

1S

# Hemijska industrija

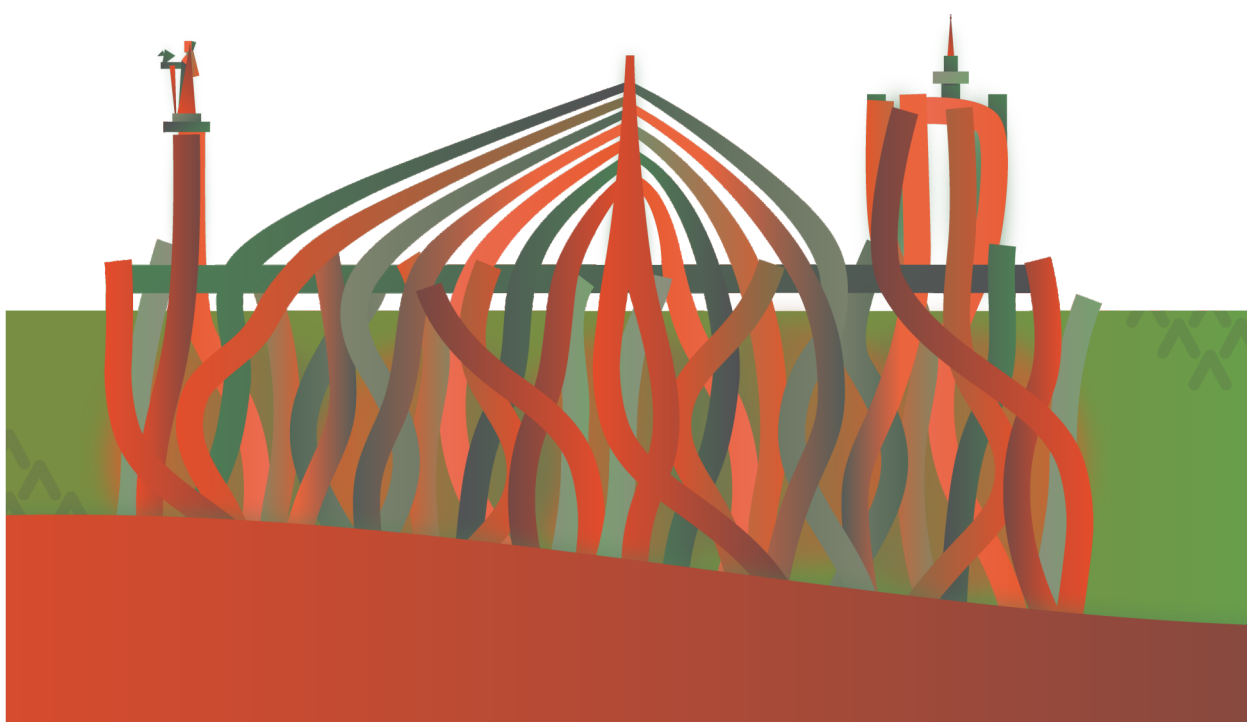
Vol. 78

Časopis Saveza hemijskih inženjera Srbije

## Chemical Industry

Supplementary Issue  
ExcellMater Conference 2024 Abstracts

Innovative biomaterials  
for novel medical devices  
Conference 2024



## Aktivnosti Saveza hemijskih inženjera Srbije pomažu:



MINISTARSTVO NAUKE,  
TEHNOLOŠKOG RAZVOJA  
I INOVACIJA  
REPUBLIKE SRBIJE



Tehnološko-metalurški fakultet  
Univerziteta u Beogradu



Prirodno-matematički fakultet  
Univerziteta u Novom Sadu



Institut za tehnologiju nuklearnih i  
drugih mineralnih sirovina, Beograd



Tehnološki fakultet  
Univerziteta u Novom Sadu



Institut za hemiju, tehnologiju i metalurgiju  
Univerziteta u Beogradu



Fakultet tehničkih nauka  
Univerziteta u Novom Sadu



Tehnološki fakultet  
Univerziteta u Nišu, Leskovac



Fakultet tehničkih nauka  
Univerziteta u Prištini  
Kosovska Mitrovica



Institut IMS, Beograd



DCP HEMIGAL  
Leskovac



Barič



Elixir Prahovo



Chemical Industry  
Химическая промышленность

# Hemijska industrija

Časopis Saveza hemijskih inženjera Srbije  
Journal of the Association of Chemical Engineers of Serbia  
Журнал Союза химических инженеров Сербии

VOL. 78

Beograd, mart 2024.

Broj 1s

#### Izdavač

Savez hemijskih inženjera Srbije  
Beograd, Kneza Miloša 9/1

#### Glavni urednik

Bojana Obradović

#### Zamenica glavnog i odgovornog urednika

Emila Živković

#### Pomoćnik glavnog i odgovornog urednika

Ivana Drvenica

#### Urednici

Jelena Bajat, Dejan Bezbradica, Ivana Banković-Ilić,  
Dušan Mijin, Marija Nikolić, Đorđe Veljović, Tatjana  
Volkov-Husović

#### Članovi uredništva

Nikolaj Ostrovski, Milorad Cakić, Željko Čupić, Miodrag  
Lazić, Slobodan Petrović, Milovan Purenović,  
Aleksandar Spasić, Dragoslav Stoilković, Radmila  
Šećerov-Sokolović, Slobodan Šerbanović, Nikola  
Nikačević, Svetomir Milojević

#### Članovi uredništva iz inostranstva

Dragomir Bukur (SAD), Jiri Hanika (Češka Republika),  
Valerij Meshalkin (Rusija), Ljubiša Radović (SAD),  
Constantinos Vayenas (Grčka)

#### Likovno-grafičko rešenje naslovne strane

Milan Jovanović

#### Redakcija

11000 Beograd, Kneza Miloša 9/1

Tel/fax: 011/3240-018

E-pošta: [shi@ache.org.rs](mailto:shi@ache.org.rs)

[www.ache.org.rs](http://www.ache.org.rs)

Izlazi kvartalno, rukopisi se ne vraćaju

Za izdavača: Ivana T. Drvenica

Sekretar redakcije: Slavica Desnica

#### Izdavanje časopisa pomaže

Republika Srbija, Ministarstvo nauke, tehnološkog  
razvoja i inovacija

Uplata pretplate i oglasnog prostora vrši se na tekući  
račun Saveza hemijskih inženjera Srbije, Beograd, broj  
205-2172-71, Komercijalna banka a.d., Beograd

#### Menadžer časopisa i kompjuterska priprema

Aleksandar Dekanski

#### Štampa

Razvojno-istraživački centar grafičkog inženjerstva,  
Tehnološko-metalurški fakultet, Univerzitet u  
Beogradu, Karnegijeva 4, 11000 Beograd

#### Indeksiranje

Radovi koji se publikuju u časopisu *Hemijska Industrija*  
ideksiraju se preko *Thompson Reuters Scietific®* servisa  
*Science Citation Index - Expanded™* i *Journal Citation  
Report (JCR)*

Guest Editor:

**Ana Janković**

*Department of Physical Chemistry and Electrochemistry*

*Faculty of Technology and Metallurgy, University of Belgrade Belgrade, Serbia*

## SADRŽAJ/CONTENTS

### Editorial

**ExcellMater Conference 2024: Innovative biomaterials for  
novel medical devices**

Bojana Obradović..... 1

### Tissue engineering and *in vitro* tissue and organ culture models

#### Translational studies of engineered human tissues

Gordana Vunjak-Novakovic..... 3

#### Regenerative engineering: designing grafts, processes and signals

Ivan Martin..... 4

#### Cartilage bioreactors: where we are and where we are going!

Mauro Alini..... 5

#### *Ex vivo* testing of biomaterials for intervertebral disc repair using organ culture bioreactors

Sibylle Grad..... 6

#### Engineering of multicellular systems by hydrodynamic waves

Tiziano Serra..... 7

#### Sound based assembly of spatially organized porous constructs

Greta Cocchi, Riccardo Tognato, Lorenzo Moroni, Tiziano  
Serra..... 8

#### Development of an *in vitro* branched vasculature using bioprinting technique in combination with sacrificial materials

Natalija Stojanovic, Nadja Hansen, Horst Fischer..... 9

#### Unraveling the transcriptome profile of pulsed electromagnetic field stimulation in bone regeneration using an *in vitro* investigation platform

Farah Daou, Rana Zarean Hafdaran, Beatrice Masante,  
Stefano Gabetti, Giovanni Putame, Eleonora Zenobi,  
Federico Mochi, Cristina Bignardi, Federica Dell'Atti,  
Francesco Favero, Costantino Del Gaudio, Diana Massai,  
Andrea Cochis, Lia Rimondini..... 10

#### Why protein isolate: a versatile dairy-derived hydrogel for bone and vascular tissue engineering and antimicrobial applications

Timothy E. L. Douglas..... 11

#### Innervation of the musculoskeletal system in physiological and pathological conditions: Insights from organ-on-a-chip models

Meriem Lamghari..... 12

#### Extracellular vesicles derived from mesenchymal stem/stromal cells derived from dental pulp of exfoliated teeth induce osteogenic differentiation

**SADRŽAJ nastavak**  
**CONTENTS Continued**

Marija Milivojević, Maja Kosanović, Marina Bekić, Miodrag Čolić, Đorđe Janačković, Sergej Tomić .....	13
<b>Examination of the effects of X-ray phase contrast imaging dose on DNA in mesenchymal stem cells by comet assay</b> Lada Živković, Biljana Spremo Potparević, <u>Vladan Bajić</u> , Jovan Brankov, Wei Zhou, Eric Brey .....	14
<b>β-glucan-enriched fraction from mosaic puffball induces inflammation in an <i>in vitro</i> 3D bovine chondrocytes model</b> Predrag Petrović, Eda Çiftçi, Zhen Li, Sibylle Grad .....	15
<b>Composite based on resveratrol and selenium as an antioxidative component in tissue engineering</b> Nina Tomić, Dragana Mitić Ćulafić, Nenad Filipović, Tea Ganić, Maja Kuzmanović, Magdalena M. Stevanović.....	16
<b>Cancer research</b>	
<b>Chemotherapy and novel proton radiotherapy in spatially advanced multicellular models of pancreatic cancer: On the design of platform for enabling low cost animal free preclinical treatment testing</b> Eirini G. Velliou .....	17
<b>Bioengineering for creating biomimetic microenvironments: bioreactors and biomaterials</b> Jasmina Stojkowska, Jovana Zvicer, Jelena Petrovic, Ivana Banićević, Mia Milošević, Bojana Obradović.....	18
<b>A 3D <i>in vitro</i> cell culture model based on perfused bone-like scaffolds for healthy and pathological bone research</b> Ivana Banićević, Mia Milošević, Jelena Petrović, Ksenia Menshikh, Milena Milivojević, Milena Stevanović, Radmila Janković, Andrea Cochis, Elena Della Bella, Martin Stoddart, Lia Rimondini, Jasmina Stojkowska, Bojana Obradović.....	19
<b>Doxorubicin and quercetin combined effect on SAOS-2 cells grown in 2D and 3D model systems</b> Luka Bojić, Jelena Pejić, Jasmina Stojkowska, Milena Stevanović, Aleksandra Medić, Isidora Petrović, Milena Milivojević .....	20
<b>Adaptable alginate-based microfibers for 3D <i>in vitro</i> cultures of cancer cells: an anticancer drug testing model</b> Jelena Petrović, Elżbieta Pańczyszyn, Marco Corazzari, Ivana Banićević, Milena Milivojević, Luka Bojić, Milena Stevanović, Miodrag Dragoj, Milica Pešić, Radmila Janković, Bojana Obradović, Jasmina Stojkowska .....	21
<b>Biomimetic tumor engineering to enhance drug discovery – Bioengineered Tumor</b> Bojana Obradović, Jasmina Stojkowska, Jovana Zvicer, Milena Milivojević, Radmila Janković, Miodrag Dragoj, Ivan Jančić .....	22
<b>Human amniotic membrane homogenate: A novel biomaterial-based strategy to impede migration and invasion of bladder cancer cells</b> Aleksandar Janev, Taja Železnik Ramuta, Urška Dragin Jerman, Hristina Obradović, Maja Čemažar, Mateja Erdani Kreft .....	23
<b>Polymer gels and composites for biomedical applications</b>	
<b>Designing biopolymer scaffolds and oral mucoadhesive films for controlled drug delivery</b> Petar Uskoković, Anđela Radisavljević, Marija Jovanović, Dušica Stojanović, Vesna Radojević .....	24
<b>Evaluation of crosslinked gelatin-polyvinylpyrrolidone scaffold for application in drug delivery and tissue engineering</b> Marija Jovanović, Miloš Petrović, Dušica Stojanović, Nataša Nataša Radulović, Danijel Pantelić, Vesna Radojević, Petar Uskoković .....	25
<b>Electrospun poly(ε-caprolactone) nanofiber mats with gallic acid and glucosamine sulfate for cartilage repair</b> Anđela Radisavljević, Dušica Stojanović, Huan Meng, Zhen Li, Sibylle Grad, Petar Uskoković .....	26

**SADRŽAJ nastavak**  
**CONTENTS Continued**

<b>Environmentally friendly hydrogels for medical and pharmaceutical applications</b> Melina Kalagasidis Krušić, Marija Lučić Škorić, Stoja Milovanović, Vesna Panić, Maja Marković .....	27
<b>Biocharacterization of hydrogels based on poly(methacrylic acid) prepared by eco-friendly method</b> Maja D. Marković, Milica M. Svetozarević, Huan Meng, Zhen Li, Sibylle Grad, Vesna Panić, Melina T. Kalagasidis Krušić .....	28
<b>Citric acid-crosslinked gelatin/hydroxypropyl methylcellulose hydrogels for biomedical applications</b> Vukašin Ugrinović, Maja Marković, Predrag Petrović, Đorđe Veljović .....	29
<b>Development of cornstarch aerogels with high porosity and their impregnation with natural bioactive compounds</b> Stoja Milovanović, Jelena Pajnik, Darka Marković, Ivona Janković - Častvan, Ivana Lukić .....	30
<b>Peculiarities of alginate gelation triggered by calcium ions in the presence of hydroxyapatite particles</b> Katarina Dimić-Mišić, Ivana Banićević, Bojana Obradović, Michael Gasik .....	31
<b>Biomaterials for orthopedic and dental applications</b>	
<b>Regulatory science for biomaterials: are we doing right things right?</b> Michael Gasik .....	32
<b>3D printing of composites containing copper-incorporated mesoporous bioactive glass induce different cell responses depending on cell type and donor</b> Vera Guduric, Richard F. Richter, Anja Lode, Michael Gelinsky .....	33
<b>The effect of surface ion-doping on the bioactive glass cytocompatibility and antibacterial performance</b> Mari Lallukka, Amel Houaoui, Ziba Najmi, Marta Miola, Andrea Cochis, Jonathan Massera, Lia Rimondini, Enrica Verné .....	34
<b>Multifunctional Sr,Mg doped mesoporous bioactive glass nanoparticles</b> Tamara Matić, Farah Daou, Andrea Cochis, Nemanja Barać, Vukasin Ugrinović, Lia Rimondini, Đorđe Veljović .....	35
<b>Development of luminescent bioactive glass for multimodal diagnostic imaging</b> Rauany Cristina Lopes Francisco, Ivana Dinić, Ljiljana Veselinović, Nina Tomić, Marina Vuković, Eliane Trovatti, Lidija Mančić .....	36
<b>The current trend in innovative bioactive materials for dental and orthopedic applications</b> Đorđe Veljović, Đorđe Janačković, Rada Petrović, Željko Radovanović, Vukašin Ugrinović, Tamara Matić, Marija Milivojević .....	37
<b>Effects of different doped hydroxyapatite-based materials on healing of critical size calvaria bone defects in rats</b> Nikola Busarać, Irena Kasalović, Suzana Živanović, Tamara Matić, Đorđe Veljović, Biljana Ljujić, Miloš Papić .....	38
<b>Sr/Mg – doped bioceramic scaffolds for biomedical application</b> Tamara Matić, Farah Daou, Alessandro C. Scalia, Andrea Cochis, Lia Rimondini, Đorđe Veljović .....	39
<b>Characterisation of strontium-substituted hydroxyapatite as potential biomedical material</b> Marija Došić, Jelena Nikolić, Jovica Stojanović, Nikola Vuković, Marija Marković, Veljko Savić, Vladimir Topalović .....	40
<b>Novel enriched hydrogel nano-hap induced osteogenic differentiation of SCAP</b> Dijana Mitić, Miloš Lazarević, Jelena Milašin, Vukoman Jokanović .....	41

SADRŽAJ nastavak  
CONTENTS Continued

<b>Anodization/anaphoretic deposition of composite zein/hydroxyapatite coatings on titanium substrate</b> Katarina Đ. Božić, Miroslav M. Pavlović, Vesna V. Kojić, Đorđe Veljović, Marijana R. Pantović Pavlović.....	42
<b>Influence of bone substitute PerOssal® on bone marrow mesenchymal stem cells</b> Hristina Obradović, Sebastian Häusner, Drenka Trivanović, Milena Živanović, Duško Spasovski, Marietta Herrmann, Aleksandra Jauković .....	43
<b>Electrochemical behavior of metallic implants in inflammatory conditions</b> Aydin Bordbar Khiabani, Michael Gasik .....	44
<b>Determination of metal ion levels in circulation in patients with joint replacement</b> Lucie Válková, Jan Emmer, Jan Kuta, Monika Pávková Goldbergová.....	45
<b>Corrosion behavior of PEO coatings with Mn<sub>3</sub>O<sub>4</sub> on Mg-Zn-Ca alloys in inflammatory conditions</b> Sara Bahrapour, Aydin Bordbar-Khiabani, M. Hossein Siadati, Michael Gasik, Masoud Mozafari .....	46
<b>Two faces of biodegradable molybdenum nanoparticles regarding oxidative stress and biomedical applications</b> Polina Navrátilová, Daniel Wojtas, Jan Burda, Luděk Ryba, Monika Pávková Goldbergová.....	47
<b>Assessing the biocompatibility of polyhydroxybutyrate scaffolds for dental stem cell applications</b> Miloš Lazarević, Dijana Mitić, Evelina Herendija, Murat Demirbilek, Gokhan Gungor, Atalayin Ozkaya .....	48
<b>Precision medicine for musculoskeletal regeneration, prosthetics and active ageing - PREMURSA: a Marie Skłodowska-Curie Innovative Training Network</b> Enrica Vernè, Silvia Spriano, Janis Locs, Dagnija Loca, Jonathan Massera, Bojana Obradović, Jasmina Stojkowska, Mauro Alini, Tiziano Serra, Marco Corazzari, Annalisa Chiocchetti, Meriem Lamghari, Michael Gasik, Manolo Venturin, Manolo Venturin, Carla Baldasso, Abhay Pandit, Lia Rimondini.....	49
<b>End-to-end multidisciplinary optimal design for improved personalized bioactive glass/ceramic bone substitute implants- ReBone: a Marie Skłodowska-Curie Doctoral Network</b> Pasquale Vena, Dario Gastaldi, Francesco Baino, Enrica Vernè, Lia Rimondini, Davide Ruffoni, Martin Schwentenwein, Barbara Misof, John Dunlop, Jasmina Stojkowska, Andrzej Skalski.....	50
<b>Novel hybrid biomimetic macroporous composites with tuned biodegradability, improved osteointegration and anticancer properties for bone tissue regeneration (HyBioComBone)</b> Đorđe Veljović, Đorđe Janačković, Rada Petrović, Biljana Ljujić, Milena Radunović, Anđela Radisavljević, Željko Radovanović, Vukašin Ugrinović, Tamara Matić, Marija Milivojević, Miloš Papić, Tamara Vlajić-Tovilović, Irena Ognjanović, Ivica Vujičić .....	51
<b>Antimicrobial biomaterials and strategies</b>	
<b>Antimicrobial coatings for orthopaedic applications</b> Mohadeseh Zare, Laura Colomina Alfaro, Antonella Bandiera, Artemis Stamboulis .....	52
<b>Discouraging cellular and bacterial adhesion on surfaces for bone temporary devices through ZrO<sub>2</sub>-Ag coatings</b> Andrea Cochis, Sara Ferraris, Alessandro C. Scalia, Silvia Spriano, Lia Rimondini.....	53

SADRŽAJ nastavak  
CONTENTS Continued

<b>Nanostructured Ag- and Cu- doped ZnO antibacterial magnetron sputtered coatings for biomedical applications</b> Ana-Marija Milisav, Maja Mičetić, Pavo Dubček, Lamborghini Sotelo, Cristina Cantalops Vilà, Tommaso Fontanot, Ina Erceg, Krunoslav Bojanić, Željka Fiket, Maja Ivanić, Silke Christiansen, Edwige Meurice, Tihomir Car, Maja Dutour Sikirić.....	54
<b>Polyelectrolyte multilayers with metal/metal oxide nanoparticles as antimicrobial solution for biomedical applications</b> Ana-Marija Milisav, Lamborghini Sotelo, Cristina Cantalops Vilà, Tommaso Fontanot, Ina Erceg, Krunoslav Bojanić, Tomislav Vuletić, Željka Fiket, Maja Ivanić, Silke Christiansen, Edwige Meurice, Maja Dutour Sikirić .....	55
<b>Zeta potential titration and Kelvin probe force microscopy as tools for the design of biomaterials</b> Silvia Spriano, Sara Ferraris, Francesca Gamna, Andrea Cochis, Lia Rimondini, Alessandro C. Scalia, Ajay Kumar, Biljana Mojsoska .....	56
<b>Electrochemically synthesized biomaterials</b> Ana Janković, Marija Đošić, Milena Stevanović, Maja Vukašinić-Sekulić, Vesna Kojić, Vesna Mišković-Stanković .....	57
<b>Innovative hydroxyapatite-based coatings for bone implants: A multifaceted approach</b> Milena Stevanović, Marija Đošić, Ana Janković, Christoph Martin Sprecher, Maja Vukašinić-Sekulić, Vesna Mišković-Stanković.....	58
<b>Bioactivity of gentamicin-loaded hydroxyapatite/poly(vinyl alcohol)/chitosan composite coatings aimed for orthopedic application</b> Maja Vukašinić-Sekulić, Marija Đošić, Ana Janković, Milena Stevanović, Svetlana Grujić, Ivana Matić-Bujagić, Vesna Kojić, Vesna Mišković-Stanković.....	59
<b>Towards laser based methods for improving surface properties of materials</b> Albena Daskalova, Matthias Ahlhelm, Liliya Angelova, Ivan Buchvarov.....	60
<b>A novel thermostable YtnP lactonase inhibits biofilm formation and induces decomposition of preformed <i>Pseudomonas aeruginosa</i> biofilms</b> Jovana Ćurčić, Milka Malešević, Branko Jovčić .....	61
<b>Novel alginate/activated-charcoal platform for local treatment of resistant pathogens in wounds</b> Andrea Osmokrović, Ivan Jančić, Ivona Janković-Častvan, Marina Milenković, Bojana Obradović .....	62
<b>Activated charcoal as a carrier of probiotics: A new approach for pathogen elimination in wounds</b> Sonja Mojsilović, Tanja Krunić, Vesna Lazić, Miloš Đuknić, Andrea Osmokrović.....	63
<b>Production technology and characterization of alginate-based impregnated gauze</b> Jovana Zvicer, Jasmina Stojkowska, Andrea Osmokrović, Bojana Obradović .....	64
<b>Various applications of novel materials</b>	
<b>Characterization of <i>Vaccinium myrtillus</i> leaf extract-loaded liposomes</b> Muna Rajab Elferjane, Milena Milošević, Vojislav Ćirić, Branko Bugarski, Aleksandar Marinković, Aleksandra A. Jovanović.....	65
<b>Stability of liposomal particles with encapsulated coumarin derivate</b> Aleksandra A. Jovanović, Edina Avdović, Ana Plečić, Natalija Čutović, Branko Bugarski, Zoran Marković.....	66

**SADRŽAJ nastavak**  
**CONTENTS Continued**

<b>Luminescent fluoroapatite nano-biomaterial for labeling yeast cells as an innovative approach for identification, imaging and monitoring</b> Dušan Milojkov, Gvozden Jovanović, Vukosava Živković-Radovanović .....	67
<b>GPT4 aided biomaterials research use case: stabilization of selenium nanoparticles with proteins</b> Zoran Stojanović, Nenad Filipović, Maja Kuzmanović, Sara Lukač, Magdalena Stevanović .....	68
<b>Novel micro- and nano- composite materials for water purification</b> Katarina Sokić, Natalija Milojković, Aleksandra Dapčević, Sanja Jevtić, Michael Gasik .....	69
<b>Impact of different concentrations of alginate in alginate-yeast hydrogel biosorbent</b> Tanja Krunić, Marica Rakin .....	70
<b>The effect of sulfuric acid treatment on physicochemical properties of g-C<sub>3</sub>N<sub>4</sub> and its efficiency for photocatalytic reduction of Cr(VI)</b> Jana Petrović, Željko Radovanović, Slavica Lazarević, Đorđe Janković, Rada Petrović .....	71
<b>Hybrid biobased composites with natural pyrophyllite</b> Srđan Perišić, Vukašin Ugrinović, Michael Gasik, Katarina Dimić-Mišić, Aleksandar Grujić, Vesna Radojević .....	72
<b>Twinning projects</b>	
<b>The ExcellMater project: Advancing biomaterials engineering towards novel medical devices</b> Bojana Obradović, Lia Rimondini, Mauro Alini, Michael Gasik .....	73
<b>Twinning for intensified enzymatic processes for production of prebiotic-containing functional food and bioactive cosmetics (TwinPrebioEnz)</b> Dejan Bezbradica, Ellen van den Bogaard, Joe Miguel Palomo, Kahlile Y. Abboud .....	74
<b>Knowledge and skills transfer for the application of nanotechnology in biosensors for foodborne pathogens</b> Vasa Radonić, Slavica Savić Ružić, Branimir Bajac, Nikolina Janković, Jasna Mastilović .....	75
<b>Experiences from BiH: H2020 Twinning project SMARTWATER</b> Đurađ Hajder, Mihajlo Marković, Mladen Todorović, Nery Zapata, Teresa A. Paço, Erminio E. Riezzo5, Sabrija Čadro .....	76
<b>Boosting Institute of Chemistry, Technology and Metallurgy in water biomonitoring – BIOLAWEB</b> Danijela Vidaković, Jelena Avdalović, Biljana Dojčinović, Aleksandra Marković, Srđan Miletić, Katarina Milanović, Željka Milovanović, Vladimir Petrović, Dragana Zlatović, Benjamin Alric, Herve Dumont, Clarisse Lemonnier, Antoine Moatti, Frederic Rimet, Andreas Ballot, Susanne Claudia Schneider, Miloš Ćirić .....	77
<b>STREAMLINE HUB: a high capacity hub for research of neuro-developmental disorders in the Western Balkan region</b> Danijela Drakulić, Spyros Petrakis, Adrian. J. Harwood, David Linden, Andrijana Lazić, Nataša Kovačević-Grujičić, Milena Stevanović .....	78
<b>Twinning for graphene-based composites in EMI shielding</b> Svetlana Jovanovć, Dejan Kepić, Miroslav Huskić, Muhammad Yasir, Kamel Haddadi .....	79



# Luminescent fluoroapatite nano-biomaterial for labeling yeast cells as an innovative approach for identification, imaging and monitoring

Dušan Milojkov<sup>1,\*</sup>, Gvozden Jovanović<sup>1</sup> and Vukosava Živković-Radovanović<sup>2</sup>

<sup>1</sup>Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, Serbia

<sup>2</sup>Faculty of Chemistry, University of Belgrade, Belgrade, Serbia

**Keywords:** Bioimaging; nano-apatite; contrast agent; *Saccharomyces cerevisiae*; cascade luminescence; monitoring

Hem. Ind. 78(15) 67 (2024)

Available on-line at the Journal web address: <http://www.ache.org.rs/HI/>

**INTRODUCTION:** The ubiquity of pathogenic yeast species in the human body and the increasing number of immunocompromised people acquiring infections have drawn attention to fungal infections [1]. Improved diagnostic imaging techniques and tools to study infection are necessary due to the commensal nature of pathogens yeast and the severity of the diseases they cause. The ability to label non-pathogenic yeast cells, such as the budding yeast *Saccharomyces cerevisiae* (*S. cerevisiae*), may facilitate the identification and monitoring of these microbes in different environments. The topic of interest in this research is the development of luminescent nano-biomaterials based on fluorapatite as a contrast agent for labeling and imaging *S. cerevisiae*.

**EXPERIMENTAL (or Materials and Methods):** The method used to manufacture fluorapatite nanopowder has been previously reported in research [2]. After being acquired locally, *S. cerevisiae* was suspended in saline. One milligram of the FAP sample was added to the yeast suspension. After mixing the resultant suspension, it was left to incubate at room temperature for one hour without being stirred. Following treatment, cells were taken out, preserved, and prepared in triplicate for microscopy. MIPAR software has been used to analyse the obtained images.

**RESULTS AND DISCUSSION:** Luminescent FAP nanoparticles were synthesized by precipitation and centrifugation at low temperature. The resulting single-phase nanomaterial exhibits cascade fluorescence in the violet and blue regions [2]. To investigate the performance of FAP nanoparticle fluorophores, cells of *S. cerevisiae* were labeled and observed with a Leica DMIL inverted fluorescence microscope. Nanofluoroapatite fluorophores were successfully labeled *S. cerevisiae* cells. MIPAR image analysis software extracted the luminescence of nano-biomaterials from yeast cells.

**CONCLUSIONS:** In this study, *S. cerevisiae* was used as a yeast model which, after labelling with a fluorapatite-based contrast agent, showed luminescent properties. The cascading nature of the agents' luminescence will allow us to monitor cellular uptake as well as monitoring cellular localization in future studies.

**Acknowledgements:** Ministry of Education, Science and Technological Development of the Republic of Serbia (451-03-68/2022-14/200023).

## REFERENCES

- [1] Akanksha Patel, Didar Asik, Joseph A. Spornyak, Paul J. Cullen, Janet R. Morrow, MRI and fluorescence studies of *Saccharomyces cerevisiae* loaded with a bimodal Fe(III) T1 contrast agent, *J. Inorg. Biochem.* 2019; 201: 110832. <https://doi.org/10.1016/j.jinorgbio.2019.110832>.
- [2] Milojkov Dušan, Miroslav Sokić, Vukosava Živković-Radovanović, Vaso Manojlović, Dragosav Mutavdžić, Goran Janjić, Ksenija Radotić, Cascade luminescence and antibacterial behavior of fluorapatite nanopowder co-doped with Pr<sup>3+</sup>, NO<sub>3</sub><sup>-</sup> and CO<sub>3</sub><sup>2-</sup> ions, *Opt. Quantum Electron.* 2023, 55: 84. <https://doi.org/10.1007/s11082-022-04347-7>.

\*Corresponding author E-mail: [d.milojkov@itnms.ac.rs](mailto:d.milojkov@itnms.ac.rs)

