2025
MATERIALS, METHODS & TECHNOLOGIES

27th International Conference

www.sciencebg.net

BOOK OF ABSTRACTS

Materials, Methods & Technologies

27th International Conference

14-17 August 2025

Burgas, Bulgaria

In collaboration with

Institute of Physical Chemistry, Bulgarian Academy of Sciences

Science & Education Foundation, Bulgaria

Faculty of Technology, University in Nis, Serbia

Al-Farabi Kazakh National University, Kazakhstan

Electronic Materials Laboratory, Institute of Physics in Belgrade, Serbia

Institute of Hydrometeorology, Georgian Technical University, Georgia











www.sciencebg.net

www.scientific-publications.net

www.science-edu.eu

DESIGN AND FABRICATION OF NEW PEROVSKITE SOLAR CELL WITH Al-DOPED TiO_2 BUFFER LAYERS FOR ENHANCING POWER CONVERSION EFFICIENCY

Dong In Kim[1], Ji Won Lee[1,2], Rak Hyun Jeong[1,2], Ki-Hwan Hwang[1,2], Jin-Hyo Boo[1,2,*]

[1]Department of Chemistry, Sungkyunkwan University, Suwon 16419, Republic of Korea

[2]Institute of Basic Science, Sungkyunkwan University, Suwon 16419, Republic of Korea

Abstract

Perovskite solar cells (PSCs) show potential commercialization strong possibility with recording high power conversion efficiency (PCE) for a short term despite low manufacturing costs. For commercialization, it is very important to prevent the decomposition of perovskite by ultra violet (UV) radiation in air environment. Also, the structure of a mesoscopic perovskite solar cell (PSC) has a great potential for the solar cell industry as well as for the new energy resources and recycling of used photocatalytic materials such as TiO_2, etc. Due to reversible performance deterioration that has observed in this structure, it is also vulnerable to UV radiation. To prevent this problem, therefore in this study, perovskite solar cells (PSCs) were prepared using an Al-doped TiO_2 buffer layer as electron transport layer (ETL) combined with a mesoporous-TiO_2 layer. In the case of Al concentration of 7 mol% in Al-doped TiO_2 buffer layer fabricated by spin-coating method, a maximum cell performance was observed for specific structure of the perovskite solar cells, as these solar cells exhibited PCE of up to 11.87%. This is a large enhancement of PCE as much as almost double from 6.37% with the newly developed ETL of Al-doped TiO_2 buffer layer combined with mesoporous-TiO_2 layer due to a passivation effect.

Keywords: *Perovskite solar cell; Al-doped TiO_2 buffer layer; Power conversion efficiency; Electron transport layer; Passivation effect*

EFFECT OF POWDER COHESION AND FLOW PROPERTIES ON CERAMIC-COATED SEPARATOR PERFORMANCE FOR LITHIUM-ION BATTERIES

Ji-Hui Oh[1,2*], Jin-Ae Kim[1,2], Dong-Won Lee[1], Weon Ho Shin[2], Jong-Min Oh[2]

[1]Material Technology Center, Korea Testing Laboratory, Seoul, Korea

[2]Department of Electronic Materials Engineering, Kwangwoon University, Seoul, Korea

Abstract

Lithium-ion batteries play a vital role in various applications, such as electronics, electric vehicles, and energy storage systems. The performance and safety of these batteries are strongly influenced by the separator, with ceramic-coated separators being a promising solution to improve thermal stability, mechanical strength, and electrical insulation. Ceramic coatings are typically applied using a slurry of ceramic powders, and the powder's agglomeration behavior significantly impacts the viscosity of the slurry, coating uniformity, and the final product's overall performance. Agglomeration control is essential to achieve high-quality ceramic coatings. Excessive agglomeration may result in uneven coatings that degrade electrical properties and durability, while insufficient dispersion can compromise mechanical stability. However, despite its significance, research on powder agglomeration in the context of ceramic-coated separator production remains limited. The objective of this study is to investigate the impact of powder agglomeration during the ceramic coating process on slurry properties and the quality of the resulting separator. The findings will help optimize the production of high-performance ceramic-coated separators, contributing to the enhancement of both the performance and safety of lithium-ion batteries.

Keywords: *cohesive properties, flow properties, boehmite, ceramic-coated separator*

Acknowledgments

The research was supported by Korea Evaluation Institute of Industrial Technology(KEIT) grant founded by the Korea Government (00449873)

STANDARDIZATION OF WARPAGE MEASUREMENT METHODS FOR CERAMIC SUBSTRATES USING NON-CONTACT METHODS

Jin-Ae Kim[1,2*], Ji-Hui Oh[1,2], Yeon-sook Lee[1], Jong-Min Oh[2], Dong-Won Lee[1]

[1]Material Technology Center, Korea Testing Laboratory, Seoul, Korea

[2]Department of Electronic Materials Engineering, Kwangwoon University, Seoul, Korea

Abstract

Thin ceramic substrates are being used in various industries such as power semiconductors, solid oxide fuel cells (SOFCs), and high-temperature electrolysis (SOEC). These ceramic substrates may experience warpage due to various factors, such as manufacturing, processing, post-treatment, and thermal stresses caused by environmental changes during usage. As ceramic substrates are scaled to larger sizes and made thinner, the technology to suppress warpage and improve flatness has become crucial. Consequently, research and development on accurate warpage measurement methods for ceramic substrates are actively ongoing. Previous studies have measured camber or warpage in ceramic substrates using contact methods; however, when evaluating thin substrates with contact methods, errors due to compressive load from the probe contacting the substrate limit the reliability of the data. To address this issue, recent research has focused on using lasers and white light to measure camber or warpage in ceramic substrates. In this study, we conducted a standardization study on methods to evaluate warpage in ceramic substrates using non-contact methods, which improve measurement accuracy without applying external forces. First, to validate the testing method, we compared and analyzed contact and non-contact methods based on the substrate thickness. Additionally, depending on the size of the substrate and the degree of warpage, we proposed a method for accurately evaluating warpage by applying various non-contact methods such as laser and white light.

Keywords: Ceramic *substrate, warpage, Camber, non-contact measurement, Optical Measurement*

Acknowledgments

The research was supported by Korea Evaluation Institute of Industrial Technology(KEIT) grant founded by the Korea Government (00432123).

STANDARDIZATION ON MEASURING METHODS FOR COHESIVE AND FLOW PROPERTIES OF CERAMCIC PWODERS

Ji-Hui Oh[1,2*], Jin-Ae Kim[1,2], Yeon-sook Lee[1], Jong-Min Oh[2], Dong-Won Lee[1]

[1]Material Technology Center, Korea Testing Laboratory, Seoul, Korea

[2]Department of Electronic Materials Engineering, Kwangwoon University, Seoul, Korea

Abstract

Ceramic powders are widely utilized across advanced industries, including semiconductors, displays, secondary batteries, and fuel cells. The basic characteristics and performance of ceramic powders are typically evaluated through methods such as particle size, particle shape, specific surface area, and flow properties. These characteristics have a direct impact on the physical, chemical, and mechanical properties of the final product. Therefore, accurately assessing these properties is crucial for the manufacturing of high-quality products. Among the various evaluation methods, particle size and particle size distribution are the most significant indicators in determining powder characteristics. However, understanding the flow and agglomeration properties, which are also highly influenced by particle size and shape, remains challenging. Traditional methods for analyzing the flow and agglomeration of powders include using a funnel, but this approach often encounters difficulties when dealing with fine powders or highly cohesive powders. Issues such as orifice clogging, arching, and rat-holding can result in unreliable measurements. These challenges highlight the need for more accurate and efficient methods. Therefore, this study aims to propose improved techniques for analyzing powder agglomeration and flow characteristics, specifically based on factors such as particle size and cohesion. By overcoming the limitations of conventional methods, this research seeks to contribute to the more reliable assessment and application of ceramic powders in various industries.

Keywords: *ceramic powder, cohesive properties, flow properties, image analysis, dynamic method, static method*

Acknowledgments

The research was supported by Korea Evaluation Institute of Industrial Technology(KEIT) grant founded by the Korea Government (00432123).

CARBON AEROGELS AND GRAPHENE QUANTUM DOTS FROM RICE HUSK FOR ELECTROCHEMICAL ENERGY STORAGE

Rubia Young Sun Zampiva*, Pierfrancesco Atanasio, Marco Rossi, Mauro Pasquali, Francesca Anna Scaramuzzo

Department of Basic and Applied Science for Engineering, Sapienza University of Rome, Via Scarpa 14, 00161 Rome, Italy

Abstract

The integration of sustainable materials into high-performance energy storage systems is a key objective in advancing the green transition. In this context, our research focuses on the valorization of agricultural waste, specifically rice husk (RH), to produce carbon-based materials for use in lithium-ion batteries (LIBs) and supercapacitors. We have developed a process to convert RH into carbon nanomaterials: carbon aerogels (CAs) and graphene quantum dots (GQDs). The synthesis of CAs involves a two-step pre-treatment to remove lignin, hemicellulose, and silica, followed by gelation, drying, and carbonization. GQDs are obtained via a one-step, solvent-free ball milling of RH-derived carbon. Both materials were thoroughly characterized using a range of morphological and structural techniques. Electrochemical testing revealed that GQDs exhibit capacitive behavior, capable of ion intercalation and surface charge accumulation. However, performance degradation, likely due to poor interfacial contact within the electrode, suggests that further optimization of the formulation is needed. In contrast, CAs demonstrated remarkable cycling stability, maintaining 81.2% of their initial capacitance after 10,000 cycles. These findings highlight the potential of RH-derived carbon materials as cost-effective, sustainable electrodes for next-generation energy storage devices.

Keywords: *Rice Husk, Carbon Aerogels, Graphene Quantum Dots, Energy Storage.*

Acknowledgments

This research was supported by the Ministero dell'Università e della Ricerca - Progetti di Rilevante Interesse Nazionale (PRIN).

STRATEGIES FOR ENHANCING THERMAL TREATMENT EFFICIENCY OF WASTE FROM ELECTRICAL ENERGY PRODUCTION AND STORAGE SYSTEMS - AN ANALYTICAL METHODS PERSPECTIVE

Agnieszka Królicka*, Anna Maj and Grzegorz Łój

Department of Building Materials Technology, Faculty of Materials Science and Ceramics, AGH University of Krakow, Mickiewicza 30, 30-059 Krakow, Poland

Abstract

The number of end-of-life photovoltaic panels, decommissioned energy storage systems, old automotive batteries, and used portable electronics is expected to increase sharply in the coming years, with the generation of electronic waste expected to exceed 80 million tons by 2030 [1], considerably contributing to the growing volume of electronic waste that requires processing.

Therefore, there is an urgent need to develop safe technologies to manage these wastes, recover valuable materials, and reuse them according to the principles of a circular economy. Accurate identification of components in electronic waste is complex due to the diverse materials and chemical compounds present in these devices. The materials used in production are multicomponent and the products themselves are multilayered, with only certain components separable by simple mechanical methods. In the case of photovoltaic panels, performing safe thermal treatment requires confirmation or ruling out the presence of fluoropolymers in the waste, as processing of these materials can release toxic and volatile fluorine compounds. A typical process for recycling lithium-ion batteries involves cell discharging followed by shredding. As a result, this processing produces a material known as 'black mass', which typically contains components of lithium-containing cathodes, graphite anodes, current collectors such as aluminum and copper, binders, and conductive additives.

Processing of the above-mentioned waste can be greatly simplified by introducing analytical procedures that (i) determine its elemental composition and (ii) segregate waste streams according to their distinct chemical properties, for example, photovoltaic waste that contains fluorine versus fluorine-free fractions, or Li ion waste separated into cathode materials, anode materials, and separators. This paper demonstrates how laser-induced breakdown spectroscopy can be used both to characterize waste before it enters the processing line and to analyze the composition of recovered raw materials.

Keywords: *End-of-life management for solar panels, Li-ion batteries waste, Laser-induced breakdown spectroscopy (LIBS), thermal treatment*

Acknowledgments

The research project was partially supported by the program 'Excellence initiative – research university" for the AGH University of Krakow.

NUMERICAL ANALYSIS OF THE PROPERTIES OF P-I-N SOLAR CELLS BASED ON INGAN/GAN HETEROSTRUCTURES

Mourad Kaddeche

Department of Electronics and Communication, FST, University Djilali Bounaâma - Khemis miliana, Route thniet elhad, Khemis miliana, 44225, Algeria

Abstract

The main objective of this work is to design and simulate the optimal PIN solar cells based on III-N materials, for more accurate results and best configuration, the optical properties and the physical models such as the Fermi-Dirac statistics, Auger and Shockley-Read-Hall recombination, and the doping and temperature-dependent mobility model were taken into account in owr simulations. In order to show the impact of this technology on the efficiency of solar cells, as well as the advantages obtained for the fields of photovoltaics and renewable energies. We made a detailed study on the photovoltaic cell based on heterojunction InGaN /GaN related to its structure, its characteristics, its physico-technological parameters and to make the comparison with other structures for different alloys based on InGaN/ GaN, AlGaN /GaN in order to obtain maximum efficiency and to present its interest for photovoltaics. The proposed structure based on InGaN / GaN heterojunction are promising candidates for high-efficiency solar cells, the results obtained globally confirm that InGaN materials represents the best choice in the field of photovoltaics.

DETERMINATION OF THE PERCOLATION THRESHOLD OF A CELLULOSE–BIO-OIL–WATER NANODROPLET COMPOSITE BASED ON DC CONDUCTIVITY STUDIES

Paweł Żukowski[1], Konrad Kierczynski[2], Rafał Pająk[3], Marek Zenker[4]

[1]Lublin University of Technology, 38d, Nadbystrzycka Street, 20-618 Lublin, Poland;

[2]Department of Electrical Devices and High Voltage Technology, Lublin University of Technology, 38a, Nadbystrzycka Street, 20-618 Lublin, Poland

[3]Nynas AB Raffinaderivagen, 21, Nynashamn Stoc, 149 82 Nynasham, Sweden
[4]Department of High Voltage and Power Engineering, West Pomeranian University of Technology, 37, Sikorskiego Street, 70-313 Szczecin, Poland

Abstract

The mineral oil traditionally used in power transformers has several significant drawbacks concerning its environmental impact. Firstly, it is produced from fossil fuels, contributing to the carbon footprint during transformer production. Secondly, it exhibits very low biodegradability, which can lead to environmental contamination in the event of a failure. Recently, an alternative to mineral oils has emerged in the form of so-called bio-oils. Nynas AB Raffinaderivagen, Sweden, produces the bio-oil Nytro Bio 300X from plant-based raw materials, utilizing green hydrogen in the production process. Furthermore, bio-oil is highly biodegradable, eliminating the risk of soil contamination. The use of bio-oil in power transformers significantly reduces the carbon footprint associated with their production.

The aim of this study was to determine the frequency–temperature dependence of DC conductivity in moisture-containing electrical pressboard used in the insulation of power transformers, impregnated with the innovative NYTRO® BIO 300X bio-oil produced from plant-based resources. Tests were conducted on pressboard–bio-oil–water nanodroplet composites with moisture content ranging from 0.6 wt. %. to 5 wt. %, over a frequency range from 10^{-4} Hz to 5×10^{3} Hz, and at temperatures from 20°C to 70°C.

The obtained results were analyzed using a hopping conductivity model for DC and AC conduction, based on the quantum mechanical tunneling phenomenon of electrons. It was found that the experimental values of activation energy for DC conductivity in the pressboard–bio-oil–water nanodroplet composite are independent of moisture content. The activation energy was determined to be $\Delta E\approx(1.064\pm0.0246)$ eV, remaining constant across the tested frequency and temperature ranges. A dependence of DC conductivity on moisture content was observed. At low moisture levels, DC conductivity remained nearly constant. As the water content increased further, a sharp rise in DC conductivity was noted. Such behavior is characteristic of the dependence of DC conductivity on composites and nanocomposites on the content of the conductive phase. Based on these findings, the percolation threshold was determined to be $x_c\approx(1.4\pm0.3)$ wt. %.

SMALL SCALE DEFORMATION AND FRACTURE OF DUAL – PHASE HIGH – ENTROPY CERAMICS

J. Dusza

Institute of Materials Research, Slovak Academy of Sciences, Watsonova 47, Košice, Slovak Republic

Abstract

The deformation and fracture characteristics of dual – phase high entropy ceramics were investigated using nano/micro mechanical testing and detailed microstructure and fractography.The microstructure and fracture characteristics were investigated using X-ray diffraction (XRD), scanning electron microscopy (SEM) in combination with electron back scattered diffraction (EBSD) and transmission electron microscopy (TEM). Atomic structure and local chemical disorder was determined by means of scanning transmission electron microscopy (STEM) in conjunction with energy dispersive X-ray spectroscopy (EDS). Depth-sensing nano-indentation of differently oriented grains and and grain boundaries has been applied to study the nano - hardness and deformation characteristics. Micro - cantilevers prepared by focused ion beam from oriented facets of grains were studied. During micro-cantilever tests in bending deformation and fracture characteristics of individual grains and grain boundaries have been investigated. The bending strength of micro-cantilevers was strongly dependent on the character/size of the present fracture origins (nano – pores or grain boundaries) which were in all cases in nano-metric range.

Keywords: *High entropy ceramics, nanoindentation, microcantilever, fractography*

Acknowledgements

This research work has been supported by the EU Next Generation EU through the Recovery and Resilience Plan for Slovakia under the project No. 09101-03-V05-00009.

MATERIALS DESIGN USING IN SITU ALLOYING AND POWDER BLENDING IN POWDER BED FUSION AND DIRECTED ENERGY DEPOSITION ADDITIVE MANUFACTURING

Vladimir Popov*, Shir Andreev-Batat, Noam Eliaz

Department of Materials Science and Engineering, Tel Aviv University, Ramat Aviv, Tel Aviv, Israel

Abstract

Design of new materials and alloys using Additive Manufacturing (AM) is a relatively novel methodology. This work shows how it can be applied to design high-entropy alloys (HEAs), functionally graded materials (FGMs), and even ceramic and composite structures, utilizing in situ alloying, powder blending, alternate powder supply, and advanced laser scanning strategies. These approaches require a comprehensive understanding of process parameters optimization, material properties, and microstructure analysis. The TAU Additive Manufacturing Center (AMC) focuses on the design and characterization of both conventional and novel materials, including metal-matrix and ceramic-matrix composites. The center operates an Optomec LENS 3D Hybrid system, enabling powder-fed laser-based Directed Energy Deposition (DED) and post-processing in a single setup. Recent research examples on material design using Powder Bed Fusion (PBF) and DED are presented, including HEAs, magnetic alloys, metal-matrix composites (MMCs), ceramics, and FGMs.

Keywords*: additive manufacturing, in situ alloying, materials design, functionally graded materials, powder bed fusion, directed energy deposition*

METAL-MATRIX COMPOSITES PRODUCED BY A BOTTOM-UP TECHNIQUE FROM CORE-SHELL POWDERS

Pavel Lejček[1*], Angelina Strakošová[1], Filip Průša[2], Drahomír Dvorský[1], Orsolya Molnárová[1],

[1]Dept. Functional Materials, Institute of Physics, Czech Acad. Sci., Na Slovance 2, 182 00 Praha 8, Czechia

[2]Dept. Metals and Corrosion Engineering, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czechia

Abstract

As metal-matrix composites (MMCs), the materials are usually considered, containing soft matrix and hard particulates of various shapes. Accordingly, they can well serve for numerous practical applications. From the viewpoint of understanding detailed mechanisms of deformation, it is also interesting to study MMCs containing not only soft matrix but also soft particulates. We refer to the production and microstructure of Ag-Cu and Ag-W MMCs using spark plasma sintering of the core-shell powders. The microstructure is bimodal as characterized by Ag matrix with the grain sizes of the order of units of micrometer, and by Cu or W particulates possessing the grain size of te order of 10 micrometers. Plastic deformation of Ag-Cu MMC results in the prolongation of the particulates relative to the straining while W particulates in Ag-W MMC do not change the shape. Quantitative evaluation of the results explained an increase of the compression yield point as well as enabled to determine the mechanism of deformation in MMCs.

Keywords: *core-shell powder, spark plasma sintering, metal-matrix composite, platstic deformation, silver, copper, tungsten*

Acknowledgements

This work was financially supported by the Czech Science Foundation under grant No. 23-05139S.

COMPARATIVE CHARACTERIZATION OF Cu–Ag AND Ag–Cu METASTABLE METAL MATRIX COMPOSITES PREPARED BY BOTTOM-UP WAY FROM CORE-SHELL POWDERS

Angelina Strakosova[1*], Filip Průša[2], Pavel Lejček[1]

[1]Institute of Physics, Czech Academy of Sciences, Na Slovance 2, 182 00 Praha 8, Czech Republic

[2]Department of Metals and Corrosion Engineering, University of Chemistry and Technology, Technická 5, 166 28 Praha 6, Czech Republic

Abstract

Metastable metal matrix composites (m-MMCs) are multi-phase materials composed of two or more metals with different atomic structures, resulting in unique mechanical properties. Typically, one of the metals serves as a matrix while the other acts as a strengthening agent. However, there is limited research on m-MMCs created from two metals with similar properties. In this work, we compare the microstructure and mechanical properties of Cu–Ag and Ag–Cu metastable metal matrix composites (m-MMCs) produced from core-shell powders using a bottom-up way. Firstly, we characterized initial core-shell powders including powder size distribution, morphology and microstructure. Then, powders were compacted using the Spark Plasma Sintering method, which allows for suppression of the diffusion processes between the core and shell of the default powder. The prepared Cu–Ag and Ag–Cu m-MMCs were finally characterized by various microscopy techniques and mechanical testing.

Keywords: *copper, silver, core-shell powders, spark plasma sintering, metastable metal matrix composite, microstructure*

Acknowledgments

This work was financially supported by the Czech Science Foundation under the grant No. 23-05139S. One of the authors (AS) acknowledges the grant of the Czech Academy of Sciences under No. L100102403.

PRODUCTION OF COPPER MATRIX COMPOSITES

Tuğba Mutuk*, Öznur Akyol

Ondokuz Mayüs University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, Samsun, Turkiye

Abstract

Composites containing two or more distinct components and having significantly different chemical, physical and mechanical properties are important materials for engineering applications. Today, copper, which is used as a matrix material in aviation, space, transportation, electrical contact transmission, etc. due to its excellent electrical conductivity, lubrication and friction prevention performance, is used as a matrix material in the fields of aviation, space, transportation, electrical contact transmission, etc. Copper, which is one of the most basic components of the electrical-electronics sector in particular, is a material with high thermal and electrical conductivity. In addition to these properties, copper is preferred in many engineering applications due to its low thermal expansion coefficient, good anti-oxidation capacity, high corrosion resistance, high alloying property, low cost and also good ductility. However, despite the many excellent properties of copper, its ductility makes it vulnerable to mechanical stresses. In the study, TiB_2 ceramic particles with properties such as high hardness, wear resistance and good thermal stability were reinforced into the copper matrix as a reinforcement material. The mechanical properties of the obtained composite will be investigated.

Acknowledgments

This research was supported by the Ondokuz Mayis University (Scientific Researched Project Department) under grant number [BAP04-A-2024-5698].

MECHANICAL AND ACOUSTICAL PROPERTIES OF THE CRUMB RUBBER CONCRETE

A.Korjakins, M.Pavlovs, V.Lapkovskis, I.Samoilenko

Institute of Sustainable Building Materials and Engineering Systems, Riga Technical University, Latvia

Abstract

The increasing demand for sustainable construction materials has led to growing interest in reusing end-of-life tire rubber as a functional component in concrete. This study explores the influence of chemically treated crumb rubber on cement-based composites' mechanical and acoustic performance. In particular, the research examines the effects of acetone surface modification on rubber particles and how such treatment impacts the mechanical and acoustic properties of the resulting concrete rubber composite.

A series of concrete mixtures were elaborated and prepared with varying volumetric contents of rubber aggregate (15%, 25%, and 35%) that was exposed to different durations of acetone treatment (one, six, and twenty-four hours). The investigation includes an extensive experimental program, which includes compressive and flexural strength testing, water absorption behavior, density measurements, and frequency-dependent sound absorption analysis using Impedance and Transfer Loss tube equipment. Analysis of acquired data was performed, and conclusions were formulated.

ANALYSIS OF REQUIRED REINFORCEMENT FOR PROTECTING CONCRETE STRUCTURES AGAINST BRITTLE FAILURE

Marta Słowik

Department of Building Structures, Lublin University of Technology, Lublin, Poland

Abstract

In the paper the analysis of minimum reinforcement in reinforced concrete structures that is required for protecting structural members against brittle failure has been performed. Different methods for determining necessary reinforcement, among them the method based of nonlinear fracture mechanics of concrete, have been presented.

Minimum reinforcement according to protection concrete structures against dangerous, brittle failure should be determined from the condition of comparing the load capacity of a reinforced concrete section with the cracking moment. However, when the axial tensile strength of concrete is used to calculate the cracking moment, too low values of crack resistance are obtained comparing to test results. The better results of a cracking moment calculation are obtained when axial tensile strength is replaced by flexural tensile strength.

In order to obtain a proper value of reinforcement ratio, the relation between flexural tensile strength and axial tensile strength of concrete should be correctly determined. The application of nonlinear fracture mechanics in numerical simulations of cracking forces in concrete members has shown that the increase of cracking moment takes place when the member's dimensions decreases. The coefficient k which characterizes the relation between flexural tensile strength and axial tensile strength has been derived from numerical analysis. It varies over a wide range and is higher in small members and in members made by high strength concrete.

In the paper the discussion of the minimum reinforcement ratio determined using the coefficient k has been presented. On the basis of the performed comparative analysis it has been concluded that the scale effect was not taken into account in standard methods of calculating reinforcement which is required for protection the structure against brittle failure.

Keywords: *concrete structures, minimum reinforcement, brittle failure*

Acknowledgments

This research was supported by Lublin University of Technology.

POROUS NANOCRYSTALLINE IRON MANGANITE POWDERS AS CATALYST FOR COMBUSTION OF SOME VOLATILE ORGANIC COMPOUNDS

Corneliu Doroftei[1]*, Gabriel Murariu[2] Aurelian Carlescu[1], Marius Dobromir[3]

[1]Science Research Department, Institute of Interdisciplinary Research, Research Center in Environmental Sciences for the North-Eastern Romanian Region (CERNESIM), Alexandru Ioan Cuza University of Iasi, Iasi, Romania

[2]Chemistry, Physics and Environment Department, Faculty of Sciences and Environment, Dunarea de Jos University of Galati, Galati, Romania

[3]Science Research Department, Institute of Interdisciplinary Research, Research Center on Advanced Materials and Technologies (RAMTECH), Alexandru Ioan Cuza University of Iasi, Iasi, Romania

Abstract

The high cost of catalysts that use noble metals in their composition has led to research into alternative materials for the production of cheap catalysts that at the same time present quite high performances. The production of materials with large specific surface areas and of nanosized particles is a priority in the performance of a ceramic catalyst. Heterogeneous catalysis being a surface phenomenon, its efficiency is determined by both the chemical composition and the surface structure of the catalyst. A nanometric structure ensures a large specific surface area and superior reactivity of the catalyst.

In this work, the porous nanocrystalline iron manganite $FeMnO_3$ powders were synthesized by the sol-gel self-combustion method using polyvinyl alcohol as the colloidal medium. This preparation procedure offers the advantage of obtaining ultrafine ceramic powders, homogeneous, reproducible and with precise stoichiometry. The obtained powder was analyzed from a morphological and structural point of view, and was also tested in terms of catalytic activity at moderate temperatures (50 – 550 °C) for acetone, ethanol, toluene and Pb free gasoline vapors. The conversion degree reaches values of over 99% for acetone vapors and over 97% for ethanol vapors at a temperature of 290 °C. Regarding the studied hydrocarbons (toluene and Pb free gasoline) the conversion degree can reach remarkable values at much higher temperatures. The catalyst based on this iron manganite can be recommended for the combustion of acetone or ethanol vapors.

Keywords: *iron manganite, structural properties, catalytic combustion, volatile organic compounds*

EFFICIENT PHOTOCATALYTIC DEGRADATION OF DYES USING TITANIUM SILICATE MOLECULAR SIEVE

Hristina Lazarova*, Borislav Barbov, Elena Tacheva, Rusi Rusew, Boris Shivachev

Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria

Abstract

This study presents the synthesis and characterization of a titanium-silicate material, TS-1, and evaluates its photocatalytic performance in the degradation of organic dyes under white light irradiation. X-ray fluorescence (XRF) analysis confirmed the materials chemical composition, showing 91.53% Si and 8.47% Ti, suggesting the successful incorporation of titanium into the silicate framework. Powder X-ray diffraction (PXRD) patterns revealed the preservation of the crystalline MFI-type structure typical for TS-1 materials. Furthermore, Brunauer–Emmett–Teller (BET) surface area measurements indicated a porous texture conducive to effective mass transport and dye molecule interaction with the active sites. The material was tested against four structurally diverse dyes: crystal violet (CV), methylene blue (MB), methyl orange (MO) and rhodamine B (RhB). The observed degradation efficiencies were 94.23% for CV, 98.25% for MB, 40.48% for MO and 95.59% for RhB, indicating high catalytic activity and selectivity, particularly toward cationic and heterocyclic dye molecules. The synergy of the material's structural, morphological, and photocatalytic properties makes TS-1 a promising candidate for environmentally friendly wastewater treatment applications. Its high activity under broad-spectrum white light offers practical advantages over UV-dependent systems.

Keywords: *photocatalytic degradation, titanium silicate (TS-1), crystal violet, methylene blue, rhodamine B, methyl orange*

Acknowledgments

This work was financially supported by the Bulgarian National Science Fund, contract KP-06-COST/28

SYNTHESIS AND CHARACTERIZATION OF TITANIUM SILICATE MOLECULAR SIEVE

Borislav Barbov*, Hristina Lazarova, Elena Tacheva, Rusi Rusew, Boris Shivachev

Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria

Abstract

Dye pollutants in industrial wastewater pose a major environmental challenge due to their persistence and toxicity. This work aims to develop an efficient catalytic system for sustainable water treatment by synthesizing zirconium-substituted titanium silicate-1 (Zr-TS-1) as a heterogeneous catalyst. Zr-TS-1 samples with 5, 10, and 20 mol% zirconium were prepared via a hydrothermal method and characterized by X-ray diffraction (XRD), X-ray fluorescence (XRF), and nitrogen adsorption–desorption (BET). Catalytic activity was evaluated through the oxidative degradation of model dye pollutants in simulated wastewater. The incorporation of zirconium improved both textural properties and catalytic performance, with 5 and 10 mol% Zr-TS-1 achieving the highest degradation efficiency. These findings demonstrate the potential of Zr-TS-1 catalysts for scalable and sustainable wastewater purification applications.

Keywords: *Zr-TS-1, zeolites, wastewater treatment, dye removal, heterogeneous catalysis*

Acknowledgments

This work was financially supported by the Bulgarian National Science Fund, contract KP-06-COST/28

VARIATIONS OF MOF STRUCTURES OBTAINED WITH TRIDENTATE LIGANDS

Magdalena Angelova[1,*], Hristina Lazarova[1], Rusi Rusew[1], Vanya Kurteva[2], Rositsa Nikolova[1], Boris Shivachev[1]

[1] Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, Sofia, Bulgaria

[2] Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria

Abstract

A novel metal–organic framework (MOF), designated MOF-S1, was synthesized via solvothermal reaction between zinc nitrate hexahydrate and the tritopic ligand 2,4,6-tris-(4-carboxyphenoxy)-1,3,5-triazine (TCPT). The framework crystallized as hexagonal rods with a two-fold interpenetrated 3D network composed of zinc paddle-wheel SBUs, stabilized by hydroxyl bridges and exhibiting ultramicroporosity. Structural integrity and phase purity were confirmed through X-ray diffraction, with thermal stability up to ~300 °C. Nitrogen sorption showed a surface area of 711 m²/g and a pore width of ~6.5 Å. Spectroscopic analysis revealed a band gap of 4.24 eV, supporting UV-light applications. MOF-S1 showed rapid and efficient adsorption of Congo Red and Methylene Blue dyes, following pseudo-second-order kinetics and Langmuir isotherm behavior. Under UV light, it achieved up to 93% degradation of Methyl Orange and 74% of Rhodamine B, surpassing several related MOFs in performance. The synthesis strategy—using DMF/H_2O without acidic additives—enabled formation of a robust, highly porous material suitable for photocatalysis and environmental remediation.

Keywords: *MOF, TCPT, dye adsorption, UV photocatalysis, zinc coordination, wastewater treatment*

Acknowledgments

This research was funded by the Bulgarian National Science Fund (BNSF), grant number KP-06-COST/3.

THE GREEN AND HIGHLY EFFICIENT SYNTHESIS OF NEW CLASS OF CARBONYL-FUNCTIONALIZED SILSESQUIOXANES

Kamil Hanek*, Patrycja Żak

Department of Organometallic Chemistry, Faculty of Chemistry, Adam Mickiewicz University in Poznań, Poland

Abstract

Polyhedral oligomeric silsesquioxane (SQs) are hybrid compounds based on silicon-oxygen scaffoldings. Thanks to its desirable thermal and mechanical properties the SQs derivatives are in the centre of interest in various branches of chemistry concerning luminescence, photoactive polymers or biomedical materials. It has been proved that SQs constitute a perfect platform for designing new nanocarrier systems for drug delivery. In such systems, α,β-unsaturated carbonyl compounds, e.g., chalcones with antiviral properties, can be successfully attached to the hybrid carrier molecule. However, most of the synthetic procedures of obtaining such compounds are characterized with many drawbacks such as: the use of harmful transition metal complexes, presence of oxidants, high temperature, long reaction time and most importantly insufficient selectivity.

In this research we present the base-catalyzed protocol for efficient functionalization of SQ-SH with ketones, esters and aldehydes. The proposed method was fully optimized and allowed successful syntheses of twelve new carbonyl-functionalized nanomaterials. All of the products were characterized using spectroscopic and spectrometric methods. Among the most significant advantages we point to the absence of transition metals, green solvent (acetone), elimination of other additives, short reaction time, aerobic conditions, full chemoselectivity. The designed method is easily scalable to gram quantities.

Based on our previous research regarding thioester synthesis, the reactions' mechanisms concerning 1,4-addition to the α,β-unsaturated carbonyl compounds were proposed. Moreover, in order to estimate the potential practical application of the obtained products, the thermal analyses were performed proving that the incorporation of SQ unit into the drug significantly increases its thermal stability, thus making it more attractive for use in further reactions.

Keywords: *silsesquioxanes, thermal analysis, carbonyl compounds, base catalysis, green chemistry*

ELECTROCHEMICAL PREPARATION OF AMORPHOUS NICKEL COATINGS

Veselina Chakarova[1], Daniela Kovacheva[2], Ljubomir Aleksandrov[2], Iskra Piroeva[1], Milko Monev[1]

[1]Institute of Physical Chemistry "Acad. Rostislaw Kaischew", Bulgarian Academy of Sciences, Sofia, Bulgaria

[2]Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria

Abstract

Amorphous nickel coatings were obtained using two methods - electroless deposition and electrodeposition. Electroless X-ray amorphous Ni-P coatings were deposited from a conventional acidic solution with sodium hypophosphite as reducing agent. Amorphous Ni-C coating were obtained by electrodeposition. The coatings were characterized using the followings methods - SEM, EDS, DTA-MS, XPS, XRD and cyclic voltammetry. In both methods, the metal layer is formed with the participation of a metalloid (P or C) and hydrogen. Heat treatment transforms the amorphous Ni-C coating into fcc Ni. The same behavior is observed in the case of the electroless Ni-P coating, but in a slightly lower temperature range. In the recrystallization temperature range, hydrogen is released from both amorphous coatings. In the case of the electrodeposited Ni-C coating, CO_2 is also released. It can be assumed that hydrogen, together with the metalloid, is involved in the formation and/or stabilization of the amorphous structure.

Keywords: *electroless deposition, electrodeposition, amorphous coating, citric acid, XRD, DTA, XPS, EDS*

Acknowledgments

Equipment supported/obtained under the project INFRAMAT (National Roadmap for Research Infrastructure) financed by Bulgarian Ministry of Education and Science was used in this investigation.

FUNCTIONAL SILVER(I) COORDINATION COMPOUNDS - SYNTHESIS, CHARACTERIZATION AND APPLICATION

Sabina Weronika Jaros

Faculty of Chemistry, University of Wrocław, Poland

Abstract

The quality of human life is closely related to several factors, including the prevention of viral and bacterial infections. Microbial contamination has a profound impact on our daily experiences and negatively affects our quality of life. Today, the resistance of microorganisms to standard antibiotics and disinfection protocols, along with their ability to form biofilms, presents serious global challenges. The development of new antimicrobial compounds, sustainable biomaterials, and surfaces to reduce the accumulation and spread of viruses and bacteria is increasingly recognized as a significant necessity in both the food and healthcare sectors.

This presentation aims to share our recent research findings on the self-assembly synthesis, structural features, morphology, and potential applications of functional silver(I) coordination polymers derived by aminophosphine and biologically active ligands. The following topics will be discussed

1) *Self-assembly synthesis and structural diversity of silver(I) coordination polymers derived from carboxylic acids and aminophosphines.*
2) *Generation of antimicrobial CP-doped polymer/hydrogel films, based on starch (PS) or chia seed mucilage (CSM).*
3) *Application of these compounds as efficient antimicrobials against different types of Gram-positive and Gram-negative bacteria, and viruses.*

Keywords: *silver coordination polymers, starch-based materials, functional materials*

Acknowledgments.

We thank the National Science Center (Grant No. 2019/35/D/ST5/01155, Poland) and FCT (PhD grant SFRH/BD/77024/2011).

SURFACE TREATMENTS OF ORTHOPEDIC IMPLANTS FOR CONTROLLED OSSEOINTEGRATION

Lucie Bacakova[1,2]

[1]Laboratory of Biomaterials and Tissue Engineering, Institute of Physiology of the Czech Academy of Sciences, Videnska 1083, 142 00 Prague, Czech Republic

[2]Faculty of Materials and Technology, VSB-Technical University of Ostrava, 17. listopadu 2172/15, 708 00 Ostrava, Czech Republic

Abstract

Despite all the advances in bone tissue engineering (e.g., based on natural and synthetic polymers, ceramics, and cells), metallic bone implants remain indispensable in orthopedics, especially in load-bearing applications such as large joint replacement (hip and knee) or fixation of bone fractures in traumatology. From this point of view, metal implants can be divided into two groups, namely long-term, optimally permanent implants (for joint replacements) and short-term implants that can be removed after fracture healing (pins, screws, plates, wires). For both groups of implants, we need different surface treatments to regulate their degree of osseointegration, ranging from a high degree for long-term/permanent implants to a low degree for short-term removable implants. In our studies, we focused mainly on surface modifications of long-term bone implants, such as the bone-anchoring parts of hip prostheses, in an attempt to increase their osseointegration potential. We evaluated this potential by monitoring cell adhesion, growth and osteogenic differentiation in cultures on titanium alloys (in particular the clinically used Ti6Al4V) coated with layers of nanocrystalline diamond (NCD), diamond-like carbon (DLC), zeolitic and ferroelectric ceramics. These coatings usually improve the osseointegration potential of implants due to their nanostructure, oxygen termination and functionalization with bone morphogenetic protein-7 (NCD coatings), degree of doping with Ti (DLC), thermal treatment (silicalite-1) or electrical charge ($BaTiO_3$, $LiNbO_3$). However, oxidic layers produced by micro-arc oxidation (MAO) technology can have a dual effect on cells. They can be prepared with high hydrophilicity and high microscale surface roughness, which has a repulsive effect on cell adhesion, spreading and subsequent growth, or with moderate wettability and roughness, which is favorable for cell colonization. At the same time, all of these surface coatings are designed to protect the material surface from wear, corrosion, and the release of potentially cytotoxic, immunogenic, and mutagenic ions and particles.

Acknowledgments

Supported by Project No CZ.02.01.01/00/22_008/0004631 of the Ministry of Education, Youth and Sports of the Czech Republic, co-funded by the European Union, and by the Praemium Academiae grant (No. AP2202) of the Czech Academy of Sciences.

SYNTHESIS, DEPOSITION, AND CHARACTERIZATION OF CO/CU/ZN-SUBSTITUTED BIOGLASS THIN FILMS

Ana-Maria-Raluca Muşat[1], Gabriela-Olimpia Isopencu[2], Cristina Busuioc[1*]

[1] Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Chemical Engineering and Biotechnology, National University of Science and Technology POLITEHNICA Bucharest, RO-060042, Bucharest, ROMANIA

[2] Department of Chemical and Biochemical Engineering, Faculty of Chemical Engineering and Biotechnology, National University of Science and Technology POLITEHNICA Bucharest, RO-060042, Bucharest, ROMANIA

Abstract

Bioglass is a bioactive material capable of bonding with living tissues, such as bone and skin, thereby promoting regeneration. It stimulates a biological response at the material-tissue interface, facilitating natural bonding and new bone formation. Owing to these properties, bioglasses are increasingly employed as thin coatings on metallic implants, significantly improving their mechanical performance and biocompatibility, as validated through extensive in vitro and in vivo studies. Their application, particularly in orthopedic and dental implants, enhances osseointegration and contributes to long-term implant stability.

Substituents in bioactive glasses are small amounts of ions or atoms incorporated during synthesis to modify properties. Based on a literature review, cobalt, copper, and zinc were selected to enhance the mechanical and biological behavior of bioglass. The sol-gel method was used to synthesize compositions by partially substituting CaO in the basic 60%SiO_2–4%P_2O_5–36%CaO formulation with CoO (1%), CuO (5%), and ZnO (5%). The resulting powders were compacted by pressing and thermally treated to produce targets for thin-film deposition.

The thin films were fabricated using Pulsed Laser Deposition (PLD), a technique employing high-intensity laser pulses (Nd:YAG laser) to ablate the target material under vacuum, with the ablated species condensing onto the substrate. During deposition, pressure, wavelength, and pulse duration were kept constant, while substrate temperature and target composition were varied, resulting in eight distinct films.

Characterization was conducted by Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), and immersion in Simulated Body Fluid (SBF) to assess compositional, structural, and morphological properties.

The synthesis and deposition of substituted bioglass thin films underline their promising potential for biomedical applications, offering prospects for further optimization in implant coating technologies.

Keywords: *bioglass thin films, Pulsed Laser Deposition, sol-gel method, substituted bioglass, biomedical coatings*

Acknowledgement

The authors are grateful to the Romanian Government for providing access to the research infrastructure of the National Centre for Micro and Nanomaterials through the National Program titled “Installations and Strategic Objectives of National Interest”.

IN VITRO CORROSION BEHAVIOR OF HYBRID PARTICLE REINFORCED MAGNESIUM NANOCOMPOSITES

Demet Zalaoğlu[1], Emre Özer[1], Mehmet Ayvaz[2], Mustafa Übeyli[1,*], Umut Aksu[1], Musa Eryilmaz[1]

[1]Osmaniye Korkut Ata University, Faculty of Engineering and Natural Sciences,

Mechanical Engineering, 80000 Osmaniye – Türkiye

[2]Manisa Celal Bayar University, Vocational School of Manisa Technical Sciences,

45140 Manisa - Türkiye

Abstract

In this paper, the in vitro corrosion resistance of Mg2Zn1Mn composites bearing equal amount of alumina and hydroxyapatite nano particles was investigated. The nanocomposites consisting of various amounts of reinforcement were manufactured by the uniaxial cold compaction at 700 MPa and the sintering operation at 620 ℃ for 2 h. After the manufacturing stage, the nanocomposites were subjected to a series of corrosion experiments in simulated body fluid (SBF) at 37 ℃. Both the electrochemical and immersion corrosion tests of these nanocomposites were made for comparison. In the electrochemical corrosion testing, a three-electrode technique was utilized by employing calomel, platinum and nanocomposite sample to be reference, counter and working electrodes, respectively. Meantime, the immersion corrosion tests were carried out for 7 days by keeping the ratio of SBF volume/sample surface area is 20 ml/cm^2 for all cases. The results brought out that the reinforcement ratio had a strong effect on the corrosion rate of the nanocomposites. The lowest corrosion rate was recorded as 6.94 mm/year for the nanocomposite with 15 wt. % reinforcement content by the electrochemical corrosion study. However, the immersion corrosion results brought out that the nanocomposite with 10 wt. % reinforcement got the highest corrosion resistance. Also, the pitting and galvanic corrosion mechanisms were observed on the corroded nanocomposites. Furthermore, the corrosion products formed on the tested samples maintained a temporary protection for the nanocomposite surfaces since they detached from their surfaces with time.

Keywords: *Magnesium nanocomposite, in vitro corrosion, mechanical alloying, hydroxyapatite.*

Acknowledgement

This study was supported by Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the grant number 223M362. The authors thank to TÜBİTAK for their supports.

VERSATILE GREEN-EMITTING CARBON NANODOTS FOR BIOMEDICAL IMAGING AND GENE THERAPY

Bogdan-Florin Craciun*, Denisse-Iulia Bostiog, Florica Doroftei, Adina Coroaba, Narcisa-Laura Marangoci, Mariana Pinteala

"Petru Poni" Institute of Macromolecular Chemistry, Center of Advanced Research in Bionanoconjugates and Biopolymers, 41A Grigore Ghica Voda Alley, Iasi, 700487, Romania

Abstract

Nanocarriers play a key role in non-viral gene delivery by enabling the targeted transport of molecular payloads, such as DNA or RNA, into specific cells, often via mechanisms linked to the cell cycle. Developing gene carriers that efficiently deliver genetic material to human cells with minimal toxicity remains a major challenge in the field. Carbon nanodots (CNDs) have emerged as promising candidates for bioimaging and gene delivery due to their photostability, biocompatibility, and tunable optical properties.

In this work, green-emitting CNDs were synthesized via a microwave-assisted method using protocatechuic acid (PA) and a β-cyclodextrin–hyperbranched polyethyleneimine conjugate (bPEI25k-CD) as precursors. The resulting nanodots (PPbetaC CNDs) exhibited a cationic, amine-rich surface ideal for plasmid DNA condensation, decorated with β-CD units suitable for targeted delivery via host–guest chemistry. These CNDs displayed uniform spherical morphology (<10 nm), strong green fluorescence (~500 nm), positive surface charge, and high colloidal stability. They were also resistant to photobleaching and stable across a broad pH and temperature range. To enhance targeting capabilities, an adamantane-PEG-conjugated decapeptide (WXEAAYQRFL) was attached through β-CD–adamantane host–guest complexation, yielding PPbetaC-P CNDs. The modified nanodots retained the core properties of PPbetaC CNDs and effectively condensed plasmid DNA at low N/P ratios. Preliminary in vitro studies on HDF, HOS, and MCF-7 cell lines demonstrated low cytotoxicity compared to bPEI25k.

These results suggest the potential further use of PPbetaC-P CNDs as multifunctional, non-viral carriers for targeted gene therapy and fluorescence-based biomedical imaging.

Keywords: *Carbon nanodots, Bioimaging, Non-viral vectors, Host–guest chemistry, Targeted Gene therapy, Photostable nanomaterials.*

Acknowledgements

The authors are thankful for the financial support from the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

ONE-STEP MICROWAVE SYNTHESIS OF BIOCOMPATIBLE CARBON NANODOTS FOR GENE DELIVERY AND IMAGING APPLICATION

Denisse-Iulia Bostiog[1], Bogdan-Florin Craciun[1], Adina Coroaba[1], Florica Doroftei[1], Natalia Simionescu[1], Isabela-Andreea Sandu[1], Andrei-Ioan Dascalu[1], Narcisa-Laura Marangoci[1], Mariana Pinteala[1], Ania Conchi [1,2]

[1]Centre of Advanced Research in Bionanoconjugates and Biopolymers, "Petru Poni" Institute of Macromolecular Chemistry of Romanian Academy, Grigore Ghica Voda 41A Alley, 700487 Iasi, Romania.

[2]Conditions Extremes Materiaux: Haute Temperature et Irradiation (CEMHTI), UPR 3079, CNRS, Université d'Orléans, 45071 Orleans, France

Abstract

Carbon nanodots (CNDs) have gained increasing attention as multifunctional nanomaterials due to their unique combination of photoluminescence, biocompatibility, and ease of functionalization. In this work, CNDs were synthesized by applying a microwave-assisted method using protocatechuic acid and branched polyethyleneimine (PEI, 25 kDa) as carbon and nitrogen sources. The resulting nanomaterials exhibited favorable optical properties, colloidal stability, and surface characteristics conducive to biological interactions. Preliminary evaluations demonstrated their ability to facilitate gene delivery with reduced cytotoxicity, while also enabling efficient cellular imaging. These findings suggest that the synthesized CNDs serve as a promising nanoplatform for integrated gene delivery and imaging, with potential applications in future biomedical strategies.

Keywords: *Carbon nanodots, microwave-assisted synthesis, gene delivery, plasmid DNA condensation, cellular imaging.*

Acknowledgments

The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

COMPARATIVE STUDY ON LITHIUM AND BORON-SUBSTITUTED BIOACTIVE GLASS-CERAMICS FOR TISSUE ENGINEERING

Mihai Fotu[1*], Adrian-Ionut Nicoara[2], Stefan Manolache[3], Isabelle-Maria Perisan[4], Roxana Popescu[5], Cristina Busuioc[6]

[1,2,6] Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, Romania

[3,4] Faculty of Medical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest

[5] Department of Life and Environmental Physics, National Institute for Research and Development in Physics and Nuclear Engineering "Horia Hulubei", Magurele, Romania

Abstract

The growing need for bone substitutes, driven by trauma, cancer, arthritis, and infections, has fueled significant advancements in bone tissue engineering. Scaffolds designed for bone regeneration must exhibit mechanical stability and possess a 3D interconnected porous architecture. To support cell maturation, these scaffolds should replicate the native tissue environment, necessitating careful optimization of their chemical composition and physical structure. Bioactive glasses and glass-ceramics are widely used in bone tissue engineering, playing a vital role in fracture repair and other tissue regeneration processes. These materials have the unique ability to bond to bone surfaces by forming an apatite layer, which initiates biomineralization and accelerates bone remodeling.

Various metallic ions can enhance bioactive glasses, such as silver for antimicrobial effects, magnesium for osteogenesis, and copper for angiogenesis. Recent studies highlight the potential of lithium and boron substitutions, with lithium improving bone density and regeneration, while boron accelerates wound healing and bone remodeling. Lithium-substituted bioglasses promote osteogenesis and angiogenesis, whereas boron-substituted variants offer superior bioactivity and controlled biodegradability, making both promising for bone tissue engineering.

This study aims to comparatively analyse lithium- and boron-substituted bioglasses in terms of degradation behaviour, mechanical strength, and biological properties, including cell viability and antibacterial activity. To ensure consistency, both types of bioglasses were synthesized under identical conditions, using the sol-gel method. The compositions were formulated with three different substitution levels – 2.5, 5, and 10 % – allowing for a systematic evaluation of how each dopant influences the material performance in biomedical applications.

This study shows that both lithium- and boron-substituted bioglass-ceramics enhance key biomedical properties, each offering distinct advantages. Boron improves strength and antimicrobial activity, while lithium increases deformability and toughness. Both outperform the control, with the optimal choice depending on application-specific needs balancing strength, bioactivity, and antimicrobial efficacy.

Keywords: bioglass-ceramics, ions substitution, sol-gel method, bioactive materials, tissue engineering.

Acknowledgements

The financial support of the "Noi materiale obținute prin fabricare aditivată pentru ingineria țesutului dur" project GNaC ARUT 2018, contract no 126/04.12.2023, as well as the infrastructure of the National Center for Micro and Nanomaterials – "Installations and Strategic Objectives of National Interest" Program are highly acknowledged.

ANTIBACTERIAL PROPERTIES OF Si-Cu NANOCOMPOSITES: INHIBITION OF GRAM-POSITIVE BACTERIA

Lilia Yordanova[1]*, Albena Buchvarova-Nedelcheva[2], Yoanna Kostova[3], Elitsa Pavlova[4], Iliana Ivanova[1]

[1] Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov Blvd., 1164 Sofia, Bulgaria

[2] Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev Str., bl. 11, 1113 Sofia, Bulgaria

[3] Institute of Metal Science, Equipment and Technologies with Hydro- and Aerodynamics Centre "Acad. A. Balevski", Bulgarian Academy of Sciences, Shipchenski Prohod Str., 67, 1574 Sofia

[4] Faculty of Physics, Sofia University "St. Kliment Ohridski", 5 James Boucher Blvd., 1164 Sofia, Bulgaria

Abstract

Silica nanocomposites have received approval from the US Food and Drug Administration (FDA) owing to their exceptional biocompatibility, chemical inertness, low toxicity, resistance to acids and high temperatures. These hybrid materials are composed of an amorphous network integrating inorganic and organic phases, with robust interface interactions typically facilitated by coupling agents. By selecting appropriate phases, these composites can be tailored to exhibit specific properties for a wide range of applications. Silica nanomaterials continue to attract significant attention in contemporary science and biomedicine, owing to their outstanding characteristics that support a variety of biological uses. Silicon-based nanoparticles have emerged as a promising alternative to traditional antibiotics in the treatment of pathogenic bacteria due to their ability to interact with bacterial cell walls and disrupt their function. These nanomaterials offer several advantages, including reduced risk of resistance development and enhanced antibacterial activity through mechanisms such as oxidative stress and physical damage to bacterial membranes. It is well known that the generation of reactive oxygen species (ROS) is one of the main toxicity mechanisms by which nanoparticles inhibit bacterial growth. The generation of ROS is an important biomarker regarding the redox properties of substances.

Silica - copper powders investigated in this survey were prepared by a sol-gel method using Tetramethyl ortosilane (TMOS) as a main precursor. This study particularly demonstrates that it is possible to find effective replacing of traditional antibiotics using low-toxic materials. They effectively address the pressing problem of resistance among most pathogenic bacteria. In this study, the antimicrobial efficacy of silica-copper nanoparticles was evaluated against two Gram-positive bacteria, Staphylococcus aureus and Bacillus cereus. The minimum bactericidal concentration (MBC) of the nanoparticles, along with their pro- and antioxidant activities, were assessed to provide a comprehensive analysis of their bactericidal potential.

Keywords: *nanocomposites, bactericidal potential, Gram-positive bacteria, pro-oxidant activity*

Acknowledgments

The team from the Faculty of Biology, Sofia University, is grateful for the financial support provided by the European Union Next Generation EU through the National Recovery and Resilience Plan of the Republic of Bulgaria, project № BG-RRP-2.004-0008-C01 contract 70-123-661.

SYNTHESIS, CHARACTERISATION AND ANTIMICROBIAL PROPERTIES OF SOL-GEL-DERIVED $80TiO_2/10TeO_2/10Nb_2O_5$ POWDERS

Kalina Ivanova[1,3]*, Albena Bachvarova-Nedelcheva[1,3], Iliana Ivanova[2], Reni Iordanova[1]

[1] Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev str., bl. 11, 1113 Sofia, Bulgaria
[2] Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov Blvd., 1164 Sofia, Bulgaria
[3] National Centre of Excellence Mechatronics and Clean Technologies, 8 bul., Kl. Ohridski, Sofia, Bulgaria

Abstract

The present paper deals with the synthesis, characterisation, and antimicrobial properties of sol–gel-derived $80TiO_2/10TeO_2/10Nb_2O_5$ powders. The sol-gel method was chosen due to its ability to produce homogeneous and highly pure nanopowders with controlled composition. The gels were prepared using a combination of organic [Ti(IV) n-butoxide, Nb(V) ethoxide ($C_{10}H_{25}NbO_5$)] and inorganic [telluric acid (H_6TeO_6)] precursors. The ageing of gels was performed in air for several days in order to allow further hydrolysis. The phase transformations of the heat-treated samples in the temperature range of 200 - 700°C were examined by XRD. Additionally, scanning electron microscopy (SEM) was employed to analyse the morphology, particle size, and microstructural characteristics of the synthesised samples, providing valuable insights into their surface properties and aggregation behaviour. The efficacy of investigated powders as potential antibacterial and antifungal agents is evaluated against Staphylococcus aureus (Gram – positive), Pseudomonas aeruginosa and Escherichia coli (Gram-negative bacteria) and Candida albicans, a representative of pathogenic yeast. To assess the antimicrobial activity of the nanopowders, two complementary methods were performed—a quantitative microdilution method to determine minimum inhibitory and bactericidal concentrations (MICs; MBCs) and a qualitative spot test to observe bacterial and fungal growth. The results highlight the potential of these sol–gel-derived powders as effective antimicrobial agents.

Keywords: *sol-gel, nanopowders, X-ray diffraction (XRD), Scanning electron microscopy (SEM), antimicrobial activity, antibacterial properties, antifungal properties, microdilution method*

Acknowledgements

The author K. Ivanova is thankful for the financial support provided by the project BG05SFPR001-3.004-0004-C01, "Interdisciplinary training for the development of knowledge and competencies of doctoral students in various areas of modern research for healthy living and clean technologies (INTERDOC)". The authors K. Ivanova and A. Bachvarova-Nedelcheva are thankful to the support by European Regional Development Fund under Research Innovation and Digitization for Smart Transformation" program 2021–2027 under the Project BG16RFPR002-1.014-0006 National Centre of Excellence Mechatronics and Clean Technologies.

ASPECTS OF THE USE OF MINERAL FILLERS FOR THE MANUFACTURE OF PRODUCTS FROM HIGHLY FILLED POLYMER COMPOSITIONS

Tomasz Garbacz[1]*, Ludmila Dulebova[2]

[1] Lublin University of Technology, Lublin, Poland

[2] Technical University of Kosice, Kosice, Slovakia

Abstract

Modification of polymeric materials is intended to give the products specific properties or in the case of hard to recycle materials, facilitate their processing. The modification process involves changing the technological conditions of the manufacturing process, the processing tools as well as the addition of auxiliary materials such as fillers, plasticizers and stabilizers. Aids can be divided into two main groups: processing and functional. Group of processing agents are processing stabilizers and processing modifiers. The functional agents include properties stabilizers and property modificators.

Keywords: *recycled plastics, mineral fillers, polymer processing, polymer composites, physical and mechanical properties*

INVESTIGATION OF THE FLEXURAL PROPERTIES OF PLA AND PLA+CF MATERIALS FABRICATED USING FDM UNDER EXTENDED EXPOSURE CONDITIONS

Aljaž Rogelj[1, 2], Elvis Hozdić[1]*

[1]University of Novo mesto, Faculty of Mechanical Engineering, Na Loko 2, SI-8000 Novo mesto, Slovenia

[2]Kranj School Centre, Kidričeva cesta 55, SI-4000, Kranj, Slovenia

Abstract

This study investigates the flexural properties of FDM 3D-printed polylactic acid (PLA) and its carbon fiber-reinforced composite (PLA+CF) at varying infill densities (40%, 60%, 80%, and 100%) and under different environmental conditions. The specimens were tested in their as-printed state and after 7 and 30 days of exposure to a cooling lubricant to evaluate the effects of lubricant absorption on mechanical performance.

The results indicate that increasing infill density enhances flexural strength and stiffness, with PLA+CF exhibiting superior mechanical properties compared to pure PLA. In as-printed specimens, flexural strength improved by 45.8% for PLA and 48.3% for PLA+CF as infill density increased from 40% to 100%. However, prolonged exposure to lubricant led to progressive mechanical degradation. After 30 days of immersion, PLA specimens exhibited a reduction of up to 14.1% in flexural strength, while PLA+CF specimens showed a decrease of 17.2%, indicating that carbon fiber reinforcement does not fully mitigate the adverse effects of lubricant absorption.

The stress-strain curves further highlight differences in failure behavior, where lower infill densities showed more brittle fracture characteristics, whereas higher densities retained greater ductility. Young's modulus followed a nonlinear trend, with diminishing improvements beyond 80% infill density. These findings emphasize the importance of optimizing infill parameters and material selection for industrial applications, particularly in environments where prolonged exposure to lubricants may affect structural integrity.

Keywords: *Additive manufacturing, cooling lubricant, flexural mechanical properties, FDM, PLA, PLA+CF*

Acknowledgments

The authors acknowledge funding from the Researchers Project *Application of Statistical and Experimental Methods for the Characterization of Mechanical Properties of 3D-Printed Polymeric and Composite Materials* (C3360-24-953022). The project is co-funded by the European Union through the European Social Fund Plus (ESF+).

PATENTABILITY OF CARRAGEENAN-BASED PRODUCTS

Snežana Ilić-Stojanović[1]*, Suzana Cakić[1], Đorđe Petrović[2], Slobodan D. Petrović[2]

[1]University of Niš, Faculty of Technology in Leskovac, Bulevar oslobođenja 124, 16000 Leskovac, Republic of Serbia

[2] University of Belgrade, Vinča Institute of Nuclear Sciences, Department of Physics,

Mike Petrovića Alasa 12-14, 11351 Vinča, Belgrade, Republic of Serbia

[3] University of Belgrade, Faculty of Technology and Metallurgy, Karnegijeva 4, 11000 Beograd, Republic of Serbia

Abstract

Carrageenan is a mucopolysaccharide from the algae class *Rhodophyceae* (red seaweed). It is an anionic, linear, high-molecular-weight sulfated polymer, that includes 1,3α-1,4β-galactans repeating units with one (κ-), two (ι-) or three (λ-) sulfates per disaccharide unit. Because of their biocompatibility, carrageenans are used in the food, pharmaceutical and biomedical industries. This study aims to provide a patent landscape of carrageenan applications.

The Espacenet (a free database of European Patent Office), Cooperative Patent Classification and the International Patent Classification were used to analyze innovative solutions and technological growth in the last ten years. Patent documents were searched according to title, abstract and claim, narrowed by adding keywords: carrageenan, hydrogel, carrier, obtaining and process for granted patents.

A comprehensive analysis was given concerning the year of publication, patent classifications, applicants, owners and authorities. This research shows 4993 patent documents (applications and granted patents) and 937 granted patents found in the period from the beginning of 2015 to the end of 2024 for the carrageenan keyword in the patent claims. After filtering the data by the keyword hydrogel, 1205 patent documents with 439 granted patents were recorded. During the analyzed period, China recorded the highest number of patents (260), followed by Korea (209). The International Patent System (PCT) was utilized by 136 applicants, while the United States of America published 113 patents, Japan 103, and the European Patent Office 96. According to the IPC/CPC subclassifications, the majority of granted patents were classified under the following classes: A61Q19/00, C08J3/075, A61K8/04, A61K8/18, C08L5/00, C08J (3/02 and 3/03).

The data analysis reveals that most granted patents based on carrageenan are classified in the field of medical or veterinary hygiene, specifically cosmetic or similar toilet preparations characterized by a specific physical form. These include dispersions and emulsions, as well as ointments and other semi-solid forms, e.g. creams, sticks and gels. Carrageenan-based products represent a significant area of innovation, particularly for cosmetic and medical applications.

Keywords: *carrageenan*, *innovation, intellectual property, patent data.*

Acknowledgments

The authors thank the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, the Program for financing scientific research work, No. 451-03-137/2025-03/200133 and 451-03-66/2024-03/200017.

DECODING KIDNEY STONES: A CHEMICAL AND MORPHOLOGICAL PERSPECTIVE

Jelena Brdarić Kosanović[1]*, Kristijan Živković[1], Berislav Marković[2], Vatroslav Šerić[3], Imre Szenti[4], Ákos Kukovecz[4], Nives Matijaković Mlinarić[5], Anamarija Stanković[1]*

[1]Department of Chemistry, University of Osijek, Cara Hadrijana 8A, 31000, Osijek, Croatia

[2]Faculty of Dental Medicine and Health Osijek, Crkvena 21, 31000, Osijek, Croatia

[3]International Medical Center Priora, Kralja Tomislava 153, 31431, Čepin, Croatia

[4]Department of Applied and Environmental Chemistry, University of Szeged, Rerich Béla tér 1, H-6720 Szeged, Hungary

[5]Ruđer Bošković Institute, Bijenička Cesta 54, 10000 Zagreb, Croatia

Abstract

As the frequency of kidney stones in the human population increases, this study examines their composition, which could guide further research aimed at reducing their occurrence. This poster presents a morphological characterization of human kidney stones, focusing on their external and internal structure, as well as elemental composition. The analysis was conducted using a combination of stereoscopic microscopy, scanning electron microscopy (SEM), micro-computed tomography (micro-CT), and energy-dispersive X-ray spectroscopy (EDX). These complementary techniques provided a comprehensive insight into the surface texture, internal morphology, and mineralogical composition of the examined specimens.

The results are grouped into two main categories: calcium-based stones and non-calcium stones. Within the calcium-based group, three main morphological and compositional profiles were identified. The first includes stones composed predominantly of calcium oxalate, in the form of whewellite and/or weddellite. The second group consists of mixed calcium oxalate stones, which combine whewellite, weddellite, and calcium phosphate (typically hydroxyapatite). The third group is characterized by stones in which calcium phosphate (mainly hydroxyapatite) is the dominant component, often accompanied by struvite, some weddellite, and a very small amount of whewellite.

The aim of this study is to visually and structurally differentiate between these groups based on their morphology and elemental profiles, contributing to a better understanding of kidney stone formation processes and aiding in potential diagnostic or preventative approaches. Particular emphasis is placed on the value of non-destructive imaging methods such as micro-CT in revealing internal features that may not be detectable by surface-based techniques alone.

This poster highlights representative examples from each group, demonstrating typical surface characteristics, internal architecture, and elemental composition patterns. The focus of the presentation will be on the morphological differences and classification potential based on the applied imaging and analytical techniques.

Keywords: *kidney stones, calcium oxalate, chemical analysis, morphological analysis, phosphate*

Acknowledgments

This research was funded by PPUZN Stanković 2024/2027 (internal project of the Department of Chemistry at J.J. Strossmayer University of Osijek).

MECHANISM OF CATALYSIS OF TDSD NITROREDUCTASE FROM THERMOPHILIC BACTERIUM *PAENIBACILLUS* SP. A11-2

Benjaminas Valiauga[1], Dovydė Žulpaitė[1], Abigail V. Sharrock[2], David F. Ackerley[2], Narimantas Čėnas[1*]

[1]Institute of Biochemistry, Vilnius University, Vilnius, Lithuania

[2]School of Biological Sciences, Victoria University of Wellington, Wellington, New Zealand

Abstract

Bacterial nitroreductases (NRs) contain a flavin mononucleotide (FMN) in their active center and perform 2(4)-electron reduction of nitroaromatic compounds ($ArNO_2$) by reduced nicotinamide adenine dinucleotides NADH or NADPH. They have been applied for biodegradation of nitroaromatic explosives and pesticide residues in the environment, and may also be used in certain types of cancer chemotherapy. Therefore, there is a permanent search for new NRs with specific characteristics. A soil metagenome-derived NR of the TdsD family (Genbank ID WNX93925.1) was expressed in E. coli, and purified to homogeneity. TdsD NR is a NADPH-specific 2x22.3 kD homodimer containing one FMN per subunit. Its reaction mechanism and oxidizing substrate specificity was studied using 12 $ArNO_2$ and 15 quinones (Q) spanning a wide range of reduction potentials, van der Waals volumes (VdWvol) and lipophilicity (log D). Our findings may be summarized as follows: i) TdsD NR performs 2(4)e^- reduction of $ArNO_2$ into hydroxylamines, and 2e^- reduction of Q into hydroquinones; ii) enzyme catalysis is described by the 'ping-pong' mechanism, which shows that NADPH and the oxidant bind at the same domain; iii) typical inhibitors of NRs, dicoumarol and Cibacron blue, act as competitive inhibitors for NADPH at micromolar concentrations. The reaction product $NADP^+$ is also a competitive inhibitor for NADPH. This means that it does not reoxidize the reduced enzyme; iv) VdWvol and log D are not important determinants of $ArNO_2$ and Q reactivity. This indicates a certain plasticity of the active center that is characteristic of many NRs, and v) despite only 19% homology with E. coli NR-A, TdsD NR possesses similar oxidant specificity - an increase in $ArNO_2$ reactivity with increasing reduction potential, their higher reactivity than Q, and increased reactivity of 2-hydroxy-1,4-naphthoquinones among quinones. This suggests that TdsD can be an alternative to E. coli NR-A in various applications.*

Keywords: *nitroreductases, nitroaromatic compounds, biodegradation, reaction mechanism*

Acknowledgements

Abigail Sharrock and David Ackerley received support from the Health Research council of New Zealand (contract 24/742).

INVESTIGATION OF MASS AND HEAT TRANSFER DURING THE SUBLIMATION OF ORGANOMETALLIC COMPOUNDS USING THERMOGRAVIMETRIC ANALYSIS

Cerasela-Ionela Cleminte*, Cătălin Lisa, Ioan Mămăligă, Gabriela Lisa

Department of Chemical Engineering, Faculty of Chemical Engineering and Environmental Protection "Cristofor Simionescu", Gheorghe Asachi Technical University, Iaşi, Romania

Abstract

Chemical Vapor Deposition (CVD) has significant practical applications in microelectronics [1,2]. Optimizing the chemical vapor deposition process requires knowledge of the saturated vapor pressure of precursors at different temperatures, as well as the thermodynamic characteristics of their transformation into vapor through sublimation/evaporation for precise concentration control [2]. The saturated vapor pressure at ambient pressure can be directly correlated with the maximum concentration of the compound of interest in the gas phase. Vapor pressure data is essential for developing chemical or physical thin-film deposition processes to maintain strict control over the precursor feed rate. Price proposed using reference materials for measuring vapor pressure across a wide range of materials using thermogravimetric analysis [3]. Recently, Treviño Kaufmann and others developed an improved method for determining the sublimation enthalpies of solid organic compounds using isothermal thermogravimetric analysis. This method involves measuring the mass loss rate as a function of temperature in isothermal experiments within a temperature range of 10 to 20 K below the sample's melting point [4]. Most studies in the literature determine vapor pressures and sublimation enthalpy for various organic substances, but less attention is given to sublimation rate and mass and heat transfer. This study employs isothermal thermogravimetric analysis to evaluate the sublimation rate and mass and heat transfer of a series of ferrocene derivatives used as precursors for chemical vapor deposition. For this purpose, anthracene and pyrene are used as reference substances. The kinetic study of the sublimation of organometallic compounds and reference materials, conducted using isothermal thermogravimetric analysis, allowed for the evaluation of kinetic parameters such as activation energy and pre-exponential factor. Additionally, global mass transfer coefficients, expressed in mol/s·m²·Pa, were determined. Several Mathcad programs were used to establish a phenomenological model for the sublimation of organometallic compounds and reference materials. Criterial equations were obtained, enabling the determination of the average values of individual mass transfer coefficients. Based on the analogy between heat and mass transfer, the average values of individual heat transfer coefficients were also determined. The obtained average values for mass and heat transfer coefficients are consistent with the limited experimental data available in the literature on the sublimation process [5].

Keywords: *sublimation, mass and heat transfer, organometallic compounds*

BIOTECHNOLOGICAL METHANOLYSIS OF ATLANTIC SALMON (*SALMO SALAR*) OIL

Milda Gumbytė, Raimondas Kreivaitis

Vytautas Magnus University Agriculture Academy, Studentu str. 11, LT-53361 Akademija, Kaunas district, Lithuania

Abstract

This study investigates the efficiency of the transesterification process of salmon oil with methanol to identify the most suitable enzyme and optimal conditions for producing biodiesel and bio-lubricants. Given the depletion of petroleum resources and the challenges posed by environmental pollution, utilizing alternative, renewable resources have become increasingly important. Salmon oil, derived from fish processing waste, is an economically viable raw material as it does not compete with food production and effectively utilizes waste products. To determine the most effective biocatalyst for the transesterification process with methanol, immobilized lipases were employed: Lipozyme 435, Lipozyme TL IM, Novozym 435, and Lipozyme RM IM. Among the enzymes tested, Novozym 435 emerged as the most effective biocatalyst. Response surface methodology was used for statistical analysis and optimization of process parameters. The most effective initial conditions were established as follows: 15% enzyme content relative to oil mass, 4.14 mol of oil, 10 mol of methanol, a temperature of 30°C, and a reaction duration of 5 hours. Subsequently, the transesterification conditions were optimized to enhance process efficiency, resulting in the following parameters: a temperature of 30°C, 2 mol of methanol, 1 mol of salmon oil, 2% enzyme content, and a reaction duration of 29.14 hours.

Keywords: *Salmon oil, transesterification, lipase, Novozym 435, response surface methodology, waste*

AN ENZYME-BASED BIOMIMETIC APPROACH TO DEVELOP ENGINEERED BIOMATERIALS FOR DIRECT CARBON CAPTURE

Aleksandar Andreev, Mariya Brazkova, Albert Krastanov*

Department of Microbiology and Biotechnology, University of Food Technologies, Plovdiv, Bulgaria

Abstract

In the face of mounting climate-related challenges, the project titled "An Enzyme-Based Biomimetic Approach to Develop Engineered Biomaterials for Direct Carbon Capture" offers a scientifically grounded solution aimed at enhancing current Carbon Capture and Utilization (CCU) technologies. Using a biomimetic approach, this project integrates insights from natural systems with advanced scientific methods to address the inefficiencies observed in current carbon capture strategies. This endeavor is positioned as a complementary technology, aiming to augment the capacity of existing CCU methodologies, many of which are currently limited by operational or environmental constraints.

The primary objective is the development of enzyme-based biomaterials, with a specific focus on carbonic anhydrase (CA) derived from microalgae. These biomaterials are designed to capture carbon directly from the atmosphere, even in environments with limited water availability. By leveraging nature-inspired solutions, the project aspires to achieve efficient carbon capture in mild, environmentally friendly conditions.

In addition to its direct implications for carbon capture, the project emphasizes the significance of biomimicry in environmental science. As the project progresses, it is anticipated to contribute to a nexus of knowledge that intersects biology, materials science, and environmental technology. By achieving this convergence, the project not only aims to advance scientific understanding but also to provide tangible solutions for mitigating the impacts of climate change. Through its biomimetic approach, the initiative seeks to create technologies that are harmonious with the natural systems they aim to benefit.

Keywords: *carbonic anhydrase, carbon capture, enzyme immobilization, enzyme-based biomaterials*

Acknowledgments

This research was funded by THE NATIONAL SCIENCE FUND OF BULGARIA, under contract No. КП-06-Н77/10 from 6 December 2023

STRUCTURAL CHARACTERIZATION OF DNA SEQUENCES, FROM THE PROMOTER REGIONS OF GENES RESPONSIBLE FOR THE DEVELOPMENT OF DEGENERATIVE DISEASES, WITH FLUORESCENT MARKERS

Hristina Sbirkova-Dimitrova*, Hristo Gerginov, Rusi Rusew, Boris L. Shivachev

Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, Acad. G. Bonchev str., bl. 107, 1113 Sofia, Bulgaria

Abstract

The object of the present work is the detection of binding interactions and co-crystallization of DNA sequences from promoter regions of genes responsible for the development of neurodegenerative diseases with fluorescent markers and new/modified ligands.

Neurodegenerative diseases such as Parkinson's (PD) and Alzheimer's disease (AD) are progressive diseases that lead to serious disabilities and impair the quality of life of patients, which in turn leads to ever higher individual and societal costs [1]. There is no reliable treatment, so patients rely only on symptomatic treatment. Current therapies unfortunately do not affect the progression of these diseases, moreover, they lose efficacy over time, and their adverse effects increase the severity of the disease [2]. For these reasons, the development of new and safe compounds is of leading importance.

The variety DNA oligonucleotide sequences were crystallized by the vapour diffusion method. The crystallization conditions contained cacodylate buffer (pH 6.5-7.5), alcohol (2-propanol or methylpentanediol (MPD)), cations (Mg^{2}+, Ba^{2+}, Zn^{2+}), cobalt hexamine $[Co(NH3)6]^{3+}$ and polyamines (Spermine). Crystals were grown by the "hanging drop" method and 1.5µl (2mM) ligand (3 µl total drop volume) was added to 1.5 µl DNA (2mM) at room temperature. Crystals suitable for single crystal X-ray analysis, formed within a month.

The improvement of the optimal conditions for crystallization and co-crystallization of selected sequences from the promoter region of the APP gene as well as their subsequent co-crystallization include markers such as Thioflavin T, Hoechst, DAPI, TO, Berenil and some new homologous Thioflavin T molecules (RR1 and XRB) [3]. Single crystal samples of the co-crystallized DNA sequence d(CGTGAATTCACG) with the Hoechst 33342 (HT1) and d(CCGGGGTACCCCGG) with the XRB (structural homolog of Thioflavin T) markers were structurally determined. The experiments were performed at low temperature (130 K). The structure including HT1 marker is solved by single crystal X-ray analysis, in (19) $P2_12_12_1$ space group, at a 1.9 °A resolution. The structure including XRB marker is solved by single crystal X-ray analysis, in (19) $P4_12_12_1$ space group, at a 1.84 °A resolution. The coordinates and structure factors are deposited in the RCSB Protein Data Bank (PDB) under entries 9FT8 and 8ASH respectively. HT1 lies in the minor groove at the centre of the B-DNA fragment, positioned over the A-T base pairs, with the ends approaching the G4-C21 and the G16-C9 base pairs, while XRB inserts itself at the end of the DNA sequence over the C-G base pairs. In addition, FID analyses were used to confirm the interaction of XRB and Hoechst 33342 with DNA [3,4].

Acknowledgement

This work was supported by the Bulgarian National Science fund grant KP-06-KOCT/5.

SYNTHESIS OF NEW ANALOGUES OF THIOFLAVIN T DERIVATIVES AND CO-CRYSTALLIZATION WITH DNA SEQUENCES

Rusi Rusev*, Hristina Sbirkova-Dimitrova, Boris Shivachev, Hristo Gerginov

Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, Sofia, Bulgaria

Abstract

Thioflavin T (ThT) is widely used as a fluorescent probe for amyloid detection, though its specificity is limited by interactions with non-amyloid structures. To better understand its binding behavior and improve diagnostic applications, we synthesized new ThT analogues—RR1 and XRB—and studied their interaction with DNA. The analogues were obtained via a two-step synthesis: condensation to form Schiff bases, followed by quaternization. Their purity and structure were confirmed by NMR, DSC, and X-ray diffraction. A variety of DNA oligonucleotides from promoter regions associated with neurodegenerative diseases were crystallized using vapor diffusion with optimized conditions. Co-crystallization experiments included known dyes (Hoechst, DAPI, TO, Berenil) and the novel ThT analogues. The co-crystal structure of the DNA sequence d(CCGGGGTACCCCGG) with XRB was determined at 130 K using single-crystal X-ray diffraction at 1.84 Å resolution, showing XRB binding via stacking over terminal C–G base pairs. Crystallographic data for RR1 and XRB were deposited in the Cambridge Crystallographic Data Centre (entries 2211388 and 2198995), and the XRB-DNA structure in the RCSB PDB (entry 8ASH). These findings contribute to the understanding of dye-DNA interactions and support the development of improved fluorescent markers for biomedical applications.

Keywords: *Thioflavin T analogues, DNA co-crystallization, X-ray crystallography, neurodegenerative diseases, fluorescent probes, RR1, XRB*

Acknowledgments

This work was supported by the Bulgarian National Science Fund, grant КП-06-КОСТ/5.

MICROENCAPSULATION OF *ORIGANUM MAJORANA* L. ESSENTIAL OIL FOR ANTIBACTERIAL APPLICATIONS IN DRUG DELIVERY SYSTEMS

Elif Can Aydogdumu[1], Deniz Akin Sahbaz[1,2]*, Nazan Karapinar[1]

[1]Department of Chemical Engineering, Faculty of Engineering, Pamukkale University, Denizli, 20070, Turkey

[2]Department of Environmental Engineering, Faculty of Çorlu Engineering, Tekirdağ Namık Kemal University, Çorlu, Tekirdağ, 59860, Turkey

Abstract

Microencapsulation is an advanced technique used to protect active ingredients by encapsulating them within a protective shell, enabling controlled release in various fields, including pharmaceuticals, food, agriculture, cosmetics, and chemistry. This study aims to synthesize and characterize the microencapsulation of Origanum majorana L. essential oil to impart antibacterial properties for potential applications in drug delivery systems. Origanum majorana L., an endemic plant native to Turkey, is widely recognized for its significant antimicrobial activity against various microorganisms. The microencapsulation process was carried out using the coacervation method, and the effect of ultrasonication time on the structure of the nano/microcapsules was evaluated. The resulting nano/microcapsules were characterized using scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC). Additionally, the surface oil and total oil content of the nano/microcapsules were determined, and their encapsulation efficiency were calculated.

Keywords: *Microencapsulation, Origanum Majorana L., drug delivery systems, complex coacervation, ultrasonication*

MEMORY CHARACTERISTICS AND CRYSTALLOGRAPHIC ASPECTS OF REVERSIBILITY IN SHAPE MEMORY ALLOYS

Osman Adiguzel

Firat University, Department of Physics, Elazig, Turkey

Abstract

Shape memory alloys take place in a class of advanced smart materials with adaptive properties and stimulus response to the external changes, by exhibiting dual memory characteristics, shape memory effect and superelasticity. Shape memory effect is initiated on cooling and deformation processes and performed thermally on heating and cooling, with which shape of materials cycles between original and deformed shapes in reversible way in bulk level. Therefore, this behavior can be called thermal memory or thermoelasticity. This is plastic deformation, with which strain energy is stored and release on heating by recovering the original shape. Thermoelasticity is governed two crystallographic transformations, thermal and stress induced martensitic transformations. Thermal induced martensitic transformation occurs on cooling, with cooperative movement of atoms in <110 > -type directions on the {110} - type planes of austenite matrix, along with lattice twinning and ordered parent phase structures turn into twinned martensite structures. The twinned structures turn into detwinned structures by means of stress induced martensitic transformation with deformation in martensitic condition.

Superelasticity is performed in mechanical manner with stressing and releasing the material in elasticity limit at a constant temperature in parent phase region, and shape recovery occurs instantly and simultaneously upon releasing, by exhibiting elastic material behavior. Superelasticity is performed in non-linear way; stressing and releasing paths are different in the stress-strain diagram, and hysteresis loop refers to energy dissipation. The strain energy is stored after releasing, and these alloys are mainly used as deformation absorbent materials in control of civil structures subjected to seismic events, due to the absorbance of strain energy during any disaster or earthquake. Superelasticity is also result of the stress induced martensitic transformation and ordered parent phase structures turn into the detwinned martensitic structure with stressing in parent phase region. Therefore, lattice twinning and detwinning reactions play important role in martensitic transformations, and they are driven by lattice invariant shear.

Copper based alloys exhibit this property in metastable β-phase region, which has bcc-based structures. Lattice twinning is not uniform in these alloys, and the ordered parent phase structures martensitically undergo the non-conventional layered structures on cooling. The long-period layered structures can be described by different unit cells as 3R, 9R or 18R depending on the stacking sequences on the close-packed planes of the ordered lattice.

In the present contribution, x-ray and electron diffraction studies were carried out on copper based CuZnAl and CuAlMn alloys. X-ray diffraction profiles and electron diffraction patterns re exhibit super lattice reflections inherited from parent phase due to the displacive character of martensitic transformation. X-ray diffractograms taken in a long-time interval show that diffraction angles and intensities of diffraction peaks change with the aging time at room temperature. This result refers to a new transformation in diffusive manner.

Keywords: *Shape memory effect, martensitic transformation, thermoelasticity, superelasticity, lattice twinning and detwinning.*

CORROSION TESTS OF HIGH-STRENGTH ALUMINUM ALLOYS: A REVIEW

Azarias Mavropoulos

Physical Metallurgy Laboratory, Dept. of Mechanical Engineering, Aristotle University of Thessaloniki, 541 24 Thessaloniki, Greece

Abstract

Accelerated laboratory corrosion tests are essential for efficiently evaluating the performance of high-strength aluminum alloys, particularly in the context of rapidly developing new materials. By adhering to established standards like ASTM, these tests not only provide valuable insights into the materials' corrosion resistance but also ensure that the results are reliable and comparable to those obtained from long-term exposure studies. This duality of testing methodologies emphasizes the importance of thorough corrosion assessment in the development and application of aluminum alloys in various environments.

Keywords*: Corrosion Testing, High-Strength Aluminum Alloys, Long-term tests, Laboratory Tests, Salt Spray Tests, Electrochemical Tests, Exfoliation Corrosion, ASTM Standard*

OPTIMIZATION OF FRICTION STIR WELDING PARAMETERS FOR SIMILAR AND DISSIMILAR ALUMINUM ALLOYS AA5083-H111 AND AA7075-T651

Azarias Mavropoulos [1*] Ioannis Tsikrikonis [2]

[1] Physical Metallurgy Laboratory, Dept. of Mechanical Engineering, Aristotle University of Thessaloniki, 541 24 Thessaloniki, Greece

[2] Hellenic Air Force, 110 Combat Wing, Larisa Air Base, Maintenance Squadron, Quality Assurance Office, Agias St, GR 41001, Larisa, Greece

Abstract

In recent years, the increasing demand in the industry for lightweight and durable materials has driven research into various aluminum alloys, which are relatively inexpensive and offer a high strength-to-weight ratio. Aluminum alloys are utilized across multiple sectors such as aerospace, automotive, and shipbuilding. Many applications require welding similar or dissimilar alloys, which, with conventional fusion methods, are often impossible or result in degraded weld quality. Friction Stir welding, a solid-state welding technique, is increasingly popular because it is eco-friendly, energy-efficient, and prevents common issues like solidification cracks. The goal of this work was to determine the optimal parameters for successful similar and dissimilar welds. Accordingly, three tools were designed and manufactured to perform butt welds on thin alloy plates of 5083-H111 and 7075-T651, both similar and dissimilar. The parameters were optimized, and the weld microstructure was examined using an optical microscope. Lastly, micro-hardness measurements were taken on the optimal welds.

Keywords: *friction stir welding, aluminum alloys, AA5083, AA7075, welding parameters*

VOLUMETRIC PROPERTIES OF SOLUTIONS OF 1-HEXYL-3-METHYLIMIDAZOLIUM CHLORIDE IONIC LIQUID IN DIMETHYL SULFOXIDE, *N,N*-DIMETHYLACETAMIDE AND *N,N*-DIMETHYLFORMAMIDE

Renato Tomaš

University of Split, Faculty of Chemistry and Technology, Department of Physical Chemistry, Ruđera Boškovića 35, HR-21000 Split, Croatia

Abstract

Binary mixtures of 1-hexyl-3-methylimidazolium chloride, [C_6mim][Cl] ionic liquid with different solvents (dimethyl sulfoxide, N,N-dimethylacetamide or N,N-dimethylformamide), at temperature T = (278.15, 283,15, 288.15, 293.15, 298.15, 303.15, 308.15 and 313.15) K have been studied using density experiment with full automated Anton-Paar DMA 5000 apparatus (Austria) with a measurement accuracy of ± 5 × 10^{-6} g cm^{-3}. From obtained density data, the volumetric properties of solutions of [C_6mim][Cl] in investigated organic solvents: the apparent molar volume, standard partial molar volumes, apparent molar volume at infinite dilution, Masson's ineraction coefficient, thermal expansion coefficient, limiting apparent molar expansibilities, and Heppler's coefficient, were calculated. Ionic liquid, [C_6mim][Cl], show structure-making properties in the above solvents.

Keywords: *1-hexyl-3-methylimidazolium chloride ionic liquid, dimethyl sulfoxide, N,N-dimethylacetamide, N,N-dimethylformamide, volumetric data.*

Acknowledgments

This research was supported by the Ministry of Science, Education and Youth of Republic of Croatia.

UNVEIL PLASMA WALL INTERACTIONS IN FUSION REACTORS WITH ION BEAM TECHNIQUES

N. Catarino[1], R. Martins1, M. Dias[1], N. Barradas[2], J. Likonen[3], A. Widdowson[4], E. Alves[1*]

[1]IPFN, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001, Lisboa, PT

[2]C2TN, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001, Lisboa, PT

[3]VTT Technical Research Centre of Finland, PO Box 1000, FIN-02044 VTT, Finland

[4]UK Atomic Energy Authority, Culham Science Centre, Abingdon, OX14 3DB Oxfordshire, UK

Abstract

Accelerator based analytical techniques play a fundamental role on the study of plasma wall interactions in fusion tokamaks. Constant fluxes of energetic neutrals and charged particles lead to erosion and re-deposition processes as well as radiation damage on the walls. In addition, plasma disruptions could cause large thermal shocks melting or vaporizing the material in the chamber walls. In combination with all these effects fuel retention is a process always present which must be fully understood.

In the present contribution, we explore the capabilities of ion beam techniques to study retention and erosion effects of deuterium plasmas in the wall materials of JET tokamak. Samples from different areas of the chamber were analyzed with Rutherford and elastic backscattering spectrometry, nuclear reaction analysis as well as electron microscopy.

Results indicate a major deposition region on the top of divertor tiles with a large retention of 2H. The position of the plasma strike point influences the distribution and deposition in the divertor walls. In the chamber walls the central part of the limiter tiles show an enhanced erosion without no deuterium retention. Retention is mostly observed in the tile gaps and deposition occurs at the ends of the tiles.

The results will be discussed and a picture of the plasma effects on the chamber walls presented.

NEW MUD WITH CATIONIC OLIGOMERS FOR DRILLING SHALES WITH ABNORMALLY LOW RESERVOIR PRESSURES

Sławomir Wysocki

Drilling, Oil and Gas Faculty, AGH University, Krakow, Poland

Abstract

Drilling through clay formations is associated with significant problems related to the hydration and swelling of this type of rock. In such cases, special drilling muds containing clay rock hydration inhibitors are used. Drilling through rocks with low formation pressures, such as Red Bedrock formations, presents additional difficulties. In such cases, reduced density muds such as Aphron or foamed muds should be used. This paper presents the results of research into the use of very low molecular weight polymeric hydration inhibitors (cationic oligomers) in newly developed aerated muds.

Keywords: *drilling fluids, foamed mud, aphrones, drill-in fluids, clay and shales drilling, low-pressure reservoirs, surfactants*

Acknowledgements

Research Project supported by program “Excellence Initiative - Research University” for the AGH University

METALLIC INK REMOVAL FROM POLYMERIC SURFACES USING LASER TECHNOLOGY

P. Santos[1], R. Santos[1], A.J.S Fernandes[1], L. Rodriges[3], F.M. Costa[1], A. Lopes da Silva[3], A. Barros[2], N.M. Ferreira[1]

[1] i3N & Physics Department, University of Aveiro, Aveiro, Portugal

[2] CICECO & Chemistry Department, University of Aveiro, Aveiro, Portugal

[3] Maxiplas, Pombal, Portugal

Abstract

The polymeric piece with metallic ink over their surface, has huge industrial applications. Especially when it is required that the metallized area has a complex shape with high definition, case of electronic circuits, company logos or QR-codes. Solutions to remove those metallic ink in a controlled region is industrial challenged. Laser technology has emerged as a promising solution for the localized metallization removal in polymeric materials. In this study, was explored the use of laser technology as an innovative approach, to selectively remove metallic layers from polycarbonate pieces. Laser technology offers significant advantages compared to traditional methods, allowing for precise and controlled removal of metallization while minimizing damage to the underlying polymer substrate. Several laser parameters, such as scanning speed, power, frequency, pulse width, and pitch, were evaluated to promote laser selectivity in metallization removal. The results obtained demonstrate the feasibility of this approach and its potential for the electric circuits, images or logos. The surface of the substrate (polycarbonate) keeps its surface characteristics (roughness and wettability) or even improves them.

Keywords: *Laser technology, removal, metallization, polycarbonate*

LASER TECHNOLOGY IN POLYMER INJECTION INDUSTRY

P. Silva[1], J. Morais[1], F. Batista[1], R. Santos[1], J. Figueiredo[2], L. Pereira[2], M. Ferro[3], F. M. Costa[1], N. M. Ferreira[1,*]

[1] i3N & Department of Physics, University of Aveiro, Aveiro, Portugal

[2] Microplásticos S.A., Figueira da Foz, Portugal

[3] Department of Materials and Ceramic Engineering, University of Aveiro, Aveiro, Portugal

Abstract

The production of plastic by injection, is expected the residues agglomeration in the mould surface. These phenomena can compromise the dimensional accuracy of the final products and are therefore rejected by quality control, resulting in monetary losses. To address this issue, it is necessary to clean the surface and times to times, replace the degraded coating. However, the new coating deposition can only occur after the removal of the degraded one. The use of laser technology has already been proven to be successful in removing paint and oxide ***Error! Reference source not found.Error! Reference source not found.****.*

In this work, is propose the use of laser technology for the removal of both the residues and coating. The identification of mould parts using QR code is an emergent issue. The present work reports the effectiveness of cleaning, PVD coating remove and QR code marking processes on injection mould, using laser irradiation.

For this study, a pulsed fibre laser (1064 nm) was used to remove residues and coating layers through ablation. A preliminary study was conducted to identify the range of parameters range such as power, frequency, scan speed, pulse width and pitch, required for the residues' as and coating's effective removal and QR code marking. From the sample's characterization (optical microscopy, contact angle and optical profilometry), was possible analyse the effect of each laser processing parameter and optimize it for the injection moulds cleaning, removal and marking process. The surface characteristic (residue, steel or PVD compositions), present high impact on laser parameters process.

The results obtained show the effectiveness of laser technology in the injection residues and thin PVD coating removal, and piece identification (QR Code). It is also highlighting the importance of optimizing laser parameters for the injection mould cleaning of each polymer.

Keywords: Fibre laser; Injection mould; Polymeric residues; Coating removal; QR code marking

DESIGN OF 4-CHANNEL POLYMER-BASED AWG DEMULTIPLEXER FOR DIRECT LASER WRITING LITHOGRAPHY

Dana Seyringer[1]*, Felix Wäger[1], Fadi Dohnal[1], Johann Zehetner[1], Peter Gaso[2], Dusan Pudis[2]

[1]Research Centre for Microtechnology, FHV - Vorarlberg University of Applied Sciences, Hochschulstr. 1, 6850, Dornbirn, Austria

[2]Department of Physics, Faculty of Electrical Engineering and Information Technology, University of Zilina, Zilina, Slovakia

Abstract

This study presents the design and simulation of a 4-channel polymer-based planar arrayed waveguide gratings optical demultiplexer for telecommunication applications. The demultiplexer was designed for a central wavelength of 1550 nm using the AWG-Parameters tool. A single-mode polymer waveguide structure with a 2 µm × 2 µm cross-section was employed, utilizing IP-Dip polymer as the core material and polydimethylsiloxane Sylgard 184 as the cladding. The AWG structure was designed and simulated using the PHASAR tool from Optiwave, while its transmission characteristics were analyzed with the AWG-Analyzer tool. Additionally, the optical properties and dimensions of the AWG structure were optimized to meet the manufacturing constraints of the direct laser writing lithography process. These optimizations are crucial for ensuring the scalability, performance, and practical fabrication of polymer-based photonic devices.

Keywords: *arrayed waveguide gratings, polymer-based AWG, direct laser writing, two-photon polymerization, photonics, telecommunication*

Acknowledgments

This work was carried out under project No. 2024-10-15-002 (POLY-MUX), SAIA, n. o., Aktion Österreich – Slowakei.

PREPARATION OF UV-CURABLE AND ALKALI-SOLUBLE POLYMER COATING AGENT

Chul Woo Lee

Department of Chemical & Biological Engineering/Rigonal Inovation Center, Hanbat National University, Daejeon, South Korea

Abstract

Alkali-soluble polymer coatings are used to protect sheet glass during the cutting process in the production of tempered glass used as display panels for LCDs and mobile phones. Alkali solubility is required to remove the polymer coating film after processing. UV-curable resins are preferred over thermosetting resins to reduce the curing time. Coatings contain monomers, oligomers, acid polymers, photoinitiators, and additives. Uniformity, curing time, adhesion, hardness, and peelability of the coating are important factors for obtaining good performance. In this study, various acrylates were used as monomers, and the effects of the monomer content and mixing ratio on the properties of the coating were investigated. The curing machine was equipped with a 600 W/cm high-pressure mercury lamp with a wavelength of 365 nm, and curing was performed by varying the UV irradiation time. Acidic polyacrylates with various acid values and molecular weights were used as monomers to impart alkali-soluble properties, and the effects of the peeling time were also investigated. The number of functional groups of the acrylate monomer, the type and amount of the photoinitiator, and the amount of talc additive added had a great influence on the physical properties of the polymer coating, such as adhesion, curing time, thickness, hardness, and peelability. The formulation was completed by adding additives to prevent adhesion loss during the curing process, antifoaming agents to remove air bubbles generated during mixing, and pigments to facilitate identification of the coating and peeling states, and adjusting the component ratios.

Keywords: *Polymer coating, UV-curable, Alkali-soluble, Acidity, Talc content, Peering time.*

RESEARCH, ANALYSIS AND OPPORTUNITIES FOR IMPROVING THE PROPERTIES OF RECYCLED HIGH-DENSITY POLYETHYLENE

Naydenova-Marinova P.[1], Bonchev M.[2]*, Velev P.[3]

[1]University of Chemical Technology and Metallurgy, 8 Kliment Ohridski, blvd., Sofia 1756, Bulgaria

[2]PMB Industries Ltd.18 Milyo Voyvoda, Pazardzhik 4400, Bulgaria

[3]University of Chemical Technology and Metallurgy, 8 Kliment Ohridski, blvd., Sofia 1756, Bulgaria

Abstract

The development of the industry over the past 20 years, both nationally and globally, has led to a continuous increase in the amount of processed polymers. This in turn leads to the generation of large amounts of waste that is non-biodegradable. In their work, the authors compare different batches of secondary HDPE, comparing them in density, presence of impurities, strength indicators and rheological properties. It has been established that different batches of secondary HDPE have different properties due to the different degree of atmospheric aging, as well as the presence of different amounts of impurities, mainly from PP.

Keywords: *Polyethylene, recycling, properties, waste.*

RHEOLOGICAL DESIGN OF RECYCLED PET–CLAY NANOCOMPOSITES THROUGH ORGANOPHILIC TUNING

Mariia Kostenko[1,2], Yurij Stetsyshyn[2], Milan Kracalik[1*]

[1]Johannes Kepler University Linz, Institute of Polymer Science, Altenberger Str. 69, 4040 Linz, Austria

[2]Lviv Polytechnic National University, St. George's Square 2, 79013 Lviv, Ukraine

Abstract

Preparation of well-dispersed recycled polyethylene terephthalate-organoclay nanocomposites with enhanced processing and mechanical properties remains a significant challenge due to the low thermal stability of organoclays. This issue is particularly critical during the melt compounding process, where high temperatures are required to process recycled PET. At elevated temperatures, organoclays, especially those modified with traditional quaternary ammonium salts, tend to degrade, releasing volatile byproducts such as ammonia and other decomposition products. This degradation not only compromises the thermal stability of the nanocomposite but also accelerates the degradation of the recycled PET matrix itself, leading to a reduction in molecular weight and deterioration of mechanical properties. The low thermal stability of organoclays is primarily attributed to the organic modifiers used to render the hydrophilic clay compatible with the hydrophobic polymer matrix. These modifiers, while effective in improving clay dispersion, often decompose at temperatures below the processing range of PET, which typically exceeds 250°C. As a result, the development of thermally stable organoclays is essential to overcome this limitation and achieve the desired improvements in nanocomposite performance. In this study, an overview of various surface modification techniques for sodium-type montmorillonite was conducted to enhance its compatibility with recycled PET. Surface modifications included the use of organic modifiers, such as quaternary ammonium salts, and other innovative approaches aimed at improving the dispersion of the clay within the polymer matrix. The thermal stability of the organoclays and the resulting nanocomposites was evaluated using melt rheology, which provided insights into the degradation behavior and processability of the materials. The results demonstrated that organoclays modified with alternative surface treatments exhibited superior performance compared to those modified with conventional quaternary ammonium compounds. Specifically, the newly prepared clays significantly suppressed matrix degradation during melt mixing, which is a common issue in the processing of PET. The findings suggest that the use of advanced surface-modified clays can open new avenues for the development of high-performance recycled PET-based nanocomposites, which can be utilized in a wide range of applications, including packaging, automotive components, and construction materials. This approach aligns with the growing demand for sustainable materials and the circular economy by adding value to recycled plastics while reducing environmental impact.

Keywords: *Recycled PET; Organoclay; Melt compounding, Rheology*

Acknowledgement

This research has been supported by the LIT Institute of Technology at Johannes Kepler University Linz, project number: LIT-2022-11-SEE-123.

OPTIMIZATION OF TECHNOLOGICAL PARAMETERS FOR THE MECHANOACTIVATION METHOD IN ACTIVATING DISPERSED COMPONENTS OF COMPOSITE MATERIALS

Umida Ziyamukhamedova, Sherali Mamayev, Jasurbek Nafasov, Elbek Turgunaliev, Umida Shaozimova, Shokhjakhon Abdurakhimov

[1]Department of Materials Science and Mechanical Engineering, Tashkent State Transport University, Tashkent, Uzbekistan

Abstract

In modern materials science, the properties of fillers, which are components of composite materials, play a crucial role in determining the mechanical, physical, and operational characteristics of these materials. To enhance the specific properties of fillers and improve their adhesion strength with the matrix material, various activation methods are employed, including mechanical, physical, chemical, or mechanochemical techniques. This process involves a series of steps related to modifying the components that are added to the composition. One of the crucial aspects of the process is ensuring the activation of dispersed and solid components along the surface areas of mechanical activation equipment. In this regard, the energy that brings particles into an active state is of paramount importance. This article proposes a new method of activating fillers using a vibro-planetary mechanism. The length of the crankshaft of the vibro-planetary mechanism and the rotation angle of the mechanism's rocker arm have been optimized based on the type and properties of the filler material being activated, as well as the desired size of the activated particles. The reliability of theoretical solutions obtained through mathematical modeling formulas has been validated using modern CAD software. Furthermore, this article demonstrates the possibility of obtaining activated particles of the desired size by adjusting the distance between the supports of the vibro-planetary mechanism's links and controlling the rotational frequencies of the electric motor. Based on the closed contour condition in a vibro-planetary mechanism, projection equations of the links onto the corresponding coordinate axes have been formulated, and a functional relationship has been established between the kinematic parameters characterizing the motion of the input and output links. The numerical calculations obtained are presented in the form of graphical relationships. The conclusions drawn in the article can be utilized in improving and designing modern technological equipment with vibro-planetary mechanisms.

Keywords: *Vibroplanetary mechanism, analytical study of the mechanism, mathematical model, closed-loop condition, metric synthesis of the mechanism, optimization, crank, guide bar.*

LABORATORY OPTIMIZATION METHOD FOR GOLD AND SILVER DISTRIBUTION PHASE ANALYSIS

Nikolay N. Nestorov, Teodora M. Yankova, Mihail D. Petrov, Irena L. Grigorova*

University of Mining and Geology “St. Ivan Rilski”, 1700 Sofia, Bulgaria

Abstract

The presentation that is summarized in this article focused on the results obtained from designing, manufacturing, and commissioning a specialized laboratory installation to analyze the phase gold and silver distribution. It features increased capacity and improved homogenization geometry for chemical solutions. The installation reduces electricity costs, enhances productivity through dehydration processes, and improves sample representativeness for chemical analysis. Additionally, it automates laboratory procedures, eliminating subjective factors. The system enables continuous monitoring of precious metal distribution across enrichment plants, allowing for data-driven decisions to optimize technological processes, increase yield, and ensure high-quality concentrates.

Keywords: *automation, productivity, gold, silver, phase analysis, concentrate quality*

Acknowledgments

This work has been carried out in the framework of the National Science Program "Critical and strategic raw materials for a green transition and sustainable development", approved by the Resolution of the Council of Ministers № 508/18.07.2024 and funded by the Ministry of Education and Science (MES) of Bulgaria.

This work has been carried out in the framework of the education program under project BG05SFPR001-3.004-0002-C01 "Development and improvement of professional and interdisciplinary education in technical and economic sciences and increasing the research capacity of the extractive industry through project-based doctoral studies", co-financed by the European Social Fund Plus (ESF+).

POLYPHOSPHATE-MODIFIED CALCIUM ALGINATE: STRUCTURAL INSIGHTS AND POTENTIAL APPLICATIONS

Alicja Wawszczak, Dorota Kołodyńska

Department of Inorganic Chemistry, Faculty of Chemistry, Maria Curie-Skłodowska University, Lublin, Poland

Abstract

Calcium alginate hydrogels are widely recognized for their biocompatibility and tunable properties, making them promising materials for biomedical applications. However, their rapid degradation in aqueous environments, particularly in phosphate buffered saline (PBS), significantly limits their usability in long-term applications such as tissue engineering and regenerative medicine. To address this limitation, polyphosphate-modified calcium alginate matrices were developed, improving both their structural integrity and biofunctionality.

Polyphosphates, known for their high-energy phosphate bonds and calcium-binding properties, were incorporated into alginate hydrogels by ionic crosslinking, resulting in a reinforced network. The modified matrices were extensively characterized using the Fourier transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD). The XPS confirmed the presence of P=O and P-OH bonds, FTIR demonstrated modifications in the carboxylate and phosphate functional groups and XRD revealed altered crystallinity as a result of calcium-polyphosphate interactions.

Degradation and swelling studies in PBS and demineralized water indicated that polyphosphate-modified hydrogels exhibited significantly reduced degradation rates, maintaining their structural integrity over extended periods. Furthermore, polyphosphates are known to promote osteogenic differentiation of stem cells, making these matrices particularly promising for bone tissue engineering and advanced cell culture applications.

This study demonstrates that polyphosphate incorporation transforms conventional calcium alginate hydrogels into durable, bioactive matrices, offering enhanced stability and extended functionality. The findings open new opportunities for regenerative medicine, controlled drug delivery, and tissue engineering applications.

SETUBAL'S PAPER LEGACY UNVEILED: THE EVOLUTION OF *COMPANHIA PORTUGUESA DE CELULOSE* TO THE NAVIGATOR COMPANY

Ana Rita Melo[1,2]

[1]C[2]TN - Centre for Nuclear Sciences and Technologies, University of Lisbon, Portugal

[2]CFisUC - Centre for Physics of the University of Coimbra, Portugal

Abstract

This study aims to explore the historical development of Companhia Portuguesa de Celulose, tracing its transformation into The Navigator Company. The focus is on the technological advancements in cellulose production, paper manufacturing, and packaging, highlighting the company's contributions to the global paper industry.

The research employs a historiographical approach, analysing primary and secondary sources. Key sources include historical documents, industry reports, and the blog post by Rui Canas Gaspar [1]. The study also incorporates data from The Navigator Company's official history [2][3] and relevant academic literature on the evolution of the paper industry in Portugal.

Early Beginnings: Companhia Portuguesa de Celulose was established in the early 1950s, with significant milestones such as the pioneering production of eucalyptus pulp using the kraft process in 1957 [2].

Technological Innovations: The company introduced several ground breaking technologies, including the "Projeto TE-24," which revolutionized the production of high-quality paper from eucalyptus [1][4].

Global Impact: The Navigator Company, formerly known as Portucel Soporcel Group, has become a leading global producer of bleached eucalyptus kraft pulp and uncoated woodfree paper [2][3]. Its products are exported to over 130 countries, contributing significantly to Portugal's economy [5].

Sustainability Efforts: The company has committed to decarbonizing its industrial complexes by 2035, positioning itself as a pioneer in sustainable paper production [5].

Keywords: *Bleached eucalyptus kraft pulp, Uncoated woodfree paper, Sustainable paper production, Decarbonization, Portuguese paper industry, Global paper market*

OXYGEN ELIMINATION IN BIOALCOHOLS BY CARBON-CARBON CONDENSATION REACTIONS OVER CARBON-SUPPORTED CATALYSTS

Jan Moravčík*, Luděk Kaluža

Institute of Chemical Process Fundamentals of the Czech Academy of Sciences, Prague, Czech Republic

Abstract

Heteroatoms N, O, S, or Cl bound in hydrocarbons pose a significant challenge during the chemical processing of fossil and renewable sources. These elements are removed through various decomposition reactions, for example hydrodeoxygenation (HDO), which is employed to remove oxygen in biomass-based feeds, such as triglycerides with long hydrocarbon chains. HDO is not suitable for feedstocks with high oxygen content, such as saccharides or bioalcohols, due to its high hydrogen consumption. A more attractive alternative is dehydration of these substrates to produce olefins, despite the necessity of subsequent oligomerization. Dehydration of bioalcohols can be accompanied by carbon-carbon condensation reactions, yielding high-value hydrocarbon derivatives. The C-C condensation process involves the Guerbet coupling, direct coupling, and the formation of 2n-1 and 2n ketones. Our research focused on investigating the activity of Li, Na, K, Mg, Ca, Sr, Ba, Sc, Y, La, Ce, Sm, Eu, Co, Ni, and Cu oxides supported on activated carbon in the reaction of 1-butanol in a fixed-bed tube reactor at 400 °C and at atmospheric pressure. The studied Li and Mg exhibited the highest C-C condensation activities within the studied alkaline and alkaline earth metal oxides, respectively. The La and Sm oxides demonstrated the highest activity among all the studied oxides. The supported Mg species were selective for Guerbet coupling (2n pathway) and the formation of C8 derivatives. The high activity of the Li, La, and Sm counterparts was accompanied with high selectivity to C7 (2n-1 pathway). The 5-day reaction of ethanol confirmed observation done with 1-butanol. The high activity in total C-C condensation is accompanied with high selectivity to the 2n-1 pathway while the coupled 2n alcohols or aldehydes are produced in low yields due to subsequent C-C coupling or dehydration reactions. The studied bioalcohol reactions provide a promising and sustainable alternative to conventional petroleum processing.

Keywords: *Guerbet reaction, C-C condensation, bioalcohols, heteroatom elimination*

METHOD FOR DEGRADATION OF COLORED ELUENTS AFTER DESORPTION FROM CHEMICALLY FUNCTIONALIZED CELLULOSIC MATERIAL

Nataša Đ. Knežević[1*], Marija D. Vuksanović[1], Milena Milošević[2], Aleksandar Marinković[3]

[1]University of Belgrade,„VINČA" Institute of Nuclear Sciences - National Institute of the Republic of Serbia, Mike Petrovića Alasa 12-14, 11351 Belgrade, Serbia

[2]University of Belgrade, Institute of Chemistry, Technology and Metallurgy - National Institute of the Republic of Serbia, Njegoševa 12, 11000 Belgrade, Serbia

[3]University of Belgrade, Faculty of Technology and Metallurgy, Karnegijeva 4, 11000 Belgrade, Serbia

Abstract

In this study, a method for the removal and degradation of colored eluents after desorption from chemically functionalized cellulosic materials was developed. Waste hemp fibers were transformed into an efficient cellulosic adsorbent through a two-step process involving delignification and subsequent quaternization with betaine hydrochloride-urea. The fibers were first subjected to delignification, followed by quaternization using the synthesized deep eutectic solvents (DES), betaine hydrochloride-urea. The adsorbent was evaluated for the removal of anionic dyes, including Metanil Yellow (MY) and Congo Red (CR), in a batch adsorption system. Structural and chemical characterization of the modified fibers was performed using Scanning Electron Microscopy (SEM), Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR), porosity measurements, and point of zero charge (pHpzc) analysis. Pore size was determined through image analysis and the dry-wet weight method. The adsorption process was found to be endothermic and spontaneous, achieving high adsorption capacities (qm) at 25°C, with the optimal pH for adsorption being 7. Kinetic studies indicated that the adsorption followed both pseudo-first-order (PFO) and pseudo-second-order (PSO) models. After adsorption, the desorbed dyes were subjected to photocatalytic degradation using zinc oxide as a catalyst, with high and rapid decolorization efficiency, particularly for Metanil Yellow. The photocatalytic process ensured that the treated water posed minimal environmental risk.

This work demonstrates the application of green chemistry principles in the functionalization of waste lignocellulosic materials and the subsequent degradation of colored eluents, offering an eco-friendly and efficient method for water purification and wastewater treatment.

Keywords: *waste hemp, cationic pollutants, adsorption process, photodegradation method, Deep eutectic solvents*

SYNTHESIS, CHARACTERIZATION AND REACTIVITY OF DONOR STABILIZED SILATRANYLIUM SALTS

Lyuba Iovkova[1], David Mroß[1], Matthias Mawick[1], Viatcheslav Jouikov[2], Norbert Krause[1], Klaus Jurkschat [1]

[1]Fakultät für Chemie und Chemische Biologie, TU Dortmund, 44221 Dortmund, Germany

[2]UMR 6226 − ISCR, University of Rennes, 35042 Rennes, France

Abstract

In the last decade main group element cations have attracted considerable interest.[1][2] Among these, silylium cations have been paid special attention for and their fascinating chemistry has recently been thoroughly revieved.[3] Silatranes are a class of hypercoordinated silicon compounds of high popularity, both from academic viewpoint and practical applications.[4-7] Strange enough and despite the ongoing research activities on these compounds, to the best of our knowledge, silatranylium salts containing the corresponding cation have not been reported yet. Notably, the structure of the silatranyl cation has been forecasted by DFT calculations.

SUPERCONDUCTIVITY: FROM WORKING PRINCIPLES, MATERIALS, TO TECHNOLOGIES USED IN QUANTUM COMPUTERS AND ENERGY APPLICATIONS

Alexandra Anghelache

Department of Interior Design and Design, "Ion Mincu" University of Architecture and Urbanism, 18-20 Academiei St., Bucharest, 010014, Romania

Abstract

Intertwined quantum physics principles govern the properties of superconductive materials at a subatomic level. Superconductive technologies are at the forefront of current research because of their potential to leverage quantum phenomena and generate new applications in diverse fields like communication, computing, and energy. Starting with zero electrical resistance and the Meissner effect, material properties allow quantum computers to initialize superposition and entanglement in qubits and qubit circuits. This creates an evolutionary leap in computing speed and performance. In the energy sector, the quantum phenomenon of superconductivity indicates the possibility of fast, lossless energy transfer, good storage, and control over CO_2 footprint. This poster provides a review regarding the working principles and properties of technologies that consider superconductive materials, starting with transmon qubits to energy applications like alternative cabling solutions and superconducting energy storage (SMES).

Keywords: *quantum materials, superconductivity, qubits, quantum computers, energy*

LEVERAGING AGRICULTURAL WASTE FOR THE DEVELOPMENT OF EFFECTIVE POLLUTANT DETECTION MATERIAL IN AQUATIC ENVIRONMENTS

Lidia Magerusan[1]*, Olivian Marincas[2], Florina Pogacean[1], Cezara Voica[1]

[1]National Institute for Research and Development of Isotopic and Molecular Technologies, 67-103 Donat Street, 400293 Cluj-Napoca, Romania

[2]Environmental Health Center – Part of ALS, 58 Busuiocului, 400240, Cluj-Napoca, Romania

Abstract

The extensive industrialization leaded to a significant waste of residual chemicals with serious negative influence on the environment and implicitly on human health due to their discharge into waterways and soil. Therefore, developing effective approaches to detect such pollutants is imperative. Apparently, agricultural waste holds remarkable potential for sustainable use in the production of novel materials. In the given context, this study reports an innovative, simple and ecological process based on the valorization of residual industrial potato juice (a by-product of the starch manufacturing process, with a high pollution potential) as electrolytic medium for the production of high quality few layer graphene material. By using the material thus prepared in the development of an electrochemical sensing platform, the rapid and selective 2-nitroaniline (NA) detection in drinking and environmental waters was achieved. The performances of the developed modified electrode were evaluated in terms of selectivity, sensitivity, accuracy, and reproducibility employing cyclic and linear square voltammetry. Under optimized conditions, at pH 7, the developed sensor shows a remarkable enhancement of the sensing abilities compared to the bare electrode, with a linear response in the 0.2 – 100µM NA concentration range, and a low limit of detection: 60.6nM. This innovative approach not only addresses the issue of agricultural waste disposal but also contributes to environmental monitoring efforts by providing a cost-effective and eco-friendly solution for the detection of hazardous compounds in water, demonstrating the synergy between waste valorization and environmental protection.

Keywords: *agricultural residue; graphene; electrochemical exfoliation; 2-nitroalniline detection; cyclic voltammetry, linear square voltammetry*

Acknowledgement

This work was supported by a grant from the Ministry of Research, Innovation and Digitization, CCCDI—UEFISCDI, project number 19PED/2025, within PNCDI IV.

COMPARATIVE STUDY ON LITHIUM AND BORON-SUBSTITUTED BIOACTIVE GLASS-CERAMICS FOR TISSUE ENGINEERING

Mihai Fotu[1*], Adrian-Ionut Nicoara[2], Stefan Manolache[3], Isabelle-Maria Perisan[4], Roxana Popescu[5], Cristina Busuioc[6]

[1,2,6] Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest, Romania

[3,4] Faculty of Medical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest

[5] Department of Life and Environmental Physics, National Institute for Research and Development in Physics and Nuclear Engineering "Horia Hulubei", Magurele, Romania

Abstract

The growing need for bone substitutes, driven by trauma, cancer, arthritis, and infections, has fueled significant advancements in bone tissue engineering. Scaffolds designed for bone regeneration must exhibit mechanical stability and possess a 3D interconnected porous architecture. To support cell maturation, these scaffolds should replicate the native tissue environment, necessitating careful optimization of their chemical composition and physical structure. Bioactive glasses and glass-ceramics are widely used in bone tissue engineering, playing a vital role in fracture repair and other tissue regeneration processes. These materials have the unique ability to bond to bone surfaces by forming an apatite layer, which initiates biomineralization and accelerates bone remodeling.

Various metallic ions can enhance bioactive glasses, such as silver for antimicrobial effects, magnesium for osteogenesis, and copper for angiogenesis. Recent studies highlight the potential of lithium and boron substitutions, with lithium improving bone density and regeneration, while boron accelerates wound healing and bone remodeling. Lithium-substituted bioglasses promote osteogenesis and angiogenesis, whereas boron-substituted variants offer superior bioactivity and controlled biodegradability, making both promising for bone tissue engineering.

This study aims to comparatively analyse lithium- and boron-substituted bioglasses in terms of degradation behaviour, mechanical strength, and biological properties, including cell viability and antibacterial activity. To ensure consistency, both types of bioglasses were synthesized under identical conditions, using the sol-gel method. The compositions were formulated with three different substitution levels – 2.5, 5, and 10 % – allowing for a systematic evaluation of how each dopant influences the material performance in biomedical applications.

This study shows that both lithium- and boron-substituted bioglass-ceramics enhance key biomedical properties, each offering distinct advantages. Boron improves strength and antimicrobial activity, while lithium increases deformability and toughness. Both outperform the control, with the optimal choice depending on application-specific needs balancing strength, bioactivity, and antimicrobial efficacy.

Keywords: bioglass-ceramics, ions substitution, sol-gel method, bioactive materials, tissue engineering.

Acknowledgements

The financial support of the "Noi materiale obținute prin fabricare aditivată pentru ingineria țesutului dur" project GNaC ARUT 2018, contract no 126/04.12.2023, as well as the infrastructure of the National Center for Micro and Nanomaterials – "Installations and Strategic Objectives of National Interest" Program are highly acknowledged.

SELECTED CARRIER MATERIAL COMPOSITIONS IN THE ANAEROBIC DIGESTION PROCESS

Agnieszka A. Pilarska[1*], Krzysztof Pilarski[2]

[1] Department of Hydraulic and Sanitary Engineering, Poznań University of Life Sciences, Piątkowska 94A, 60-649 Poznań, Poland

[2] Department of Biosystems Engineering, Poznań University of Life Sciences, Wojska Polskiego 50, 60-627 Poznań, Poland

Abstract

In anaerobic digestion processes, the application of microbiological carriers constitutes a crucial element in intensifying the biochemical transformations occurring under oxygen-free conditions. These carriers facilitate the development of active microbial cells by increasing the available surface area for their attachment and immobilisation, stabilising the microenvironment of the reactor, and enhancing mass transfer conditions. Their presence can also mitigate the effects of methanogenesis inhibition, thereby improving the stability and efficiency of the digestion process.

In recent years, there has been growing interest in carriers based on natural materials and hybrid composites, which combine favourable physicochemical properties with high biocompatibility. This group includes porous structures, sorptive materials, and biopolymers exhibiting microbiological activity. Appropriate selection and surface modification of these carriers enable the optimisation of digestion conditions, particularly in systems based on complex or compositionally variable substrates.

The subject of the presented research comprises selected microbiological carrier systems: silica/lignin, diatomaceous earth/peat, and chitosan/perlite. Their properties supporting anaerobic digestion were analysed with particular emphasis on the impact on microbial activity, the stability of process parameters, and the resulting biogas yield.

Keywords: *anaerobic digestion, microbial carriers, biogas production, natural composites, process efficiency*

EFFECT OF NANOPARTICLES ON MECHANICAL PROPERTIES OF POLYMERS

Umut Tanyeri, Farshid Khosravi*

Mechanical Engineering Department, Faculty of Engineering, Manisa Celal Bayar University, Manisa, Türkiye

Abstract

Composite filaments were produced by plastic injection method, which is one of the conventional polymer production methods, and their mechanical properties were obtained. Then, the effect of nanoparticles and their weight percentages on the mechanical properties of these filaments was investigated by subjecting the filaments to tensile testing. TiO2, Sic and CNT powders as nanoparticles were mixed into PLA filaments. To examine the weight percentages of nanoparticles, 0.5, 1, and 1.5% were selected. Tensile samples were produced from the reinforced polymer filaments in a 3D printer. Mechanical properties were obtained from the tensile test, and the effect of nanoparticles was investigated.

Keywords: *Polymers, mechanical properties, 3D printer, nanoparticle, composite materials*

Acknowledgments

This research was supported by the Scientific Research Projects Coordination Unit of Manisa Celal Bayar University under grant number 2024-119.

CLOSED CIRCUITS FOR POWERTRAIN COMPONENTS - RESOURCE EFFICIENCY THROUGH THE EXTRACTION AND PROCESSING OF SECONDARY SEMI-FINISHED PRODUCTS INTO NEW PRODUCTS IN FORMING PROCESS CHAINS

René Selbmann, Verena Kräusel*, Patrick Alexander Schmidt

Fraunhofer Institut für Werkzeugmaschinen und Umformtechnik, 09126 Chemnitz, Deutschland

Abstract

In order to be able to react to disruptions in global supply chains in a targeted manner, in this paper the development of process chains aimed at the repurposing of components in the powertrain of passenger cars is presented. Semi-finished products are obtained directly from end-of-life vehicles as secondary semi-finished products and further processed using bulk metal forming processes. As an example, it is demonstrated how, after disassembly and the necessary separation processes as well as a specific heat treatment, drive shafts are reworked into connecting elements such as screws or gear racks in tie rods, while ensuring identical mechanical properties compared to the original product. On the one hand, this contributes to a significantly higher utilization of resources and, on the other hand, it demonstrates solutions for closing material cycles for automotive components.

Keywords: *power train,* circular economy, repurpose*, connectors, vehicle rod*

Acknowledgments

We thank the Federal Ministry of Education and Research (BMBF) for funding the project "Efficient and economical recycling-oriented disassembly and processing (EKODA)" within the funding measure "Zukunftsfonds Automobil – MobilKreis".

DESIGN THINKING FOR CIRCULARITY: IDENTIFYING CHALLENGES & DEVELOPING INNOVATIVE SOLUTIONS IN THE PLASTICS INDUSTRY

Andra-Cristina Enache*, Petrisor Samoila, Adrian Bele, Valeria Harabagiu

"Petru Poni" Institute of Macromolecular Chemistry, 41A Grigore Ghica Voda Alley, Iasi 700487, Romania

Abstract

The transition toward circularity in the plastics industry requires systemic innovation and collaboration across sectors. This study explores how Design Thinking—a structured, user-centered methodology—can drive the development of sustainable solutions in plastics management. A dedicated workshop brought together experts from academia, industry, and environmental agencies to identify challenges and generate circular solutions in key areas such as packaging, construction materials, healthcare plastics, and waste management. Proposed solutions addressed both technical advancements and policy-driven initiatives, emphasizing product redesign for extended reuse, improved recycling infrastructure, and the integration of digital tools for enhanced resource efficiency. These findings contribute to the mission of the Plan-C project, which boosts the transformation of the plastics value chain in the Danube region.

Keywords: *Design Thinking, circular economy, plastics, innovative solutions, transnational cooperation*

Acknowledgments

The project Moving Plastics and Machine Industry towards Circularity (acronym Plan-C, ID: DRP0200194), supported by the Interreg Danube Region Programme and co-funded by the European Union, is kindly acknowledged.

PHOTOCHEMICAL ACTIVITY OF SOME ZINC PHTHALOCYANINE DERIVATIVES

Carmen Gherasim[1*], Anton Airinei[1], Ionut Radu Tigoianu[1], Tamara Potlog[2], Ion Lungu[2], Victor Suman[3]

[1]Petru Poni Institute of Macromolecular Chemistry, Physical Chemistry of Polymers laboratory, 41A Grigore Ghica Voda Alley, 700487 Iasi, Romania

[2] Moldova State University, Laboratory of Organic/Inorganic Materials for Optoelectronics, Chisinau, Republic of Moldova

[3]Doctoral School "Natural Sciences" Moldova State University Chisinau, Republic of Moldova

Abstract

Metallophthalocyanine derivatives are good candidates for a variety of applications including medicine as photosensitizers in photodynamic therapy. The wide range of the potential utilization of these compounds can be determined by the nature and number of groups of non-peripheral or peripheral positions of the phthalocyanine ring.

Novel substituted zinc phthalocyanines with COOH groups and conjugated with dextran or chitosan with improved photodynamic characteristics were obtained. These systems improve the singlet oxygen production and assure a good solubility in biological media. The phthalocyanine derivatives were characterized by electronic absorption and emission spectra. Their photophysical properties including quantum yield, fluorescence lifetimes and phosphorescence were investigated. In this way, values of quantum yield below 15 % and lifetimes of the excited state around 10 ns were estimated. Also, the transient absorption spectroscopy was utilized in order to study the excited state processes and the involvement of the higher energy electronic state in the photochemical processes. In the transient absorption map, these compounds displayed a ground state baseline band at lower wavelengths absorptions in excited state can occur. At higher wavelengths, stimulated emission band is present. Also, the biological characteristics such as low dark and photoinduced toxicity, the ability to generate reactive oxygen species and storage stability were studied.

Keywords: *ZnPc phthalocyanine derivatives, photosensitizer, excited states*

Acknowledgments

This presentation was supported by a grant from the Romanian Ministry of Research, Innovation, and Digitization, CNCS-UEFISCDI, project number ***PN-IV-P8-8.3-ROMD-2023-0048, DSUPRAMED.***

FREE RADICAL SCAVENGING AND ANTIOXIDANT BEHAVIOR OF NITROGEN- AND OXYGEN- FUNCTIONALIZED CARBON DOTS

Adina Coroaba[1], Anca Roxana Petrovici[1], Cornel S. Stan[1,2], Florica Doroftei[1], Narcisa-Laura Marangoci[1], Mariana Pinteala[1]

[1]Centre of Advanced Research in Bionanoconjugates and Biopolymers, "Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania

[2]Faculty of Chemical Engineering and Environmental Protection, "Gheorghe Asachi" Technical University of Iasi, Iasi, Romania

Abstract

Reactive oxygen species and reactive nitrogen species play a critical role in mediating tissue damage and disease progression. In response, a wide range of antioxidative nanomaterials has been engineered, with particular focus recently on low-dimensional carbon-based nanostructures due to their promising properties. Prior to biomedical application, verifying the antioxidant activity of these materials is essential. Compounds with antioxidant properties neutralize free radicals generated by cellular metabolism or oxidative stress, including superoxide, hydroxyl, peroxyl, alkoxyl, and nitric oxide species.

This study investigates the antioxidant activity of nitrogen- and oxygen-doped carbon dots synthesized under atmospheric conditions using a temperature/flow regulated hot air gun at different reaction times (10, 20, 30, and 40 minutes). Antioxidant activity was assessed using DPPH and ABTS radical scavenging assays, which simulate neutral to slightly alkaline conditions. DPPH measures electron or hydrogen donation, while ABTS assesses both mechanisms. Low sample concentrations were used to enable comparison with ascorbic acid, which is naturally found in the human body at a concentration of 45 μg/mL.

The ferrous ion (Fe^{2+}) chelation tests showed a very low affinity, suggesting minimal interaction between the carbon dots and free metal ions. To build a comprehensive antioxidant profile, DPPH, ABTS, and FRAP assays were carried out in parallel. The carbon dots exhibited notable antioxidant activity under acidic conditions (FRAP assay) and demonstrated strong hydroxyl radical scavenging, surpassing the performance of standard antioxidants like Trolox and ascorbic acid. Although their scavenging activity against DPPH and ABTS radicals was limited, the carbon dots were found to generate superoxide anions under oxidative stress conditions. Despite this, the overall results highlight the antioxidant potential of the carbon dots and support their possible application in biomedical fields, particularly in the development of therapies for oxidative stress-related disorders.

Keywords: *carbon dots, radical scavenging, antioxidant activity*

Acknowledgements

The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

PHOTOLUMINESCENT CARBON DOTS DERIVED FROM N-HETEROCYCLIC PHTHALAZINE-BASED QUATERNARY SALTS

Narcisa-Laura Marangoci[1], Marius Savu[1,2], Adina Coroaba[1], Florica Doroftei[1], Ionel Mangalagiu[2], Mariana Pinteala[1]

[1]Centre of Advanced Research in Bionanoconjugates and Biopolymers, "Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania

[2]Faculty of Chemistry, "Alexandru I. Cuza" University of Iasi, Iasi, Romania

Abstract

Carbon dots, a promising class of nanomaterials, are distinguished by their low cytotoxicity, high water solubility, chemical stability, and tunable fluorescence. In this work, phthalazine-based monoquaternary salts were used as both carbon and nitrogen sources in the hydrothermal synthesis of C-dots. These salts, rich in nitrogen (N) and aromatic structure, facilitate N doping and contributes to the development of surface states responsible for photoluminescence properties. Reaction parameters, including temperature, duration, and precursor concentration, were carefully optimized to ensure consistent particle formation and dispersion in aqueous environments.

Photoluminescence (PL) properties were thoroughly investigated through fluorescence spectroscopy, including emission, excitation, and synchronous spectra. The carbon dots exhibited excitation-dependent emission behavior, with maximum fluorescence observed in the green region of the visible spectrum. This is indicative of diverse surface emissive states and the presence of functional groups formed during hydrothermal synthesis. The observed Stokes shift and broad emission bands further confirm the heterogeneity of the electronic states within the carbon dots, which is typical for heteroatom-doped carbon dots. The synchronous spectra further supported the presence of multiple emissive centers, reflecting the complex surface chemistry introduced during synthesis. Morphological evaluation using scanning transmission electron microscopy (STEM) confirmed that the synthesized carbon dots exhibit spherical shape with narrow size distributions.

Together, the spectroscopic and microscopic analyses confirmed the successful synthesis of nitrogen-doped carbon dots with well-defined nanostructures and stable fluorescence. These findings highlight the effectiveness of the hydrothermal method when using phthalazine-based precursors, and suggest a versatile and accessible approach to generating photoluminescent carbon nanomaterials.

Keywords: *carbon dots, phthalazine-based quaternary salts, nitrogen doping*

Acknowledgements

The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

FLUORESCENCE AND MORPHOLOGICAL PROPERTIES OF LASER-IRRADIATED *MIMOSA PUDICA*-DERIVED CARBON NANOSTRUCTURES

Florica Doroftei, Maurusa Ignat, Leonard Ignat, Adina Coroaba, Narcisa-Laura Marangoci, Cristian Ursu, Mariana Pinteala

Centre of Advanced Research in Bionanoconjugates and Biopolymers, "Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania

Abstract

In this work, two Mimosa pudica solutions at a concentration of 0.25 mg/mL were sonicated for 30 minutes, then left to rest for another 30 minutes to allow the sedimentation of larger particles. The supernatants were then subjected to laser ablation at two different pulse energies (60 mJ and 90 mJ). In addition, a third sample containing carbon nanostructures (0.25 mg/mL), prepared from Mimosa pudica leaf powder thermally treated in a thermogravimetric cell under nitrogen flow up to 400 °C, was irradiated under the same laser conditions. After irradiation, all three samples showed improved colloidal stability, with no visible precipitation, and a noticeable color shift to a brownish tint. These changes were evident both between the irradiated samples and the untreated control, and among the irradiated samples themselves, depending on the laser energy applied.

The resulting colloidal solutions were purified using a 3 kDa MidiKros fiber filter module connected to a peristaltic pump. The purified fractions were subsequently analyzed by fluorescence spectroscopy. Emission, excitation, and synchronous spectra were recorded under identical experimental conditions. Excitation spectra were acquired at the emission maxima identified in prior measurements, while synchronous spectra were collected over an offset range of 10 to 150 nm.

Fluorescence measurements indicated a slight difference in the optical properties of the samples, likely due to the laser treatment used during irradiation (60 mJ and 90 mJ, respectively), as well as the thermal treatment at 400 °C. These variations may have altered the chemical composition of the resulting carbon nanostructures, along with morphological changes induced by the compounds present in the extracts prior to laser ablation.

Keywords: *carbon dots, Mimosa pudica, laser ablation*

Acknowledgements

The authors are thankful for the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2022-I8-291, contract no. 760081/23.05.2023, within the National Recovery and Resilience Plan.

ELECTRODEPOSITION OF AU NANOPARTICLES ON 2D LAYERED MATERIALS AND THEIR APPLICATIONS IN ELECTROCATALYSIS OF NITRITE

Oana Elena Carp

"Petru Poni" Institute of Macromolecular Chemistry, Centre of Advanced Research in Bionanoconjugates and Biopolymers, Grigore Ghica Voda Alley 41A, 700487 Iasi, Romania

Abstract

This study presents a comparative study of gold nanoparticles (AuNPs) electrodeposited on various two-dimensional (2D) materials used as electrode substrates—namely graphene (Gr) and molybdenum disulfide (MoS_2)—as well as AuNPs co-deposited with metallic MoS_2. The electrodeposition process, carried out via cyclic voltammetry, facilitates nucleation and growth of AuNPs on the substrates, with the nature of the 2D material significantly influencing the morphology and distribution of the nanoparticles. Morphological characterization by SEM reveals that the lamellar, porous structures of Gr and MoS_2 provide abundant nucleation sites, while co-deposition with MoS_2 notably enhances particle density and surface coverage. Electrochemical characterization in 0.1 M H_2SO_4 demonstrates superior electronic transfer properties and enhanced oxidation peak currents for AuNPs co-deposited with MoS_2 compared to AuNPs electrodeposited on Gr, MoS_2 alone, or bare gold electrodes. The electrocatalytic activity of these configurations was evaluated through nitrite (NO^{2-}) oxidation using cyclic voltammetry and amperometry. Among the tested electrodes, the MoS_2-AuNPs/SPE configuration exhibited the highest electrocatalytic efficiency, with a specific sensitivity of 1.043 $\mu A\ \mu M^{-1} cm^{-2}$ over a linear concentration range of 0.5–600 μM nitrite, a detection limit as low as 0.16 μM, and excellent resistance to common interferents. Optimization of sensor parameters, including applied potential (optimal at 0.7 V) and acid concentration (0.25 M H_2SO_4), further improved the sensor's analytical performance.

Overall, this study confirms that co-deposition of AuNPs with MoS2 on screen-printed electrodes significantly enhances the electrocatalytic detection of nitrite, making the MoS_2-AuNPs/SPE electrode a promising candidate for sensitive and selective electrochemical sensors.

Acknowledgments

The authors thank the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2023-I8-161, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

GOLD-MODIFIED ZNO AND GAN NANOPARTICLES FOR SENSITIVE ELECTROCHEMICAL DETECTION

Oana-Elena Carp[1], Denisse-Iulia Bostiog[1], Tudor Braniste[1,2], Narcisa-Laura Marangoci[1], Ion Tighineanu[1,2,3], Alexandru Rotaru[1].

[1]"Petru Poni" Institute of Macromolecular Chemistry, Centre of Advanced Research in Bionanoconjugates and Biopolymers, Grigore Ghica Voda Alley 41A, 700487 Iasi, Romania

[2]National Center for Materials Study and Testing, Technical University of Moldova, Chisinau, Republic of Moldova.

[3]Academy of Sciences of Moldova, Chisinau, Republic of Moldova.

Abstract

Erythromycin is a widely used macrolide antibiotic for treating bacterial infections, but its excessive presence in the environment or food products can lead to antimicrobial resistance and adverse ecological effects. Therefore, the development of rapid, sensitive, and selective methods for erythromycin detection is critically important in environmental monitoring, as well as in pharmaceutical and food safety applications. In this context, electrochemical techniques have emerged as an attractive alternative to conventional methods due to their low cost, short analysis time, and suitability for miniaturization. This study presents the optimization of an electrochemical sensing platform based on screen-printed gold electrodes (GSPE), functionalized with GaN-PEI and GaN-PEI-Au nanostructures, for the sensitive detection of erythromycin.

To improve the stability of the active material on the electrode surface, the nanoparticles were dispersed in a Nafion-containing mixture, ensuring efficient anchoring and good signal reproducibility. Various electrolytes were tested, with TRIS buffer providing the most stable and well-defined electrochemical response. Additionally, the optimal volume of active material was determined to be between 1.5–2 µL, ensuring high signal intensity without surface overcrowding.

Erythromycin detection in the range of 0.1–0.5 mM was performed using differential pulse voltammetry (DPV), showing a linear increase in peak current with concentration. Electrodes functionalized with GaN-PEI-Au exhibited significantly stronger signals compared to those modified with GaN-PEI, highlighting the catalytic role of gold nanoparticles. The results demonstrate the high potential of the optimized electrochemical platform for efficient erythromycin monitoring, with promising applications in quality control and environmental protection.

Acknowledgments

The authors thank the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2023-I8-161, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

SURFACE DECORATION OF ZnO AND GaN WITH GOLD NANOPARTICLES FOR SERS ENHANCEMENT

Denisse-Iulia Bostiog[*1], Elena-Laura Ursu[1], Tudor Braniste[1,2], Narcisa-Laura Marangoci[1], Mariana Pinteala[1], Ion Tighineanu[1,2,3], Alexandru Rotaru[1]

[1]Centre of Advanced Research in Bionanoconjugates and Biopolymers, "Petru Poni" Institute of Macromolecular Chemistry of the Romanian Academy, Grigore Ghica Voda 41A Alley, 700487 Iasi, Romania.

[2]National Center for Materials Study and Testing, Technical University of Moldova, Chisinau, Republic of Moldova.

[3]Academy of Sciences of Moldova, Chisinau, Republic of Moldova.

Abstract

Surface-enhanced Raman spectroscopy (SERS) significantly increases the sensitivity of conventional Raman spectroscopy by amplifying molecular signals through plasmonic effects, making it a powerful technique for detection. Herein, we report on the synthesis and detailed characterization of two hybrid nanostructured systems based on gallium nitride (GaN), zinc oxide (ZnO) nanoparticles, and gold nanoparticles (AuNPs). The semiconductor nanoparticles were surface-functionalized with AuNPs using two distinct approaches to investigate their influence on SERS activity and structural properties. The first system involved the surface functionalization of GaN and ZnO nanoparticles with branched polyethyleneimine (PEI, molecular weight 25,000 Da), with subsequent PEI-assisted growth of AuNPs on their surface. The second system integrated combination between GaN/ZnO nanoparticles with pre-synthesized gold complexes: phosphine-coated AuNPs and DNA-coated AuNPs, enabling alternative routes to metallic surface decoration. Both types of nanohybrids were characterized to assess their physicochemical properties via Dynamic Light Scattering (DLS), UV–Vis spectroscopy, High-resolution Scanning Transmission Electron Microscopy (STEM). The obtained materials were assessed as SERS supports for methylene blue. The results suggested that ZnO and GaN nanoparticles decorated with AuNPs via Au-phosphine conjugates demonstrated superior SERS performance compared to those functionalized with PEI, where the presence of the polymer significantly hinders signal enhancement due to surface passivation and reduced analyte accessibility. This work contributes to developing efficient SERS substrates by integrating complex architectures based on metal and semiconductor components.

Keywords: *Surface-Enhanced Raman Scattering, ZnO/GaN Nanoparticles, Gold Nanoparticles, Hybrid Metal–Semiconductor Substrates,*

Acknowledgments

The authors thank the financial support of the grant of the Ministry of Research, Innovation and Digitization, project no. PNRR-III-C9-2023-I8-161, contract no. 760285/27.03.2024, within the National Recovery and Resilience Plan.

XANTHAN GUM/POLYVINYL ALCOHOL NANOCOMPOSITE HYDROGELS DOPED WITH CERIUM OXIDE NANOPARTICLES FOR POTENTIAL ENVIRONMENTAL APPLICATIONS

Nicusor Fifere*, Maria Marinela Lazar, Irina Elena Raschip, Maria Valentina Dinu

"Petru Poni" Institute of Macromolecular Chemistry, Department of Functional Polymers, Grigore Ghica Voda Alley 41 A, 700487 Iasi, Romania

Abstract

Composite materials-based cerium oxide nanoparticles (CeO_2 NPs) with natural polymers have attracted significant attention in recent years, due to synergistically physico-chemical properties arising from their distinct individual characteristics. Xanthan gum (XG), a natural polysaccharide, exhibits a strong affinity for metal ions, making it a promising candidate for the development of metal oxide-based nanocomposite hydrogels.

In this study, CeO_2 NPs were successfully incorporated into a hydrogel matrix composed of xanthan gum and polyvinyl alcohol (PVA), yielding a novel composite material with enhanced and distinctive properties relative to its individual components. Subsequent thermal treatment of the as-prepared composite, followed by cross-linking using an environmentally benign cross-linking agent, facilitated specific interactions that further reinforced the polymeric network. The structural, morphological, and wettability characteristics of the resulting hydrogel were comprehensively characterized employing FT-IR, SEM, and AFM, respectively.

Acknowledgements

The authors are grateful for the financial support from project number PN-IV-P1-TE-2023-2005 (TE4/08.01.2025).

POLYSACCHARIDE NANOCOMPOSITE FRAMEWORKS FOR ADSORPTION OF HEAVY METAL IONS AND CATALYTIC HYDROGENATION OF 4-NITROPHENOL

Claudiu-Augustin Ghiorghita*, Maria Marinela Lazar, Maria Valentina Dinu

"Petru Poni" Institute of Macromolecular Chemistry, Grigore Ghica Voda Alley 41A, 700487 Iasi, Romania

Abstract

Circular economy aims for sustainable exploitation of materials by transforming waste into raw products by successively tackling different technological processes over their life cycle [1,2]. In this context, this study presents the development of new polysaccharide nanocomposite cryogels for dual applications in environmental remediation and catalysis. Specifically, native and thiourea-functionalized polysaccharide cryogels were prepared by covalent formaldehyde-mediated cross-linking using the cryogelation technique [3]. These macroporous materials were first evaluated as adsorbents for Cu(II) and Ag(I) ions, the adsorption performance being optimized as a function of initial solution pH, contact time, and equilibrium concentration. Following metal ions uptake, the retained Cu(II) and Ag(I) ions were converted to CuNPs and AgNPs by chemical reduction with $NaBH_4$. The prepared nanocomposite cryogels demonstrated high efficiency and reusability in the catalytic hydrogenation of 4-nitrophenol.

Keywords: *chitosan, cryogels, adsorption, heavy metal ions, catalysis, 4-nitrophenol*

Acknowledgements

This work was supported by the following grants funded by the Ministry of Research, Innovation and Digitization, CNCS/CCCDI – UEFISCDI: PN-III-P1-1.1-TE-2021-0771 (TE3/2022), PN-IV-P2-2.1-TE-2023-2005 (TE4/2025), and PN-IV-P1-PCE-2023-1968 (PCE4/2025).

ENGINEERING SPINEL-TYPE MIXED OXIDES FOR POTENTIAL WASTEWATER APPLICATIONS

Ionela Grecu*, Andra-Cristina Enache, Petrisor Samoila, Corneliu Cojocaru, Bogdan-Constantin Condurache, Valeria Harabagiu

Department of Inorganic Polymers, "Petru Poni" Institute of Macromolecular Chemistry, 41A Grigore Ghica Voda Alley, Iasi, 700487, Romania

Abstract

The complexity of environmental pollution has intensified in recent decades, extending its impact beyond human health to broader socio-economic issues, particularly in developing countries. Rapid industrialization remains a major contributor, discharging untreated effluents that lead to elevated levels of toxic contaminants in water bodies. The harmful and potentially carcinogenic nature of many pollutants has raised significant concerns, driving the search for cost-effective and efficient treatment solutions.

Magnetic nanoparticles, particularly spinel ferrites, have emerged as promising candidates for wastewater treatment due to their adsorption and catalytic properties. To enhance their performance and address limitations such as agglomeration and metal ion leaching, this study introduces a novel approach for the synthesis of structurally modified or ion-substituted spinel ferrites with improved surface and magnetic characteristics.

These engineered ferrites are subsequently embedded into chitosan matrices to form magnetically responsive composites with enhanced adsorption capacity for organic pollutants. The biopolymeric matrix improves dispersion and stability, while the magnetic properties enable easy recovery and reuse of the materials.

Thus, a novel cost-effective solution is proposed through the development of recoverable hybrid sorbents based on tailored spinel ferrites and chitosan, offering a circular and sustainable solution for pollutant removal from wastewater.

Keywords: *spinel ferrite, magnetic properties, composites, wastewater*

Acknowledgments

This work was supported by a grant from the Ministry of Research, Innovation and Digitization, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-1830, within PNCDI III.

DECODING KIDNEY STONES: A CHEMICAL AND MORPHOLOGICAL PERSPECTIVE

Jelena Brdarić Kosanović[1]*, Kristijan Živković[1], Berislav Marković[2], Vatroslav Šerić[3], Imre Szenti[4], Ákos Kukovecz[4], Nives Matijaković Mlinarić[5], Anamarija Stanković[1]*

[1]Department of Chemistry, University of Osijek, Cara Hadrijana 8A, 31000, Osijek, Croatia

[2]Faculty of Dental Medicine and Health Osijek, Crkvena 21, 31000, Osijek, Croatia

[3]International Medical Center Priora, Kralja Tomislava 153, 31431, Čepin, Croatia

[4]Department of Applied and Environmental Chemistry, University of Szeged, Rerich Béla tér 1, H-6720 Szeged, Hungary

[5]Ruđer Bošković Institute, Bijenička Cesta 54, 10000 Zagreb, Croatia

Abstract

As the frequency of kidney stones in the human population increases, this study examines their composition, which could guide further research aimed at reducing their occurrence. This poster presents a morphological characterization of human kidney stones, focusing on their external and internal structure, as well as elemental composition. The analysis was conducted using a combination of stereoscopic microscopy, scanning electron microscopy (SEM), micro-computed tomography (micro-CT), and energy-dispersive X-ray spectroscopy (EDX). These complementary techniques provided a comprehensive insight into the surface texture, internal morphology, and mineralogical composition of the examined specimens.

The results are grouped into two main categories: calcium-based stones and non-calcium stones. Within the calcium-based group, three main morphological and compositional profiles were identified. The first includes stones composed predominantly of calcium oxalate, in the form of whewellite and/or weddellite. The second group consists of mixed calcium oxalate stones, which combine whewellite, weddellite, and calcium phosphate (typically hydroxyapatite). The third group is characterized by stones in which calcium phosphate (mainly hydroxyapatite) is the dominant component, often accompanied by struvite, some weddellite, and a very small amount of whewellite.

The aim of this study is to visually and structurally differentiate between these groups based on their morphology and elemental profiles, contributing to a better understanding of kidney stone formation processes and aiding in potential diagnostic or preventative approaches. Particular emphasis is placed on the value of non-destructive imaging methods such as micro-CT in revealing internal features that may not be detectable by surface-based techniques alone.

This poster highlights representative examples from each group, demonstrating typical surface characteristics, internal architecture, and elemental composition patterns. The focus of the presentation will be on the morphological differences and classification potential based on the applied imaging and analytical techniques.

Keywords: *kidney stones, calcium oxalate, chemical analysis, morphological analysis, phosphate*

Acknowledgments

This research was funded by PPUZN Stanković 2024/2027 (internal project of the Department of Chemistry at J.J. Strossmayer University of Osijek).

BRIDGING PARTICLE PHYSICS AND NANOMECHANICS: SHARED PRINCIPLES IN EMERGENT BEHAVIOR

Halil Mutuk

Physics Department, Faculty of Sciences, Ondokuz Mayis University, 55200, Samsun, Turkey

Abstract

The urgent need for sustainable materials with improved performance and durability requires a deeper understanding of how nanoscale mechanical behavior controls macroscopic material properties. While significant progress has been made in nanoscale research, a holistic understanding remains elusive due to the fragmented nature of current knowledge. In this work, we explore the conceptual parallels between particle physics and nanomechanics, highlighting how both fields study emergent phenomena arising from fundamental interactions.

In particle physics, complex systems such as hadrons emerge from the strong interactions between quarks and gluons, which are governed by quantum chromodynamics (QCD). Similarly, in nanomechanics, the macroscopic properties of materials emerge from the collective behavior of atoms and molecules at the nanoscale. By drawing analogies between these systems, we aim to identify common principles that can inform new approaches to understanding and predicting nanoscale mechanical behavior. For example, the concept of scale separation in QCD - where phenomena at different length scales can be studied independently - can provide insights into the hierarchical organization of materials.

To further bridge these fields, we propose the integration of machine learning techniques, such as neural networks and Gaussian process regression, to analyze and predict emergent behavior in both particle physics and nanomechanics. These methods can help identify patterns in complex data, enabling the discovery of universal principles that govern diverse systems.

This interdisciplinary perspective not only enriches our understanding of emergent phenomena, but also provides a novel framework for addressing challenges in nanomechanics.

Acknowledgments

This work is supported by Ondokuz Mayis University Scientific Project Unit Coordination Unit (OMU BAPKOB) with project no BAP05-2025-5384.

HYDROPHILIZATION OF POLYPROPYLENE TEXTILE USING BACTERIAL NANOCELLULOSE

Jakub Wiener

Technical University of Liberec, Studentská 1402/2, Liberec 461 17, Czech Republic

Abstract

Bacterial nanocellulose (BNC) is produced by bacteria in the form of nanofibers with a diameter of approximately 50 nm. It is an environmentally friendly product. The unique fiber structure of bacterial cellulose enables a range of technical applications that utilize the strength, porosity, hydrophilicity, and insolubility of bacterial nanocellulose. This study focuses on the possibility of hydrophilizing rough surfaces using bacterial nanocellulose. Specifically, the possibility of ecologically and permanently increasing the wettability of polypropylene textiles using bacterial nanocellulose is being tested. The experimentally prepared samples are evaluated using electron microscopy and other appropriate methods. The results are discussed. Bacterial cellulose effectively reduces the contact angle and improves the wettability of polypropylene.

Keywords: *Bacterial nanocellulose, polypropylene, fibers,* con*tact angle, wettability*

Acknowledgments

The Project Eco-clothing collection, reg. no. TQ01000450, is co-financed from the state budget by the Technology agency of the Czech Republic under the Programme for Support of Applied Research and Innovation SIGMA

NEW BALL BURNISHING TOOL FOR REGULAR RELIEFS ON INNER CYLINDRICAL SURFACES

Aleksandr Valentinovich Markov

Department of Manufacturing Technologies and Machine Tools, Technical University of Varna, 1 "Studentska" Street, Varna 9010, Bulgaria

Abstract

The article presents the design and fabrication of a specialized ball burnishing tool for forming regular relief patterns on the inner cylindrical surfaces of metal samples. The method is based on surface plastic deformation, which contributes to the improvement of the surface layer structure and the enhancement of functional performance. The tool was 3D modeled and after that assembled using SolidWorks software.

Keywords: *ball burnishing tool, regular reliefs*

PRODUCTION OF DIESEL FUEL BY SIMULTANEOUS RAPESEED OIL EXTRACTION AND INTERESTERIFICATION IN DIESEL FUEL MEDIA

V. Makareviciene, E. Sendzikiene

Agriculture Academy, Vytautas Magnus University, Lithuania

Abstract

The purpose of the research was to evaluate the process of enzymatic biodiesel synthesis by applying the simultaneous oil extraction from rapeseed and interesterification with methyl formate in mixture with mineral diesel, choosing the amount of mineral diesel so that the ratio between it and the rapeseed oil in the seeds was 9:1. As the final product of the interesterification process, a mixture of mineral diesel and biodiesel was obtained directly. The interesterification tests were performed using enzymatic catalysis - the lipase Lipozyme TL TIM. Process optimization was performed using the response surface methodology. A model describing the interaction of three independent variables and their influence on the yield of rapeseed oil methyl esters was developed. The optimal conditions have been determined. A 73% yield of rapeseed oil methyl esters was obtained at a 6:1 ratio of methyl formate to rapeseed mass, with the process running for 70 h and using 23% of the enzyme preparation Lipozyme TL IM (based on oil content). The physical and chemical indicators of the product obtained under optimal interesterification conditions were evaluated.

Keywords: *biodiesel, rapeseed oil, interesterification, quality*

Acknowledgements

This research has received funding from the Research Council of Lithuania (LMTLT), agreement No MIP-22/59 Synthesis of innovative biodiesel.

AN EXPERIMENTAL MODEL FOR THE OBJECTIVE STUDY OF SKIN MOBILITY

Ivan Ivanov

National Sports Academy "Vasil Levski", Sofia, Bulgaria

Abstract

Skin mobility is used as a diagnostic method in various manual therapy approaches. Objective instrumental tools for assessing skin mobility are lacking. The proposed experimental model for the objectification of skin mobility can be used as an alternative to the palpatory "skin displacement" test used in manual-therapeutic approaches (segmental-reflex therapies, including massage; osteopathy, etc.).

Keywords: *skin mobility, skin displacement*

Acknowledgment

This research was supported by institutional funding from National Sports Academy "Vasil Levski", Sofia, Bulgaria, in collaboration with Bulgarian Academy of Sciences.

EXPERIMENTAL MODEL FOR ESTIMATION OF ISOMETRIC STRENGTH AND ENDURANCE/FATIGUE OF THE HEAD AND NECK MUSCLES

Stela Ivanova

National Sports Academy "Vasil Levski", Sofia, Bulgaria

Abstract

The cervical spine is part of the overall postural chain of the body, and the spine in particular, and a change in its position can affect the position and function of the other "links" in the chain. Muscle imbalance is common cause and effect of postural disorders. The proposed experimental model enables an objective assessment of the isometric muscle strength, endurance/fatigue and imbalance in order to be used for rehabilitation and sport purposes.

Keywords: *cervical muscles, isometric muscle strength, muscle endurance, muscle fatigue.*

Acknowledgment

This research was supported by institutional funding from National Sports Academy "Vasil Levski", Sofia, Bulgaria, in collaboration with Bulgarian Academy of Sciences.

OPTICAL SPECTROSCOPY AND SURFACE PROPERTIES OF NANOCRYSTALLINE THIN FILMS

Zdenek Remes

Institute of Physics of the Czech Academy of Sciences, Czech Republic

Abstract

The surface-related effects were studied using custom-built inductively coupled plasma (ICP) 13.56 MHz reactor with up to 300 W RF discharge power and optical spectroscopy. We have shown that plasma hydrogenation of ZnO nanocrystalline thin films effectively suppresses defects, significantly increasing electrical conductivity and exciton-related UV luminescence. We found good room temperature stability of the plasma hydrogenated ZnO nanocrystals in air, but fast degradation at elevated temperature. The nominally undoped and doped (Co, Al, In, Ga) nanocrystalline ZnO thin films were pulsed laser deposited (PLD) on fused silica glass and interdigitated gold electrodes (MicruX Technologies, Spain) and tested using absorption, photoluminescence and photocurrent spectroscopy.

COMSOL MODELLING OF CHROMIUM(VI) ADSORPTION ON CITRIC ACID FUNCTIONALIZED CHITOSAN HYDROGEL BEADS

Đorđe Petrović*, Katarina Stanković, Igor Telečki, Ksenija R. Kumrić

Vinča Institute of Nuclear Sciences, Department of Physics, University of Belgrade, Mike Petrovića Alasa 12-14, 11351 Vinča, Belgrade, Republic of Serbia

Abstract

The COMSOL Multiphysics is a software tool with a graphical user interface (GUI) for modeling and solving partial differential equations using the Finite element method (FEM) together with adaptive meshing and error control using a variety of numerical solvers.

To predict the breakthrough curves for Cr(VI) adsorption in a continuous fixed-bed column packed with citric acid functionalized chitosan hydrogel beads (CA-GLA-CHB) as adsorbent, the axially dispersed plug flow model described by the Advection-Dispersion-Reaction (ADR) equation was implemented and solved numerically by COMSOL Multiphysics software. The validity of the proposed mathematical model under different operating conditions was evaluated by comparing the experimental breakthrough profiles with those simulated by the software.

Using the software, the column geometry, material properties characterized by diffusion, porosity, adsorption capacity and flow rate were defined. The equilibrium adsorption data obtained by batch experiments described by Langmuir isotherm were incorporated in calculations.

Based on the experimental values, it was obtained that the value of the axial dispersion coefficient, D_z, has a significant impact on the shape of simulated Cr(VI) breakthrough profiles.

The breakthrough curves based on the Rastegar-Gu correlation and the fitted D_z values showed higher R^2 values, in the range of 0.961 – 0.993 and 0.975 – 0.994, respectively, and the predicted breakthrough time and exhaustion time were much closer to the experimental values compared to the breakthrough curves based on the D_z value calculated from the Chung-Wen correlation.

Therefore, the proposed mathematical model based on either Rastegar-Gu correlation or the fitted values of D_z can be used to accurately predict the concentration profiles of Cr(VI) ions at the outlet of a fixed-bed column using COMSOL Multiphysics software.

The ultimate goal of this work is to confirm the correctness of the COMSOL calculations for future application in large-scale fixed column wastewater treatment systems.

Keywords: *COMSOL, adsorption, continuous fixed-bed column, Cr(VI).*

Acknowledgments

This research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia through contract No. 451-03-66/2024/200017.

OLIVE OIL DEGRADATION USING NANOREACTORS WITH ENTRAPPED LIPASE AND ADDITIVES

Anca Leonties

Institute of Physical Chemistry, Romania

Abstract

Plant-based oil spills pose a significant threat to aquatic ecosystems and contaminate water sources, necessitating intricate purification techniques that incorporate advanced separation and filtration processes. Lipases, a class of enzymes, exhibit remarkable efficiency in breaking down oil pollutants, promoting degradation in a more sustainable and environmentally friendly manner. These enzymatic reactions occur at the interface between the aqueous phase, which contains the enzyme, and the non-aqueous phase containing the fatty substrate. However, the reaction rates are often limited by low substrate accessibility, distribution, orientation, partitioning, and exchange dynamics. Microemulsions can be utilized to enhance enzymatic activity and protect the delicate structural integrity of the enzyme. Additionally, optimizing enzyme efficiency, selectivity, and reaction stability within these complex systems can be achieved through the strategic use of additives. This study examines the impact of trehalose, myo-inositol, and phytic acid on lipase structure and oil degradation efficiency in a microemulsion composed of isooctane, sodium salt, dioctyl sulfosuccinate (AOT), n-butanol, and water. Kinetic analyses reveal that lipase-catalyzed olive oil decomposition in microemulsions containing these additives follows a "ping-pong" mechanism, incorporating steps for inactivation by oleic acid and time-dependent enzyme deactivation.

MODULATION OF TRAMETES VERSICOLOR LACCASE ACTIVITY WITH SODIUM SULFATE AND ITS POTENTIAL APPLICATION IN THE DEGRADATION OF NAPHTHOL GREEN

Ludmila Aricov

Institute of Physical Chemistry, Romania

Abstract

The increasing interest in using fungal laccase (Lc) in biotechnology comes from its ability to oxidize various harmful substances in wastewater, like synthetic dyes, pesticides, and pharmaceuticals. The use of laccases for the biodegradation of aqueous contaminants involves disadvantages, including high production costs, low activity under extreme environmental circumstances, vulnerability to proteolysis, and inactivation, making Lc treatment economically unfeasible. Certain adverse effects can be mitigated by the application of activity modulators. To modulate the enzymatic activity of Lc during the decomposition of naphthol green (NG), we used sodium sulfate. This salt was selected due to its high presence in textile wastewater. The decomposition reaction of NG in the presence of Lc and sodium sulfate adheres to Michaelis-Menten kinetics, and the salt functions as a non-essential activator. The activation process of Lc involves a significant increase in enzymatic activity in the presence of sodium sulfate. The interaction between Lc and sodium sulfate followed a nonlinear model, which means that the level of reaction rate enhancement is activator concentration dependent.

EFFECTS OF X-RAY EXPOSURE ON THE OPTICAL BEHAVIOR OF TM IONS IN CAF2:TMF3

Carla Schornig Zeicu

West University of Timisoara, Romania

Abstract

Valence state manipulation in rare-earth doped fluoride crystals has become a central theme in the development of advanced photonic materials, scintillators, and solid-state dosimeters. Among these, the charge-state conversion between Tm^{3+} and Tm^{2+} under ionizing radiation is particularly intriguing due to the distinct optical properties of Tm^{2+} [2]. While previous studies have reported the formation of Tm^{2+} centers in CaF_2 and related hosts, a systematic investigation of how dopant concentration influences their spectral behavior, formation dynamics, and stability remains incomplete. This work presents a detailed study of X-ray-induced enhancement of Tm^{2+} absorption in CaF_2:TmF_3 single crystals at three representative doping levels: 0.1, 1, and 5 mol%. The evolution of Tm^{2+}-related absorption bands was tracked via UV-VIS spectroscopy before and after irradiation. Distinct spectral features attributed to Tm^{2+} centers and radiation-induced color centers were observed in the 190–210 nm, 290–330 nm, and 390–420 nm regions. At low doping (0.1 mol%), the Tm^{2+} absorption increased moderately during irradiation and remained stable over time. At 1 mol%, the Tm^{2+} bands intensified more strongly, followed by a gradual exponential decrease. In the 5 mol% sample, the Tm^{2+} absorption reached saturation and persisted without significant loss for over 20 days post-irradiation. Kinetic modeling based on exponential fitting functions provided good agreement with the experimental trends, confirming both the reproducibility of the X-ray-induced optical behavior and the key role of dopant concentration in modulating the charge-state response of Tm ions.

TOBACCO, TOBACCO PRODUCTS AND WASTE VALORIZATION OPPORTUNITIES

Peya Karova[1]*, Ivanka Hambarliyska[2], Tanya Ivanova[3], Venelina Popova[3], Anton Slavov[2]

[1]Department of Microbiology and Biotechnology, University of Food Technologies, 26 Maritza Blvd., 4002 Plovdiv, Bulgaria

[2]Department of Organic Chemistry and Inorganic Chemistry, University of Food Technologies, 26 Maritza Blvd., 4002 Plovdiv, Bulgaria

[3]Department Technology of Tobacco, Sugar, Vegetable and Essential Oils, University of Food Technologies, 26 Maritza Blvd., 4002 Plovdiv, Bulgaria

Abstract

Tobacco holds huge potential as a source of bioactive compounds, edible proteins, terpenoids, antioxidants and other active components beyond the mass production of cigarettes and other smoking products. Tobacco production and processing generate a large amount of waste and by-products, such as flower buds and seeds, stems, stalks, and leaves. Waste like cigarette butts has significant role in the environment pollution globally. Implementing sustainable and circular economy-oriented methods to the whole chain of tobacco life (harvesting – processing – usage – waste) is crucial to minimize litter and pollution and to fully valorize the plant. The value of tobacco is high in the pharmaceutical industry due to its chemical components. Tobacco is the richest source of solanesol, which is a key intermediate in coenzyme Q10 and vitamin K2 synthesis. Derived compounds of tobacco include alkaloids (anabasine, anatabine, nicotine, nicotine derivatives), phenolic compounds (chlorogenic acid, scopoletin, rutin), cellulose, and pectin. The phytoremediation feature of tobacco should be highlighted as a powerful method for soil detoxification. Furthermore, tobacco could be used for natural pesticides and biocontrol agents production. Many studies point out opportunities for bioenergy produced by tobacco waste. Recycling cigarette butts is researched and worked on. Challenges include toxicity management. As governments all over the world take measures to minimize smoking due to its health risks, tobacco farmers should seek opportunities for the realization of their harvest in other industries.

Keywords: *tobacco, tobacco waste, tobacco by-products, tobacco valorization, phytoremediation, cigarette butts, solanesol, circular economy*

Acknowledgements

We acknowledge the financial support from the National Science Fund of Bulgaria; project КП-06-Н87/13 from 06.12.2024 "Complex valorization of by-products and waste from the tobacco industry".

RECENT TRENDS IN CRAFT BREWING – MINI REVIEW

Aleksandar I. Ivanov*, Georgi A. Kostov

Department of Wine and Beer Technology, University of Food Technologies, 26 Maritsa Boulevard, 4002 Plovdiv, Bulgaria

Abstract

Craft brewing has been developing at a very rapid pace in the last decade, being a major driving force behind innovation and diversity in the brewing industry. This publication examines the main trends in the development of craft brewing, paying attention to the new styles of beer offered on the market, the development of technology, and sustainable practices. In addition, new methods for controlling the main technological processes – mashing, brewing, fermentation, etc. – are being sought and imposed in production. Special attention is paid to market dynamics, as well as consumer preferences.

Keywords: *craft brewing, trends, new beer styles*

Acknowledgments

This work was supported by the project "E-learning tools for food technology and development education (E-FOOD)", financed by ERASMUS+ program, KA 2, project №: 2022-1-BG01-KA220-HED-000085089

PROCESS OPTIMIZATION AND TECHNOLOGICAL CHALLENGES IN CRAFT BEER PRODUCTION

Aleksandar I. Ivanov[1]*, Georgi A. Kostov[2]

[1] Department of Wine and Beer Technology, University of Food Technologies, 26 Maritsa Boulevard, 4002 Plovdiv, Bulgaria

[2] Department of Wine and Beer Technology, University of Food Technologies, 26 Maritsa Boulevard, 4002 Plovdiv, Bulgaria

Abstract

The growing craft beer industry is characterized by its emphasis on product diversity, traditional brewing methods, and innovation in flavor and style. However, this artisanal approach presents significant technological and operational challenges, particularly in maintaining quality, process consistency, and sustainability. This study examines critical aspects of craft beer production, focusing on the optimization of brewing processes across diverse beer styles. Key challenges identified include variability in raw materials, fermentation control, and the scalability of production without compromising sensory quality. Strategies for addressing these challenges are reviewed, including advanced monitoring systems, yeast management, and sustainable process interventions.

Keywords: *craft brewing, optimization, mashing, fermentation*

Acknowledgments

This work was supported by the project “E-learning tools for food technology and development education (E-FOOD)”, financed by ERASMUS+ program, KA 2, project №: 2022-1-BG01-KA220-HED-000085089

E-LEARNING TOOLS FOR FOOD TECHNOLOGY AND DEVELOPMENT EDUCATION (E-FOOD) – CASE STUDY DEVELOPMENT AND EVALUATION

Rositsa Denkova-Kostova

University of Food Technologies, Bulgaria

Abstract

The aim of the present work is to present the main elements of the development of a Case study and the stage of its evaluation. Through an analysis of existing programs and activities, content for the development of a Case study and elements for its evaluation have been developed. The development of a Case study and its evaluation are carried out in a virtual environment using cloud technologies and conducting webinars and workshops between mentors and teams.

E-LEARNING TOOLS FOR FOOD TECHNOLOGY AND DEVELOPMENT EDUCATION (E-FOOD) – DATABASES, TRAINING MATERIALS AND E-RAPID TOOLS FOR TRAINING

Georgi Kostov

University of Food Technologies, Bulgaria

Abstract

The aim of the work was to present the developed databases, training materials and e-rapid tools for training students within the framework of the E-learning tools for Food technology and development education (E-Food) project. Through an analysis of existing training platforms, the project offers a new approach based on the development of unique training content in the field of food technology, databases through which information filtering can be applied. A new element in training is the development of the so-called e-rapid tools of training materials, through which short-term training of students and specialists in an electronic environment can be implemented.

ARTIFICIAL INTELLIGENCE (AI) DRIVEN ADAPTIVE COMBUSTION FOR ENERGY-EFFICIENT COMMERCIAL GAS COOKING OVEN

Murat Hacı[1], Zafer Kahraman[1*], Remzi Timur[1], Kadir İçibal[1], Hakan Serhad Soyhan[2,3]

[1]Öztiryakiler Madeni Esya San. Ve Tic. A.S, R&D Center, Istanbul 34500, Türkiye

[2]Sakarya University, Department of Mechanical Engineering, Esentepe Camp,Sakarya 54050, Türkiye

[3]Team-San Ltd. Sti., Esentepe Campus, Sakarya University, Sakarya 54050, Türkiye

Abstract

Large-scale gas-fired ovens used in the food industry are among the major energy consumers and contributors to carbon emissions in commercial kitchens. This study presents the development of a novel commercial gas cooking oven prototype that integrates adaptive combustion technology with artificial intelligence (AI) for improved performance, energy efficiency, and environmental sustainability. The prototype dynamically regulates combustion under varying operational and climatic conditions by leveraging real-time data from multiple sensors and advanced AI algorithms. This system improves fuel efficiency and significantly reduces carbon emissions, supporting the transition toward sustainable commercial kitchen practices.

Keywords: *commercial gas cooking oven, adaptive combustion, Artificial Intelligence (AI), energy efficient*

Acknowledgments

This study was prepared from the project studies numbered 3245026 within the scope of TÜBİTAK TEYDEB 1707 coded Order-Based R&D Projects Support Program. We would like to thank TÜBİTAK-TEYDEB Transport, Defence, Energy and Textile Technologies Group (USETEG) for contributing to the project.

USE OF ARTIFICIAL INTELLIGENCE METHODS IN THE SELECTION OF VARIABLE TENSION PULLEY DIAMETER IN BELT PULLEY MECHANISMS

Serkan Beller

Department of Natural Gas and Fitting Technology, Vocational School of İmamoğlu, Çukurova University, Adana 01790, Turkey

Abstract

Belt pulley systems transfer power and motion from shaft to shaft via a flexible, bendable belt wrapped around pulleys. The flexibility and bendability of the belt prevent the negative effects, such as vibration and impact, that may occur on one shaft from being transferred to the other shaft. Power transmission occurs through the friction (force) bond between the belt and the pulley. There may be slippage between the belt and the pulley during moment increases. While this provides an advantage in that sudden load increases are not transmitted to the motor shaft, it provides a disadvantage in that it does not provide a constant rotation ratio. Other disadvantages of these mechanisms are that permanent elongation occurs in the belt over time, and tensioning systems are needed to eliminate the looseness. In addition to these disadvantages, the shaft bearings are strained due to the forces exerted by the arms pressing the belt against the pulley, and the power transmission is limited by the belt's strength. In this study, a group of pulleys consisting of different diameters was used as a tension pulley as an alternative to weighted or spring tension pulleys. Different amount of weights that have different distances from the main pulley (Driven pulley) hub were tested with different rotation speeds and tension pulleys with different diameters in the experimental set. In addition, the resulting main pulley rotation numbers were tried to be estimated by artificial intelligence methods too. Thus, by ensuring minimum slippage with the most suitable tension pulley diameter, an attempt was made to prevent possible strain on the shaft bearing and belt.

Keywords: *belt pulley mechanisms, tension pulley, artificial intelligence, GRNN, ANFIS*

Acknowledgments

The Scientific Research Projects Unit of Çukurova University supported the present work. Project ID: 16425.

INTEGRATION OF VIRTUAL AND AUGMENTED REALITY IN NEUROSURGICAL EDUCATION AND PRACTICE

Michal Filip

University of Ostrava, Czech Republic

Abstract

Virtual reality and augmented reality are innovative technologies that significantly enhance the teaching of surgical techniques. In the simulation of surgical procedures, we integrate immersive virtual reality with the cognitive-motor dual-tasking method, similar to its application in rehabilitation. Augmented reality merges the physical world with digital information and is increasingly being utilized in neurosurgical planning, enabling, for example, the synchronization of robotic systems with virtual reality imaging in brain and spinal surgeries. Initial experiences with surgical training, incorporating four modules utilizing these technologies, demonstrate improved visualization of anatomical structures and enhanced student motivation through real-time feedback from instructors. Preliminary data also suggest a reduced learning curve and lower error rates, contributing to increased patient safety, both of which are currently being validated within the project. Virtual and augmented reality represent a significant advancement in medical education and clinical practice.

Acknowledgment

This project was supported by the Just Transition Operational Program of the State Environmental Fund of the Czech Republic as part of the LERCO project CZ.10.03.01/0 0/22_003/0000003.

ADVANCING DIAGNOSTIC ACCURACY: INTEGRATING AI INTO MEDICAL PRACTICE

Saliha. Berrached, Kadda. Boumedienne

University of Science and Technology of Oran Mohamed-BOUDIAF, El Mnaouar BP 1505, Bir El Djir, Oran 31000, Algeria

Abstract

The integration of Artificial Intelligence (AI) into medical diagnostics marks a transformative shift in healthcare delivery. AI technologies, particularly machine learning and deep learning algorithms, have demonstrated remarkable potential in improving diagnostic accuracy across various specialties, from radiology to pathology. By analyzing complex datasets and recognizing subtle patterns often imperceptible to the human eye, AI systems can assist clinicians in detecting diseases earlier and with greater precision.
This research explores how AI is currently being adopted in clinical workflows, the benefits it offers in enhancing diagnostic reliability, and the challenges associated with its implementation, including issues of data privacy, algorithmic transparency, and clinician trust. Real-world case studies highlight successful applications, while future perspectives suggest that AI will not replace physicians but rather empower them, leading to a new era of augmented medical decision-making. Ultimately, the thoughtful integration of AI has the potential to significantly elevate patient care and outcomes. Our work aims to enhance the process of identifying some specific diseases on medical images by employing a series of techniques for object detection and automatic segmentation to make precise decision.

Keywords: *AI, machine learning, deep learning, medical diagnostics, decision-making*

AUTOMATED PRICING FOR INDUSTRIAL GOODS USING FUZZY LOGIC

Mario Thron[1], Marian Witte[2], Giuliano Persico[2]

[1] Institut f. Automation und Kommunikation e.V., Werner-Heisenberg-Str. 1, 39106 Magdeburg, Germany

[2]Demag Cranes & Components GmbH, Ruhrstraße 28, 58300 Wetter, Germany

Abstract

Pricing complex industrial products often involves manual assessment of dynamic factors such as factory load, regional purchasing power, and customer success rates. This paper proposes an automated solution for the final pricing stage, integrating manufacturer and customer-specific conditions using a Service-Oriented Architecture (SOA). Real-time data from ERP systems and MES is processed via web services, while fuzzy logic formalizes expert knowledge into pricing rules. Sales engineers input basic case characteristics, and the system dynamically computes the price factor. An open-source implementation of IEC 61131-7 for fuzzy control programs demonstrates feasibility, showing that automation enhances decision-making, supports knowledge transfer, and offers flexibility for future integrations.

Keywords: *Sales Management, Fuzzy Logic, Pricing, Configurable Industrial Goods*

Acknowledgments

This work was supported by the ITEA3 programme, within the EUREKA Cluster ITEA, and funded by the German Federal Ministry of Education and Research (BMBF) under grant number FKZ 01IS21084 (InnoSale).

OPTIMISED 5G NETWORK SUB-SLICING ORCHESTRATION (ONSSO) IN A FULLY VIRTUALISED SMART COMPANY USING MACHINE LEARNING

Abimbola Efunogbon*, Enjie Liu

Faculty of Creative Arts, Technologies & Science, University of Bedfordshire, United Kingdom

Abstract

This paper presents a novel framework for optimal 5G network sub-slicing orchestration in a fully virtualised smart company environment using machine learning. As 5G networks evolve to support diverse applications with varying quality of service (QoS) requirements, traditional static slicing approaches struggle to efficiently allocate resources. Our proposed AI-driven orchestration model, ONSSO, dynamically optimizes sub-slices by analysing real-time traffic patterns, latency constraints, and resource availability.

By integrating this ML-based framework with a sub-sliced model, we streamline mobile network provider services, enabling seamless and intelligent network management. This approach ensures efficient resource utilisation, improved service differentiation, and enhanced scalability. Simulation results demonstrate that our model enhances network efficiency by up to 25% compared to conventional slicing techniques while reducing operational overhead. This work contributes to the advancement of intelligent network automation, enabling future-ready smart enterprises in the era of 5G and beyond.

Keywords: *5G, network slicing, sub-slicing, orchestration, machine learning, AI, virtualization, mobile network services*

DIGITALIZATION OF THE TREE MARKING OPERATION AND C STOCK ESTIMATION IN THE FOREST USING RFID TECHNOLOGY

Dorin Florențiu Palie*, Laura Bouriaud

Stefan cel Mare University of Suceava, Romania

Abstract

Over the past decade, the specialized literature has highlighted a series of relevant findings regarding the use of RFID (Radio Frequency Identification) technology in various forestry-related fields. In this context, a systematic assessment of the applicability of this technology is necessary in order to determine the extent to which it can be effectively integrated into forest management practices in Romania, particularly in timber marking and tracking operations.

This research is justified by the urgent need to modernize the forestry sector, which cannot remain competitive without embracing emerging digital technologies. Failure to adapt may lead to dysfunctions and security breaches in the supply chain. Verifying the origin of harvested wood within the value chain represents a major challenge, given the limitations and vulnerabilities of classical tree marking methods, which are often inefficient and easy to tamper with. In this context, radio frequency identification (RFID) technology could be a promising alternative, with the potential to enhance transparency and efficiency in the management of forest wood resources.

The experiment was conducted in a production forest located in the Eastern Carpathians, Romania. Two different RFID tag application systems - manual and pneumatic - were tested under real conditions over two growing seasons as well as during the dormant season, analyzing work time, reading distances, mechanical resistance, and cost-effectiveness.

After two years of monitoring, the results indicate that 98% of the tags remained functional, demonstrating the potential of RFID technology to increase transparency in timber traceability, reduce illegal logging, and improve forest management. The study also addresses the challenges and limitations of implementing RFID in forestry, offering recommendations for decision-makers, future research directions, and opportunities for integration with existing digital solutions in Romania.

Keywords: *marking standing trees, RFID technology, wood, forestry activities*

Acknowledgments

This research was carried out within the framework of the WILDCARD project - Effects of rewilding in forests and agricultural lands on carbon sequestration and diversity, Call HORIZON-CL5-2022-D1-02. Grant Agreement: 101081177.

INSECT DAMAGE DETECTION IN CORN LEAF USING YOLOV10 MODELS: A TRANSFER LEARNING APPROACH

Suresh Timilsina[1,2], Sandhya Sharma[1], Biplove Pokhrel[3], Pradip Aryal[2], Kazuhiko Sato[1], Yoshifumi Okada[1], Shinya Watanabe[1], and Satoshi Kondo[1]*

[1] Muroran Institute of Technology, 27-1 Mizumoto-cho, Muroran, Hokkaido 050-8585, Japan

[2] Tribhuvan University, IOE, Pashchimanchal Campus, Pokhara, Gandaki Province, Nepal

[3]Pokhara University, Gandaki College of Engineering and Sciences, Gandaki Province, Nepal

Abstract

Insect pests affecting corn leaves are significant contributors to agricultural losses. Despite corn being a globally consumed food crops, there is lack of research on the automated identification of these pest's damage, which limits farmers` ability to implement effective control measures. This research aims to fill these gaps by implementing various YOLOv10 architectures (10n, 10s, 10m, 10l, 10x) for the automated identification and localization of insect pests on corn leaves. A total of 1,391 images of highly affected corn leaves from Pokhara, Nepal, were collected, showing damage from grasshoppers and fall armyworms. The collected images were imposed 5-fold cross validation and split dataset into Train, Valid, Test in a ratio of 3:1:1 being fed into various architectures. Among the pest detection models tested, YOLOv10x outperformed the others in terms of mean average precision (mAP50 = 0.799) at a IoU threshold of 50%. Regarding the Precision-Recall (PR) relationship Yolov10m has balancing nature of highest precision (Precision= 0.808) with high recall value (Recall= 0.807), this trend is not followed by Yolov10l and Yolov10x. In terms of latency, YOLOv10n required the least average time to detect each image during testing, making it the most lightweight model among those tested. The central tendency of Yolov10m is highest among all Yolov10 variants with decent spread box over inter-quartile range. This research is valuable for farmers in detecting insect pests on corn leaves, enabling timely implementation of measures to reduce agricultural damage caused by pests. We also recommend optimizing the architectures to enhance the precision of pest detection.

Keywords: *Corn; Insect damage; Object Detection; Yolov10*

Acknowledgements

We extend our appreciation for the assistance supported through the Project Based Learning-AI (PBL AI) program and the Ministry of Education, Culture, Sports, Science, and Technology (Monbukagakusho: MEXT) scholarship awarded to Suresh Timilsina and Sandhya Sharma. We are deeply grateful to Anup Neupane, Sarmila Gautam, Ashok Adhikari, Samit Poudel, Santosh Panth and Arjun Awasthi for their invaluable assistance in data collection in the field.

DISTRIBUTION OF THE NUMBER OF FOGGY DAYS IN THE TERRITORY OF GEORGIA

[1;2]Mikheil Pipia, [1]Elizbar Elizbarashvili, [2]Avtandil Amiranashvili, [1,3]Nazibrola Beglarashvili, [2]Nino Jamrishvili

[1]Institute of Hydrometeorology of Georgian Technical University

[2]Mikheil Nodia Institute of Geophysics of Ivane Javakhishvili Tbilisi State University

[3]Samtskhe-Javakheti State University

Abstract

Heavy fog reduces the visibility to 50 meters and more, thereby negatively affecting the normal functioning of all types of transport (land, air). It also negatively affects the normal thermoregulation processes in living organisms (including the human body).

The paper discusses such a dangerous and unfavorable meteorological phenomenon as fog, which negatively affects the economy of Georgia and the economic activities of the population. According to the data of 44 meteorological stations, covering the years 1993-2022, the distribution of one of the climatic characteristics of this phenomenon - the average and maximum number of days - has been determined by the regions of Georgia and the corresponding geoinformation map has been compiled. The number of foggy days has been determined by seasons and months.

The results obtained will allow the relevant services to develop a methodology that will help reduce the risks caused by heavy fog in both land and air transport and implement preventive measures.

Keywords: *fog, meteorology phenomena, climatology*

Acknowledgments

This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG), Grant number - FR-22-2882.

MATHEMATICAL MODEL FOR PREDICTION OF OZONE CONCENTRATION IN THE SOUTHEASTERN REGION OF EUROPE, USING RECURSIVE LEAST SQUARES FILTER (RLS)

Gabriel Murariu[1,2], Sorin Frasina[1,4], Iulian Racoviță[1], Corneliu Doroftei[3*], Fetecău Cătălin[4,5]

[1]Chemistry, Physics and Environment Department, Faculty of Sciences and Environment, Dunarea de Jos University of Galati, Galati, Romania

[2] Rexdan - Research and innovation infrastructure, 98 Cosbuc Boulevard, Galati, Romania

[3]Science Research Department, Institute of Interdisciplinary Research, Research Center in Environmental Sciences for the North-Eastern Romanian Region (CERNESIM), Alexandru Ioan Cuza University of Iasi, Iasi, Romania

[4]Manufacturing Engineering Department, Faculty of Engineering, Dunarea de Jos University of Galati, Galati, Romania

[5]Polymer Processing Center of Excellence (CE-PP), Faculty of Engineering, Dunarea de Jos University of Galati, Galati, Romania

Abstract

Ground-level ozone (O_3) plays an important role in controlling the atmospheric oxygen budget at ground level. In this way, the mechanism and role played by O_3 could be deciphered and especially how it affects the environment and causes serious health disorders. Ozone gas, being one of the well-known greenhouse gases, directly contributes to the phenomenon of global warming. In this study, we present a predictive model for ozone concentrations measured in the period 2017 – 2024 at ground level in a national network of monitoring stations. The model is based on a statistical approach to measurements from 152 automatic measurement points, with an hourly resolution. The analysis carried out allowed the construction of a mathematical model in order to make an effective prediction. The algorithms used were of the Recursive least squares filter type.

It was found that the model for daytime concentrations depends linearly on the ratio of NO_2 and NO concentrations, while for the night period it was shown that this concentration would be inversely proportional to the NO_2 concentration. Finally, aspects regarding the prediction possibilities using Recurent Neural network structures are presented for comparison.

Keywords: *ozon, algorithm, RLS, statistical analysis*

OPTIMIZATION OF HYPERNEURONAL STRUCTURES

Alexander N. Sychev

Riga, Latvia

Abstract

The paper describes the principles of constructing a cascade neural structure using Walsh spectral representations. The method of tangent stratification of the definition space of a logical function for efficient optimization of the structure is explained. Solutions are proposed that reduce design costs.

Keywords: *tangent bundle, neuron, Walsh spectral representations*

UNCERTAINTY AND RISK IN CONSTRUCTION SCHEDULES AND COST ESTIMATES IN BIM METHODOLOGY

Magdalena Rogalska

Lublin University of Technology, Poland

Abstract

This work aims to develop and verify the mathematical basis of a model that allows for the probabilistic quantification of the total life cycle costs of buildings using probabilistic cost estimation, scheduling, risk analysis, service life studies, and the selection of probability density functions for costs, construction times, and the service life of buildings and their components. Section 8.3 of ISO 15686-5 requires calculations to be performed using statistical methods such as Monte Carlo analysis. The results of the calculations should be reported with probabilities of 10%, 50% and 90%. Statistical calculations can be performed after determining the probability density distributions of cost estimates. Calculations using Risky Project Professional software were proposed.

EUROPEAN DIGITAL IDENTITY WALLET – A CONVENIENCE OR A BURDEN FOR MODERN MAN?

Katarzyna Tomaszewska

Research Centre for Legal and Economic Problems of Electronic Communication, Faculty of Law, Administration and Economics, University of Wroclaw, Poland

Abstract

Entry into force of Regulation (EU) 2024/1183 of the European Parliament and of the Council of 11 April 2024 amending Regulation (EU) No 910/2014 as regards the establishment of a European framework for digital identity Official Journal of the European Union L, 2024/1183, 30.4.2024 - eIDAS 2) entailed changes in the area of electronic identification. It established the obligation for each Member State to set up a European Digital Identity Wallet, an electronic identification means that enables the user of an application to securely store, validate, and manage the data that identifies them and the credentials of the attributes they possess (Article 2, point 3, letter j, eIDAS 2). The primary objective of this study is to assess the advantages and disadvantages of this technological solution, considering the relevant legal regulations. This will enable us to determine whether the electronic identification means in question will be perceived as a convenience to modern individuals or, conversely, as a burden once it is introduced to the general public.

Keywords: *European digital identity wallet, electronic identification, identity, electronic services*