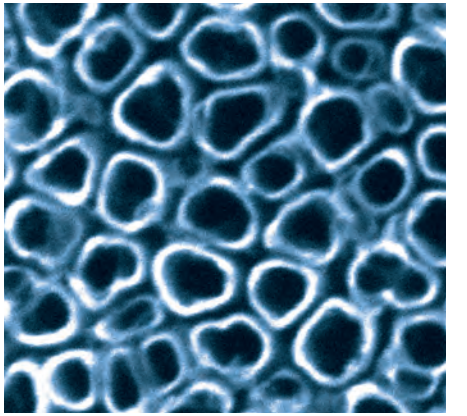
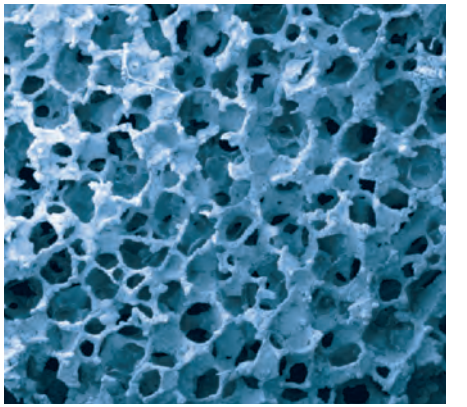
NANOTECH FTM

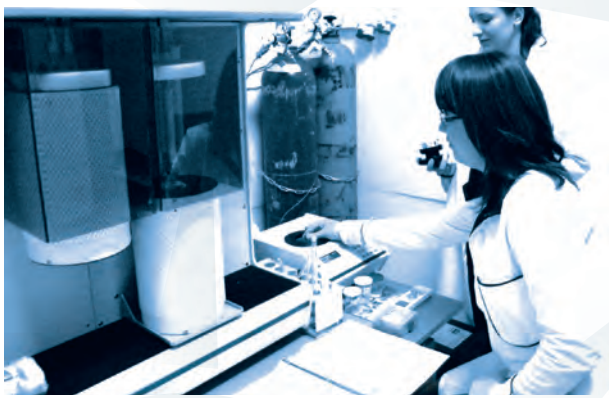
# Nanotechnology and Functional Materials Centre

Faculty of Technology and Metalurgy, University of Belgrade





**Nanotechnology and functional materials centre NANOTECH FTM** was established and rainforced by Faculty of Technology and Metallurgy, University of Belgrade trough the FP7 REGPOT-2009-1 project NANOTECH FTM (GRANT AGREEMENT No 245916) in January 2010.

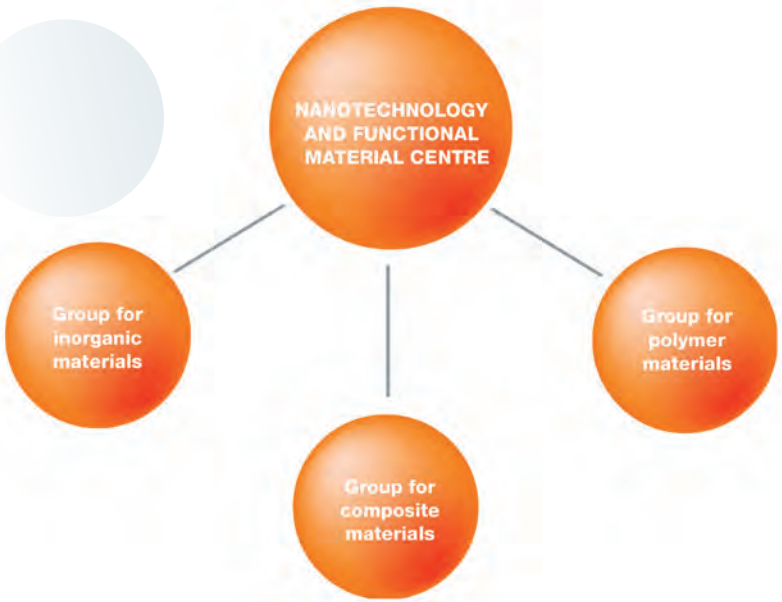


**NANOTECH FTM** was created in order to integrate small faculty research groups or individuals, which have all conducted their research in the field of nanotechnology and functional materials independently, and in such a way to improve and strengthen resources and perform competitive and up-to date research activities.

**NANOTECH FTM** is one of the leading teaching and scientific institutions in the field of nanostructured and functional materials in the region.

## ORGANIZATION

**The centre consists of three groups:**




These groups deal with materials for application in environmental engineering, biotechnology, biomedicine and pharmaceutics, photovoltaics, batteries, fibre-optic light guide, nanocomposite coatings etc.

## Professors

Prof. Dr. Đorđe Janaćković, head of the Center

Prof. Dr. Petar Uskoković
Prof. Dr. Radoslav Aleksić
Prof. Dr. Vesna Mišković-Stanković
Prof. Dr. Bojana Obradović
Dr. Melina Kalagasidis-Krušić
Dr. Jelena Miladinović
Dr. Snežana Grujić
Dr. Aleksandar Marinković

## Researchers

Prof. Dr. Aleksandar Orlović
Prof. Dr. Branko Bugarski
Prof. Dr. Rada Petrović
Prof. Dr. Ivanka Popović
Prof. Dr. Vesna Radojević
Prof. Dr. Aleksandra Perić-Grujić
Dr. Ana Janković
Dr. Jelena Bajat

Dr. Velimir Radmilović
Dr. Sandra Glišić
Dr. Dušica Stojanović
Dr. Đorđe Veljović
Dr. Bojan Jokić
Dr. Slavica Lazarević



## PhD students

Mr Ivona Janković-Častvan
Mr Jasmina Stojkovska
MSc Željko Radovanović
MSc Veljko Đokić
MSc Anđelika Bjelajac
MSc Sanja Eraković,
MSc Željka Jovanović
MSc Ivana Jevremović
MSc Rade Surudzić
MSc Vera Obradović
MSc Ivana Radović
MSc Vuk Radmilović
MSc Srđan Perišić
MSc Mirjana Mlađenović
MSc Marija Dimitrijević
MSc Srđan Vidović
MSc Danijela Kostić
MSc Ivana Madžorovski
MSc Jelena Pajnik
MSc Ivana Mijatović
MSc Danijela Brković
MSc Danijela Popović
MSc Sonja Ždrale

**NANOTECH FTM centre compromise the numerous research subjects related to the nanomaterials and their applications. The research subjects are strongly linked between the groups under the NFMC centre. Some of the research topics are as follows:**

Modified nanoparticles and nanocomposite materials for improving antibacterial, antistatic, thermal and mechanical properties of polymer composite materials.

Nanocomposite bioactive porous structures - felts, based on nanofibres of bioactive polymers for control drugs delivery.

Nanocarriers of drugs and medicament for biomedical applications with control and time relies delivery;

Nanocarriers of drugs and medicament for biomedical applications with control and time relies delivery;

Bioactive cements and composites based on α-TCP designed to simultaneously stimulate appropriate cell response at molecular level that is to activate genes to stimulate accelerated regeneration of tissue;

Bioactive coatings with higher wettability, osteoinductivity and osteoconductivity based on TiO2/HAP/biactive glass/ polymer;

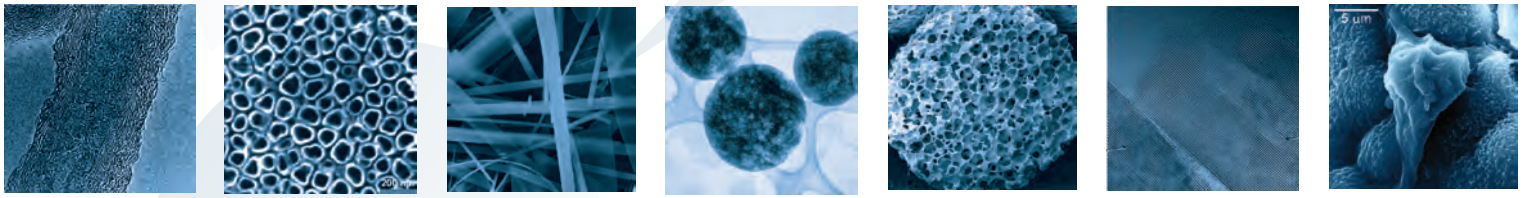
Bioactive scaffolds based on HAP/α-TCP/ polymer for osteochondral implants engineering for regenerative medicine and tissue engineering;

Hydrogels based on nano-composite polymers (poli-N-vinil-2-pirolidona and alginate) with nanoparticles for applications in medicine as soft tissue implants;

Hydrogels based on nano-composite polymers (poli-N-vinil-2-pirolidona and alginate) with nanoparticles for applications in medicine as soft tissue implants;

Photo-catalyst based on TiO2 for photocatalytic degradation of pollutants with improved photo activity in the visible range of the spectrum;

Photovoltaic systems based on doped TiO2 composite systems.



NANOTECH FTM

**NANOTECH FTM centre has established strong cooperation with outstanding research institutions from Europe and other regions of the World:**

- European Centre for Nanostructured Polymers ECNP, Italy
- CNRS Institut De Physique Et De Chimie De Strasbourg, France
- Agriculture University of Athens, Greece
- National Institute for Lasers, Plasma and Radiation Physics, Romania
- Riga Technical University/Institute of Inorganic Chemistry, Latvia
- Laboratoire de Mécanique Appliquée R Chaléat, University of Franche Comte, France
- UCL (University College London), London, UK
- The Hong Kong Polytechnic University, Hong Kong, P.R. China
- Institut fur Physikalische Chemie der Universitat Gottingen, Germany
- Institute of Optoelectronics, Military University of Technology, Poland
- Institute of Biochemistry Romanian Academy, Romania
- Bulgarian Academy of Sciences / Institute of Solid State Physics, Bulgaria
- Institut De Chemie Des Surfaces Et Interfaces – Cnrs, France
- Lab. Du Genie De La Conception Equipe D'Ingenierie Des Surfaces De Strasbourg, France
- University of Birmingham, School of Dentistry, UK
- ELKEDE Technology and Design Centre, Greece
- Laval University, Quebec, Canada
- Shandong University, Jinan, China
- ICMT - Institute for Corrosion and Multiphase Flow Technology, Ohio University, USA
- Jožef Štefan Institute, Ljubljana, Slovenia
- Laval University, Quebec, Canada
- Kyung Hee University, Gyeonggi, Seoul, Republic of Korea
- University Hospital Basel, Switzerland
- Faculty of biology and pharmacy, University of Cagliari

**And numerous industrial partners:**

- Procter & Gamble-Technical Centres Ltd, UK
- Veolia Water Solutions and technologies, France
- MaHyTec Ltd., Dole, France
- Tehnomed Impex Co S.R.L, Romania
- Plasma and Ceramics Technologies Ltd (Pct Ltd), Latvia
- NIS GAZPROM NEFT, Serbia

The centre aims are to develop and strengthen institutional ties of with cooperating research institutions from the European Union. Further activities of the Center will be to attract other centres from this region to join and participate in the future research activities, giving perspective for further integration of the region into ERA. It is expected that Centre will become a leading institution for education and research in this field in this region, contributing to the generation of added value in research. The centre will continue to increase impact of regional research capacity, and in that way will contribute to the regional sustainable development in the field of nanomaterial processing.

Sputtering System - AJA International, Inc. ATC ORION series 5 Alberta

## EQUIPMENT FOR PROCESSING

- ATC ORION series 5 Alberta Sputtering System, AJA Internacional Inc
- Microwave Assist Tehnology Furnace, Carbolite, MRF 16/22
- Microwave Synthesis, Anton Paar - Monowave 300
- Incubator, MMM Medcenter Einrichtungen GmbH, Germany
- High temperature furnace, Elektron - Banja Koviljača, Serbia
- GFS33 Combined Graphite Furnace for AAS, Thermo Scientific
- Planetary ball mill, MTI Corporation SFM-1 Desk-Top Planetary Ball Miller
- Cryostat, Sakura,Torrance, California
- Sputter Coater, Fisons Instruments Polaron SC502
- Microwave Digestion System Speedwave four, Berghof
- BTRS Jr reaction system with Carberry reactor, Autoclave engineers
- Reactor for high pressure and temperature, 2L, Ernst Haage Aparatebau
- Supercritical Extraction Screening System, Autoclave engineers
- Laminar flow chamber, BIOAIR INSTRUMENTS, Italy
- Electrostatic extruder, Scientific Instruments, SAD; Bertan Associates Inc.,SAD
- Incubator, MMM Medcenter Einrichtungen GmbH, Germany
- Molder, Dynisco
- Vacuum drayer, VIMS ELECTRIC
- Spin coater, Laurele Technologies Corporation
- Electric tube furnace, Lenton, UK

High pressure reactor system Autoclave Engineers BTRS Jr

Hysitron TriboIndenter TI-900 for nanomechanical characterization

Micromeritics ASAP 2020 Surface Area and Porosimetry Analyzer

## EQUIPMENT FOR CHARACTERIZATION

- Ultra-High Resolution Field Emission SEM, Tescan Mira 3
- SEM with Energy-dispersive X-ray spectroscopy (EDS), Jeol JSM 5800, Oxford Inca 3.2
- Transmission electron microscope, Jeol 100CX, produced 1971; general repairment 2002
- NanoIndenter, Hysitron, Inc TI-900 TriboIndenter
- The device for determining the specific surface area and porosity, Micromeritics ASAP 2020
- Gas Chomatograph Perkin Elmer 8700
- Liquid Chromatograph Thermo separation products 4100, Thermo separation products
- Gas chromatograph Trace GC Ultra AI 3000, Thermo Scientific
- Thermomicroscope, E. Leitz Wetzlar
- UV-Vis Spectrophotometer, Shimadzu UV-1800 Spectrophotometer
- Difraktometar X-Ray, Rigaku Corporation Ultima +
- Optical microscope with a camera OLYMPUS UC30, OLYMPUS, 2007
- Servo-hidraulic tensile testing machine “INSTRON - 1332”, Instron England
- Electrospinner Linari Engineering
- DMA module, TA
- DSC, TA
- Adhesion testing device, Adhesionmaster 525 MC, Erichsen
- Simultaneous Differential Thermal Analyzer SDT Q600, TA Instruments, USA
- SIGMATEST 2.069, Foerster, USA
- Instrument for Dissolved Gas Analysis 6890n, Agilent Technologies
- Oil tester for measurement of electrical beakdown strenght DPA 75C, Baur
- Infrared spectrometer Nicolet iS10, Thermo Scientific
- Dissipation factor and resistivity system DTL 2A, Baur
- Atomic Absorption Spectrometer S2 Spectrometer, Thermo Electron Corporation
- Electrophoresis power supply, Peqlab EV231
- Potentiostat/Galvanostat ZRA Reference 600, Gamry Instruments
- High speed Puncture Impact testing machine Hydroshot HITS-P10, SHIMADZU

**Ultra-High Resolution Field Emission Jeol JSM - 7500F SEM**

**ESCAN MIRA 3XMU FEG Scanning Electron Microscope**

**High speed Puncture Impact testing machine Hydroshot HITS-P10, SHIMADZU**

The potential of the NFMC FTM UB centre was proven in large number of publications in leading international journals, national research and industrially funded projects, European projects such as EUREKA projects, professional engagement and collaboration with global technology leaders, as well as participation of its members in international research projects.

**During the period of 2006-2012 the professors and researchers published more then 230 research papers, published in leading international journals as:**

- Journal of Optoelectronics and Advanced Materials,
- Journal of Materials Science: Materials in Medicine,
- Chemical Engineering Journal,
- Powder Technology,
- Materials Chemistry and Physics,
- Industrial and Engineering Chemistry Research,
- Sustainability Science,
- Colloids and Surfaces A: Physicochemical and Engineering Aspects,
- Chemical Engineering and Processing: Process Intensification,
- Materials Letters,
- Carbohydrate Polymers,
- Latvian Journal of Physics and Technical Science,
- Colloids and Surfaces
- A: Physicochemical and Engineering Aspects, Separation and Purification Technology,
- Journal of Applied Polymer Science,
- Material Science Forum,
- Sensors and Materials,
- Russian Journal of Electrochemistry,
- Polymer Degradation and Stability,
- Materials in Technology,
- Journal of Chemical Technology and Biotechnology,
- Intrnational Journal of Nanomedicine,
- Ceram-Silikaty,
- Key Engineering Materials,
- Journal of Europian Ceramics Society,
- Industrial Ceramic,
- Applied Clay Science,
- Digest Journal of Nanomaterials and Biostructures,
- Applied Surface Science,
- Desalination, Journal of Supercritical Fluids,
- Journal of Advanced Materials,
- Fluid Dynamics and Materials Processing,
- Applied Surface Science,
- Journal of Hazardous Material,
- Journal of Environmental Engineering,
- Journal of Sol-Gel Science Technology,
- Thin Solid Films,
- Sensors,
- Journal of Applied Polymer Science,
- European Polymer Journal,
- Progress in Organic Coatings,
- Applied Clay Science,
- Ceramics International,
- Superlattice and Microstructures,
- General Physiology and Biophysics,
- Materials and Manufacturing Processes,
- Journal of Biomedical Materials Research part A,
- International Journal of Hydrogen Energy,
- Journal of Power Sources,
- Polymer Bulletin,
- Polymer Composites,
- Water, Air and Soil Pollution

.....and many others.

## SELECTED REFERENCES:


- V. Radmilovic, C. Ophus, E.A. Marquis, M.D. Rossell, A. Tolley, A. Gautam, M. Asta, U. Dahmen, “Highly monodisperse core-shell particles created by solid-state reactions”, Nature Materials, 10 (9) (2011) 710-715.



- Z. Veličković,G.D. Vuković, A.D. Marinković, M.-S. Moldovan, A. Perić-Grujić, P.S. Uskoković, M.T. Ristić, “Adsorption of arsenate on iron(III) oxide coated ethylenediamine functionalized multiwall carbon nanotubes”, Chemical Engineering Journal 181-182 (2012) 174-181.

- B. Jokić, S. Drmanić, T. Radetic, J. Krstić, R. Petrović, A. Orlović, Dj. Janaćković, “Synthesis of submicron carbon spheres by the ultrasonic spray pyrolysis method”, Materials Letters 64 (2010) 2173-2176.

- G. D. Vuković, S.Z. Tomić, A.D. Marinković, V. Radmilović, P.S. Uskoković, M. Čolic, “The response of peritoneal macrophages to dapsone covalently attached on the surface of carbon nanotubes”, Carbon 48 (11) (2010) 3066-3078.

- J. Stojkovska B. Bugarski B. Obradovic, “Evaluation of alginate hydrogels under in vivo – like bioreactor conditions for cartilage tissue engineering”, J ournal of Matererial Science: Materials in Medicine 21 (10), (2010) 2869-2879.

- D. Stojanovic, A. Orlovic, S.B. Glisic, S. Markovic, V. Radmilovic, P.S. Uskokovic, R. Aleksic, “Preparation of MEMO silane-coated SiO2 nanoparticles under high pressure of carbon dioxide and ethanol”, Journal of Supercritical Fluids 52 (3), (2010) 276-284.

- B. Jokic, M. Mitric, V. Radmilovic, S. Drmanic, R. Petrovic, Dj. Janackovic, “Synthesis and characterization of monetite and hydroxyapatite whiskers obtained by a hydrothermal method”, Ceramics International 37 (2011) 167-173.


- V. Marjanović, S. Lazarević, I. Janković-Častvan, B. Potkonjak, Dj. Janackovic, R. Petrović, “Chromium (VI) removal from aqueous solutions using mercaptosilane functionalized sepiolites”, Chemical Engineering Journal, 166 (1) (2011) 198-206.

- S. Lazarević, I. Janković-Častvan, A. Onjia, J. Krstić, Dj. Janaćković, R. Petrović, “Surface characterization of iron-modified sepiolite by inverse gas chromatography”, Industrial and Engineering Chemistry Research 50 (20), (2011) 11467-11475.Janković-Častvan, S. Lazarević, D. Tanasković, A. Orlović, R. Petrović, Dj. Janaćković, “Phase transformation in cordierite gel synthesized by non-hydrolytic sol-gel route”, Ceramics International 33 (7) (2007) 1263-1268.

- V.R. Djokić, A.D. Marinković, M. Mitrić, P.S. Uskoković, R.D. Petrović, V.R. Radmilović, D.T. Janaćković, “Preparation of TiO 2/ carbon nanotubes photocatalysts: The influence of the method of oxidation of the carbon nanotubes on the photocatalytic activity of the nanocomposites”, Ceramics International, 38 (2012) 6123–6129.

- B. Jokic, I. Stamenkovic, M. Zrilic, K. Obradovic-Djuricic, R. Petrovic, D. Janackovic, “Silicon-doped biphasic α-calcium-phosphate/ hydroxyapatite scaffolds obtained by a replica foam method using uniform pre-annealed spherical particles”, Materials Letters 74 (2012) 155-158.

- Dj. Veljović, M. Colic, V. Kojic, G. Bogdanovic, Z. Kojic, A. Banjac, E. Palcevskis, R. Petrovic, Dj. Janackovic, “The effect of grain size on the biocompatibility, cell-materials interface and mechanical properties of microwave sintered bioceramics”, Journal of Biomedical Materials Research part A, 100 (2012) 3059-3070.

- B. Jokic, M. Mitric, M. Popovic, L. Sima, S.M. Petrescu, R. Petrovic, Dj. Janackovic, “The influence of silicon substitution on the properties of spherical- and whisker-like biphasic a-calcium-phosphate/hydroxyapatite particles”, Journal of Materials Science: Materials in Medicine 22 (10) (2011) 2175-2185 1.

- D. Stojanovic, A. Orlovic, S. Markovic, V. Radmilovic, P.S. Uskokovic, R. Aleksic, “Nanosilica/PMMA composites obtained by the modification of silica nanoparticles in a supercritical carbon dioxide-ethanol mixture”, Journal of Materials Science 44 (23) (2009) 6223-6232.

- Dj. Veljovic, E. Palcevskis, I. Zalite, R. Petrovic, Dj. Janackovic, ”Two-step microwave sintering - a promising technique for the processing of nanostructured bioceramics”, Material letters 93 (2012) 251–253.


NANOTECH FTM

**Nanotechnology and Functional Materials Centre**

Faculty of Technology and Metallurgy
University of Belgrade

Address: Karnegijeva 4, 11000 Belgrade, Serbia

Phone: +381 11 3370 503
+381 11 3370 489

Fax: +381 11 3370 387
+381 11 3370 503

e-mail: nht@tmf.bg.ac.rs
nanotech@tmf.bg.ac.rs