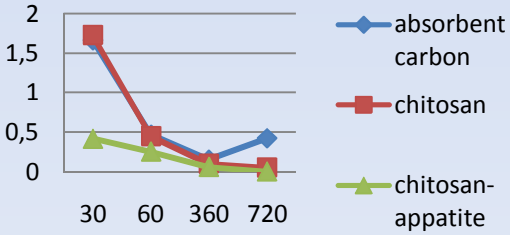
One of the promising materials for sorbent is chitosan which is linear natural polysaccharide. High sorption activity of chitosan was noted in a number of papers, thus noted that the active centers in the sorption processes are amino groups, which form complexes with metal ions. The combination of chitosan with the mineral component changes sorption activity of the polymer. An additional component, not only affect the sorption activity but also overcomes the solubility of chitosan under acidic conditions. In our work we investigate the sorption capacity of chitosan in combination with hydroxyapatite.

Iron



We obtain new chitosan-based sorbents in granular form with nano-hydroxyapatite. New sorbent have high efficient to some trace elements such as Cu, Fe, Co, Pb.

Cadmium

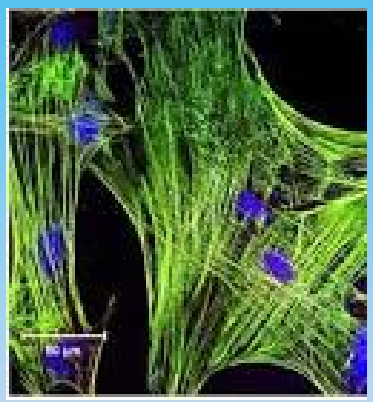


Future research:

1. To make experiment on sorption in different environmental media (water, waste etc.)
2. Study the dependence of sorption on the temperature and pH of the medium

Chitosan-based materials for tissue regeneration

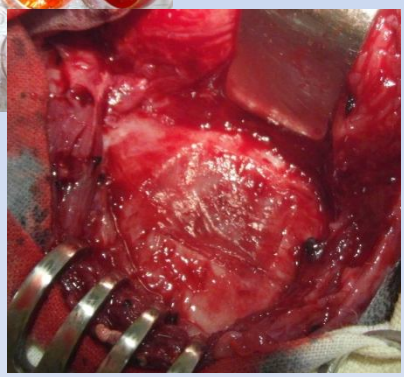
At present time biomaterials use for joint and cochlear replacements, as a bone plates, bone cement, artificial ligaments and tendons, dental implants for tooth fixation, blood vessel prostheses, heart valves, skin repair devices (artificial tissue), contact lenses, breast implants, drug delivery systems, vascular grafts, and stents etc.

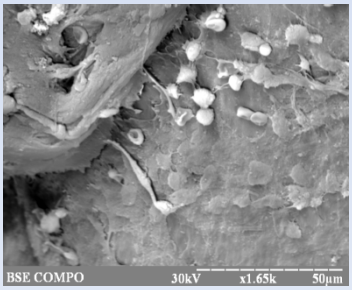


Our group has created two types of materials for tissue regeneration: chitosan films and chitin-chitosan composites. We used chitosan films as a wound healing agent and chitin-chitosan composite for duraplasty.

Our materials:

- Induce tissue regeneration
- Prevent inflamation
- Have no acute and chronic total body toxicity
- Have no pyrogen response, skin irritation and hemolysis activity



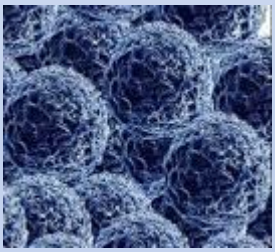


Future research:

1. Combine chitosan-based materials with ion nanoparticle to improve antibacterial effect
2. Combine chitosan-based materials with drugs and active molecules to improve regeneration properties

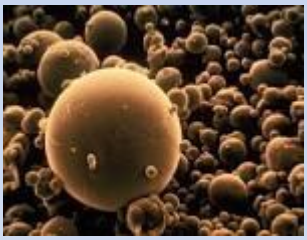
Trace elements nanoparticle as a antimicrobal drugs

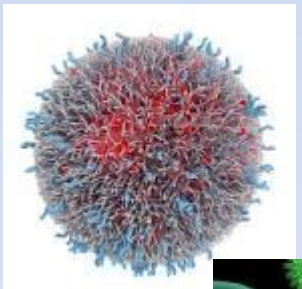
Several factors, including the widespread use of broad-spectrum antibiotics and invasive devices have contributed to the emergence of some bacteria as important pathogens and perhaps most important is their extensive resistance to a wide range of antimicrobial agents. These properties allow this organism to survive and multiply with a selective advantage over other flora in a hospital environment where antimicrobial agents are extensively used.



The extensive use of chemotherapeutic antimicrobial agents has generated the selective pressure to encourage the escalating rates in antimicrobial resistance and increase the necessitates of the search for new alternatives to antimicrobials. In this regard, the metal nanoparticle is one of the most promising candidates to create a new class of antibacterial agents since they have low toxicity and a prolonged action.

We make nanoparticles of nickel, chrome and iron and incorporate it to the chitosan matrix. It is allow to make slow release of nanoparticle and their prolong effect to microorganisms.





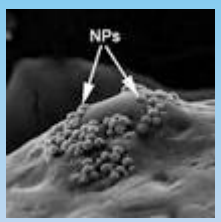
Future research:

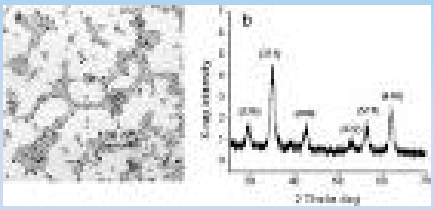
1. Evaluation of the NPs (nickel, chromium and iron) antimicrobial activity against clinical strains of intestinal and lung pathogens
2. Evaluate effectiveness of NPs bounded with chitosan matrix
3. Study the influence of the nickel, chromium and iron NPs on enzymatic activity of different microbal strain

Nanomaterials characterization and Animal Modeling Center

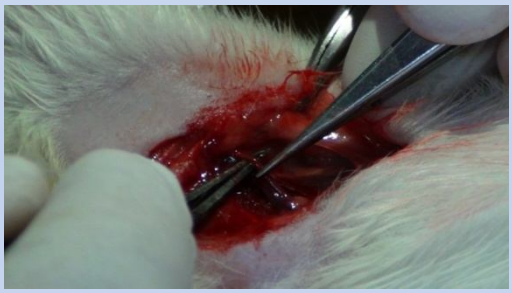
Our University used following facilities for nanomaterials testing:

- Scanning Electron Microscopy
- Transmission Electron Microscopy
- X-Ray diffraction
- IR-spectroscopy
- Atomic absorption spectroscopy





Animal Modeling Center have wide range of animals such as rats, mice, rabbits, dogs etc. We used following models:



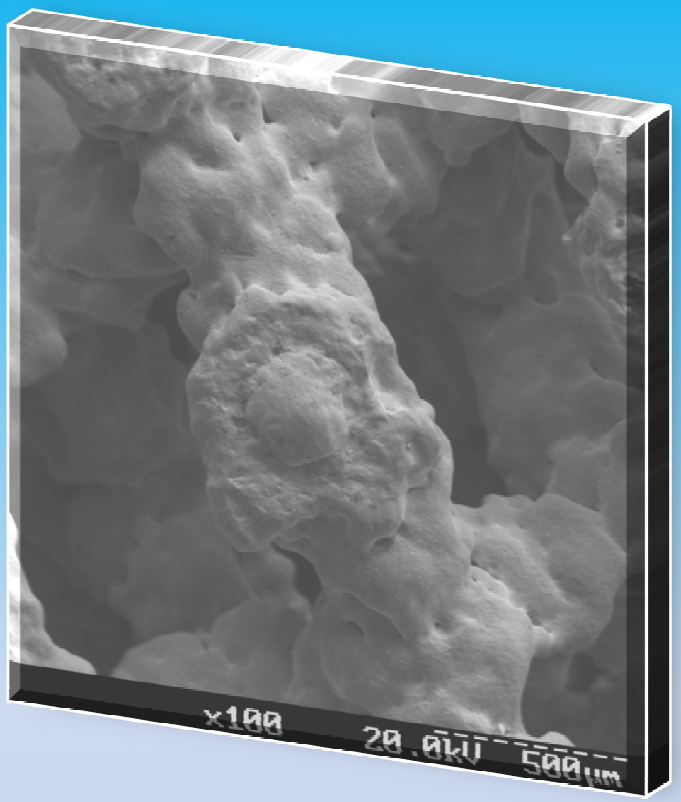
- Bone defects healing in normal condition and during different pathologies
- Skin defect
- Dura mater defect
- Vascular grafting
- Modeling of different diseases such as diabetis melitus, heart and brain stroke etc.

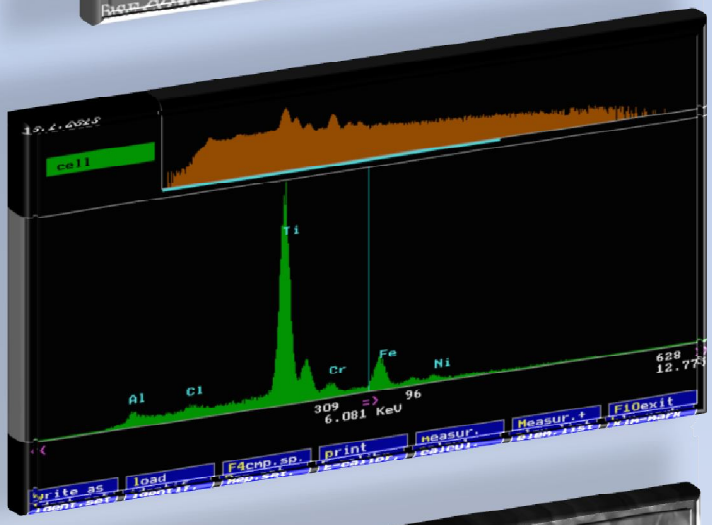
We can make following in-vivo tests to obtain:

-Cell and general toxicity
-Allergenicity
-Tissue response
-Bacteriological studies
-DNA analysis

Samples	*K+	**K-	700 2%	700 1%	500 5%	500 3%	500 2%	200 5%	200 3%	200 2%
Results	++++	-	N/A	-	++++	++++	-	++++	++	-
Image										

*positive control – erythrocyte mass and agglutinating serum
**negative control - erythrocyte mass and saline solution


x100 20.0kV 500µm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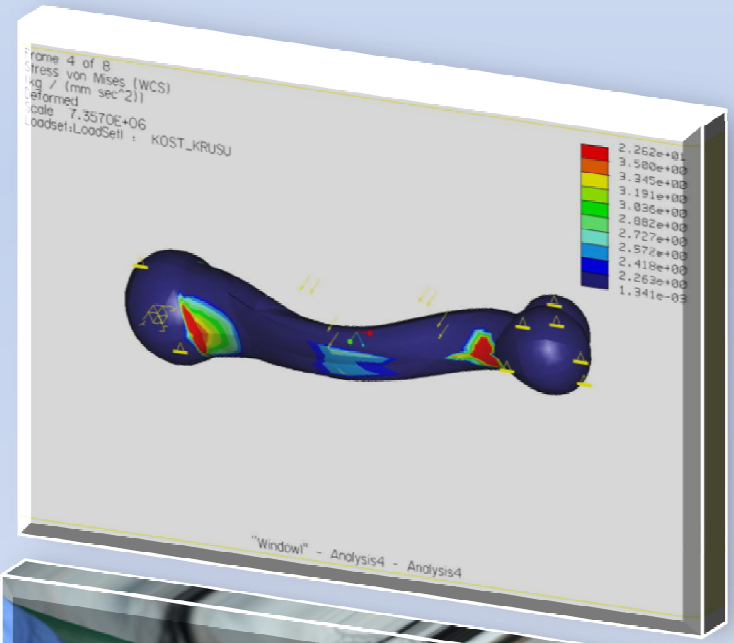
Frame 4 of 8
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