PolymerTalent 2025

International Seminar on Polymer Materials in Environmental and Climate Protection

International Seminar on Polymer Materials in Environmental and Climate Protection

Organizer:

CENTRE OF POLYMER AND CARBON MATERIALS
POLISH ACADEMY OF SCIENCES

Zabrze, 17 July, 2025

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70th Anniversary of Centre of Polymer and Carbon Materials, Polish Academy of Sciences „History and Present Day”

The **Centre of Polymer and Carbon Materials of the Polish Academy of Sciences (CMPW PAN)** has a rich history dating back to 1954 when the Institute of Organic Chemistry of the Polish Academy of Sciences in Warsaw established a Petrochemical Laboratory in Gliwice, which works mainly focused on petroleum as an energy and chemical raw material. The rapid increase in interest in carbon properties, structure and its processing products meant that in 1970 this institution was transformed into Institute of Petro- and Carbochemistry of the Polish Academy of Sciences in Gliwice headed by Prof. Włodzimierz Kisielow (later the Institute of Carbochemistry). The growing need for the development of semiconductor-based electronics and the necessity to advance research on renewable energy sources were the foundation for the establishment of the Department of Solid State Physics of the Polish Academy of Sciences in Zabrze in 1967, organized by Professor Jerzy Kołodziejczak. Almost simultaneously, in 1968, the Institute of Polymers of the Polish Academy of Sciences was established (later the Centre of Polymer Chemistry), initially in Gliwice and later in Zabrze under the direction of Prof. Zbigniew Jedliński. This scientific institution conducted basic and applied research on polymer materials.

In the early 1990s, the research topics of the Institute of Carbochemistry gradually changed towards research on various types of carbon materials and new polymer materials with controlled structure, and studies of their synthesis, modification and properties. The research conducted at that time in Centre of Polymer Chemistry of the Polish Academy of Sciences focused on biodegradable polymers for applications in medicine, the packaging industry and environmental protection, as well as bioresorbable polymers for medical purposes, mainly as drug carriers. In 1999, the Department of Solid State Physics of the Polish Academy of Sciences was incorporated into the Centre of Polymer Chemistry of the Polish Academy of Sciences, which enabled the extension of the scope of research conducted at the Centre to new polymers with potential applications in electronics and optoelectronics.

Over the years, the research topics of the Centre of Polymer Chemistry and the Institute of Carbochemistry began to converge, focusing on various aspects of material research. The growing importance of interdisciplinary research, using the achievements of various scientific disciplines and creating new directions of science and technology, has resulted in merger of the Centre of Polymer Chemistry and the Institute of Carbochemistry in **2007** into the **Centre of Polymer and Carbon Materials** of the **Polish Academy of Sciences**. In 2011, the established Centre was granted the status of an Institute of the Polish Academy of Sciences conducting interdisciplinary research on polymer and carbon materials, their synthesis, properties, and applications.

Today, CMPW PAN continues to be a leading research institution, contributing to advancements in polymer chemistry, polymer and carbon materials for biomedical, electronic and environmental applications. It plays a crucial role in scientific innovation, serving as the basis for cooperation with universities, industries and international research centers.

The Centre of Polymer and Carbon Materials of the Polish Academy of Sciences conducts research within five laboratories actively engaged in cutting-edge research in polymer science and carbon-based materials.

The **Laboratory of Nano- and Microstructural Materials** carry out studies focused on:

- application of living and controlled polymerization methods
- controlled synthesis of amphiphilic polymers
- syntheses and studies of the properties of star and branched polymers
- self-assembly of amphiphilic polymers in an aqueous environment, including polymers with a non-linear structure of a macromolecule

- polymers reacting to environmental stimuli ("smart polymers"), primarily in the aspect of biomedical applications
- nanolayers of polymers of different composition and topology, covalently bonded to a solid substrate, with potential applications, m.in. in tissue engineering, and as antifouling and antibacterial materials.

The Laboratory have experience in the implementation of national and international research projects, including projects financed under the "Innovative Economy" Programme, projects of the VII Framework Programme of the European Union, the Applied Research Programme of the National Centre for Research and Development, research projects of the National Science Centre and others.

The **Laboratory of Biodegradable Materials** conducts research in the field of:

- synthesis of polyhydroxyalcanoate analogues, among others by anionic polymerization of β-lactones
- synthesis of aliphatic biopolyesters for applications in medicine and cosmetology
- applications of multi-stage mass spectrometry in the study of the structure of (co)polyesters and the mechanisms of polyreactions and (bio)degradation of polymers
- processing and modification of the properties of biodegradable polymer materials, as well as studies of the relationship between the structure and the properties and biodegradation of new polymer materials and composites.

The Laboratory cooperates with national and European research centers and has experience in the implementation of national and international research projects.

Research topics of **Laboratory of Carbon and Polymer-Carbon Materials** consists of:

- functionalization and characterization of carbon structures for the development of advanced multifunctional materials, including as active materials in electronic components, active elements of photodetectors or sensors, energy storage systems, as well as in the role of thermoelectric materials
- synthesis, modification and characterization of carbon nanomaterials (carbon nanotubes, carbon nanofibers, and graphene materials, including 3D structures) decorated with nanoparticles of transition metal oxides and spinels, and determining the effect of their chemical composition and architecture on sensory properties and electromagnetic radiation absorption capacity
- developing and characterizing multifunctional polymer matrix composites using carbon materials as nano- and microfillers, studies of the relationships between the structure and distribution of carbon fillers and the properties of polymer composites
- development of methods for producing and characterizing porous carbon materials from polymer precursors.

The Laboratory maintains collaborative partnerships with national and European research institutions and possesses extensive experience in the execution of national and international research initiatives.

The research of **Laboratory of Polymer Biomedical Materials** focuses on the topics:

- synthesis and characterization of bioresorbable polymers with a designed chain microstructure
- development, preparation and characterization of bioresorbable, polymeric controlled drug release systems
- development, preparation and characterization of polymer materials for medical applications
- production of filament intended for 3D printing (medical grade)
- characterization of biological properties of polymeric materials intended for medical and pharmaceutical applications.

The Laboratory is successful in commercial implementations, as evidenced by numerous patents and finalized implementations of technological solutions in the fields of exact and natural sciences and engineering and technology.

The research topics of **Laboratory of Functional Materials Engineering** are focused on:

- determining the influence of the chemical structure of new materials, both small-molecule compounds and polymers, on their properties that define their potential applications in organic optoelectronics, photonics, or as modern membrane materials
- the synthesis of functional materials and their advanced characterization
- the modification of the chemical structure of the obtained compounds to achieve desired properties (optical, electrical, mechanical and separation), based on the principles of molecular and supramolecular engineering

- obtaining thin layers, blends or composites containing molecularly dispersed appropriate compounds intended for use as components of active layers in organic optoelectronic devices such as: photovoltaic cells, field-effect transistors, and light-emitting diodes, as well as in layers organizing liquid crystals, materials exhibiting a photomechanical effect, and materials for gas separation membranes, also controlled by light.

Moreover, CMPW PAN has the **Independent Microscopy Team** carrying out research on polymer and carbon materials using the following methods:

- Transmission Electron Microscopy (TEM)
- Scanning Electron Microscopy (SEM)
- Atomic Force Microscopy (AFM).

The Centre conducts extensive scientific cooperation with both domestic and international institutions (universities, research institutes, and European Academies of Sciences). Currently, research works are being carried out in collaboration with institutions from England, Bulgaria, Belgium, Romania, Czech Republic, Slovakia, and Ukraine. Researchers from various parts of the world work at CMPW PAN, and the Center itself holds the HR Excellence in Research logo.

PROGRAM

Thursday, 17 July, 2025

9:00 – 9:30 Registration

9:30 – 9:40 Welcome Address

Morning Session (Chair: Prof. G. Adamus / Dr. K. Filus)

9:40 – 10:15 **Prof. I. Radecka**
University of Wolverhampton, School of Pharmacy and Life Sciences, Faculty of Science & Engineering
"From Trash to Treasure – Role of Microbes in the Circular Economy"

10:15 – 10:30 **R. Mattsson**, M. Hakkarainen
Department of Fibre and Polymer Technology, KTH Royal Institute of Technology, Stockholm, Sweden
"*Photocurable Double Dynamic Polyester Resins with Circular End-Of-Life"*

10:30 – 10:45 **I. Anastasova**, P. Tsekova, M. Ignatova, O. Stoilova
Laboratory of Bioactive Polymers, Institute of Polymers, Bulgarian Academy of Sciences, Sofia, Bulgaria
"Hybrid Electrospun Poly(L-Lactide-co-D,L-Lactide) Materials with Antioxidant and Photocatalytic Properties"

10:45 – 11:00 **A. Thakur**, K. Duale, M. Musioł, M. Kowalczuk
Centre of Polymer and Carbon Materials, Polish Academy of Sciences, M. Curie-Skłodowskiej 34, 41-800 Zabrze, Poland and Joint Doctoral School, Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, Poland
"Mechanical Impact of Yerba Mate Waste Fillers in PHBV Biocomposites"

11:00 – 11:15 **Z. Mansoor**, F. Tchuenbou-Magaia, G. Manning, I. Radecka, H. Khan
Faculty of Science and Engineering, University of Wolverhampton, Wolverhampton WV1 1 LY, UK
"Application of Bacterial Cellulose Developed from Waste Materials, as Mulch Film for Sustainable Agriculture"

11:15 – 11:30 **R. Stříž**, I. Minisy, P. Bober, O. Taboubi, J. Smilek, A. Kovalcik
Faculty of Chemistry, Brno University of Technology, Czechia
"Exploring Conductive Biopolymer Composites: From Environmental Remediation to Biomedical Potential"

11:30 – 12:00 Coffee Break & Poster Session

12:15 – 12:35 **Dr. K. Filus**
Institute of Theoretical and Applied Informatics, Polish Academy of Sciences
"Transforming Science with Artificial Intelligence: A Beginner's Guide"

12:35 – 13:35 **Dr. K. Filus**
Institute of Theoretical and Applied Informatics, Polish Academy of Sciences
"Artificial Intelligence for Scientists: Using Generative Models for Research and Data Analysis – AI Practical Workshops"

13:35 – 14:30 Lunch Break

Afternoon Session (Chairs: Prof. I. Radecka / Prof. M. Kowalczuk)

14:30 – 15:20 Poster Session

15:20 – 15:35 **M. Medrihan,** B. C. Condurache, M. Ignat, V. Harabagiu
"Petru Poni" Institute of Macromolecular Chemistry, Iasi, Romania
"Modified Silica Functionalized with 1,3,5-Trione as a Potential Inorganic Cation Catcher"

15:35 – 15:50 **K. Walkowiak**, S. Paszkiewicz
West Pomeranian University of Technology, Department of Materials Technology, Al. Piastow 19, 70-310 Szczecin, Poland
"Integrated Experimental and Mathematical Approaches for Exploring Chemical Modifications of Furan-Based Polyesters"

15:50 – 16:05 **N. Konios**, D. Pathiwada, Z. Kroneková, J. Mosnáček
Polymer Institute, Slovak Academy of Sciences, Dúbravská cesta 9, 845 41 Bratislava, Slovakia
"Poly(2-isopropenyl-2-oxazoline) Brushes Grown from Silica Substrates via Surface Initiated Photochemically Induced Atom Transfer Radical Polymerization (SI-photoATRP)"

16:05 – 16:20 **N. Mehta**, B. Kozielska
Department of Air Protection, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Gliwice, Poland
"Characterization and exposure assessment of indoor microplastics in hospital indoor settled dust: First insides from India"

16:20 – 16:35 **B. Dave**, E. Łobos-Moysa
Department of Water and Wastewater Engineering, Faculty of Environmental Engineering, Mining and Energy
"Microbial Degradation Strategies for Emerging Pollutants: A Platform for Future Application in Biodegradable Polymer Breakdown and Environmental Protection"

16:35 – 17:10 **Prof. M. Kowalczuk**
Centre of Polymer and Carbon Materials, Polish Academy of Sciences
"Forensic Engineering of Advanced Polymer Materials for Environmental and Climate Protection"

17:10 Closing Remarks

ABSTRACTS OF INVITED LECTURES

FROM TRASH TO TREASURE – ROLE OF MICROBES IN THE CIRCULAR ECONOMY

I. Radecka

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Mountains of waste, including plastic wastes are buried in landfill sites around the world each year. This continues to pose a growing challenge for authorities at both the local and national level. Microbes are key players in circular economy as they can convert waste into a range of products. This can contribute to better environmental sustainability through reducing greenhouse gas emissions, improving resource efficiency, and enhancing animal and human health.

Naturally occurring bacterial polymers have an enormous potential as they can be synthetised from renewable biogenic resources under well controlled conditions, and they also can be efficiently degraded. Over the past decades many biopolymers originating from various types of microorganisms have been reported. Ongoing research has increased rapidly the number of possible applications, ranging from food additives, polymeric controlled-release systems of agricultural products, and biomedical/pharmaceutical agents to biodegradable packaging, fashion industry, and even electronic components.

There are still challenges in developing biodegradable, high performance bacterial based materials. Attempts are therefore being made to find new ways to increase the rate and efficiency of microbial synthesis of biomaterials. This presentation will highlight the significant contribution that the Biopolymer Research Group at the University of Wolverhampton, together with collaborating institutions, is making towards these global issues.

TRANSFORMING SCIENCE WITH ARTIFICIAL INTELLIGENCE: A BEGINNER'S GUIDE

K. Filus
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Artificial Intelligence (AI) is rapidly changing scientific research in every possible domain. It offers powerful tools, new means of discovery and automation. Using the data-driven approach and the power of AI, people no longer have to find non-trivial patterns in data manually. Moreover, AI can find patterns that people simply cannot find due to the multi-dimensional dependencies and large volumes of data. This beginner-friendly lecture explores the growing necessity and potential of using AI in scientific research. A particular emphasis is put on applications in areas, such as chemistry, material science and polymer research. Different AI-based methods will be described, with distinction between traditional AI, usually used for tasks like clustering, regression, and classification in domain-specific data analysis, and generative AI, which is based on large foundation models trained on broad, general-purpose datasets, books, internet data. Examples will highlight how these AI approaches support different tasks of a scientist – from automatic data analysis to scientific writing. The lecture aims to provide a short overview and practical guidelines on how researchers can integrate AI into their work easily and effectively, and what problems AI can solve.

Practical workshop:

ARTIFICIAL INTELLIGENCE FOR SCIENTISTS: USING GENERATIVE MODELS FOR RESEARCH AND DATA ANALYSIS

The workshop offers a practical introduction to applying generative Artificial Intelligence (AI) models to make scientific research easier and more efficient. Participants will complete two simple exercises: (1) they will use generative AI models, such as ChatGPT to perform a preliminary literature search on a selected topic connected to polymer research, and (2) they will generate and execute Python code for data generation and visualization (temperature-dependent conductivity as an example), and then use ChatGPT to analyze the plots as a preliminary data analysis. The aim is to demonstrate how general-purpose generative AI models can assist scientists in their early-stage research tasks, from information gathering to basic data analysis. Participants may work individually or in small groups; at least one device per group must have access to ChatGPT. To do this, an account has to be created (a free account is enough to perform the exercises). The participants can either use their laptops, which will facilitate the execution of the exercises, but their mobile phones with the ChatGPT app will also be enough. During the exercise, a standalone and simplified tool for code execution will be used, which does not require any applications, only the browser access.

FORENSIC ENGINEERING OF ADVANCED POLYMER MATERIALS FOR ENVIRONMENTAL AND CLIMATE PROTECTION

M. Kowalczuk

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Keywords:
Biodegradable polymers, polylactide (PLA), thermoformed rigid packaging, composting

Forensic engineering of advanced polymer materials (FEAPM) plays a crucial role in environmental and climate protection by ensuring the integrity, durability, and sustainability of polymer-based products. This study explores methodologies for assessing material failures, degradation mechanisms, and environmental impacts, focusing on innovative forensic techniques such as spectroscopy, thermal analysis, and mechanical testing. By examining polymer materials under real-world conditions, researchers can develop more resilient and eco-friendly solutions, contributing to pollution reduction and climate resilience. The findings underscore the importance of forensic engineering in shaping sustainable polymer applications for a greener future. [1].

The long-term environmental impacts of advanced polymers are complex and multifaceted. Key considerations include: (i) Degradation and microplastic pollution (ii) Chemical leaching from additives, plasticizers, and stabilizers into the environment (iii) Persistence and waste management challenges (iv) Regulatory and sustainability efforts aimed at improving polymer assessment and management to mitigate environmental hazards, as well as enhancing biodegradability and recyclability (v) Energy consumption and carbon footprint affecting climate change.

FEAPM significantly impacts climate protection in several key ways: (i) Reducing environmental pollution (ii) Enhancing sustainability (iii) Improving energy efficiency (iv) Mitigating climate change effects.

The lecture will address the above aspects of FEAMP.

Acknowledgement:
This research was partly supported by European Union's Horizon2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 872152, project GREEN-MAP.

Reference:

[1] Kowalczuk, M. (2017), *Forensic Engineering of Advanced Polymeric Materials,* Mathews Journal of Forensic Research, 1(1): e001.

ABSTRACTS OF ORAL PRESENTATIONS

HYBRID ELECTROSPUN POLY(L-LACTIDE-CO-D,L-LACTIDE) MATERIALS WITH ANTIOXIDANT AND PHOTOCATALYTIC PROPERTIES

I. Anastasova[1]*, P. Tsekova[1], M. Ignatova[1], O. Stoilova[1]

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Keywords:
electrospinning, electrospraying, PLDLLA, ZnO, Fe_3O_4, antioxidant activity, photocatalytic activity

The aim of the present study is the fabrication of novel, hybrid fibrous materials, based on poly(L-lactide-co-D,L-lactide) (PLDLLA), ZnO and Fe_3O_4, designed for antioxidant and photocatalytic performance. The fibrous materials were purposefully engineered in a single step using two approaches: electrospinning (materials type "in") and simultaneous electrospinning and electrospraying (materials type "on"). Electrospinning of PLDLLA and its mixture with Fe_3O_4 resulted in materials with the "in" design. Additionally, the surfaces of the electrospun PLDLLA and Fe_3O_4-in-PLDLLA fibers were decorated with ZnO particles via simultaneous electrospraying, producing "on" design materials [1]. In this setup, quaternized N,N,N-trimethyl chitosan iodide (QCOS) served as both an effective stabilizing agent for ZnO dispersion and an adhesive for fixing ZnO particles onto PLDLLA fibers. The morphology of the electrospun materials was characterized using SEM equipped with EDX. Thermogravimetric analysis and XRD showed that the incorporation of inorganic particles influenced the thermal properties and crystallinity of the electrospun materials. It was demonstrated that the presence of ZnO on the surface of PLDLLA fibers significantly enhanced their antioxidant activity (as measured by the DPPH free radical assay) and their photocatalytic activity (as assessed by the degradation of the model organic pollutant Methylene blue under UV-light irradiation). Meanwhile, Fe_3O_4 nanoparticles, embedded within the fibers, imparted magnetic properties to the mats, enabling easy removal from the reaction medium by applying an external magnetic field. The electrospun ZnO/QCOS-on-PLDLLA and ZnO/QCOS-on-(Fe_3O_4-in-PLDLLA) hybrid materials retained their photocatalytic activity even after five cycles of use, making them promising candidates for the development of highly efficient water purification membranes.

Acknowledgement: I.A. acknowledges financial support from the Bulgarian Science Fund (Grant КП-06-МНФ/48). Some of the research equipment used in this study was part of INFRAMAT (Bulgarian Roadmap for Research Infrastructure), supported by the Bulgarian Ministry of Education and Science.

References:

[1] Anastasova, I., Tsekova, P., Ignatova, M., Stoilova, O. (2024). Imparting Photocatalytic and Antioxidant Properties to Electrospun Poly(L-lactide-co-D,L-lactide) Materials. *Polymers,* 16, 1814.

MICROBIAL DEGRADATION STRATEGIES FOR EMERGING POLLUTANTS: A PLATFORM FOR FUTURE APPLICATION IN BIODEGRADABLE POLYMER BREAKDOWN AND ENVIRONMENTAL PROTECTION

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Keywords:
Biodegradation; Microbial consortia; Constructed wetlands; Emerging pollutants; Biodegradable polymers

Our research addresses environmental contamination by persistent organic pollutants (POPs) through integrated microbial degradation strategies. Central to our innovation is a biomimetic constructed wetland (CW) system built with porous media and surface vegetation, which mimics natural wetland processes. Synthetic wastewater (SWW) was used to simulate real-world scenarios, with microbial treatments achieving up to 99–100% degradation of caffeine and parabens, and 80–99% degradation of nicotine under optimized pH and temperature conditions. TCC degradation was partially hindered by solubility issues, which provides a future avenue for coupling microbial degradation with polymer-supported extraction technologies. The entire process was tracked using advanced analytical techniques, including Nuclear Magnetic Resonance (NMR) and an upgraded High-Performance Thin-Layer Chromatography (HPTLC) protocol. These microbial degradation platforms, while initially developed for small-molecule pollutants, show strong potential for expansion into the field of **biodegradable polymer breakdown**. By modifying microbial consortia or optimizing environmental conditions, the same systems can be tailored to support the degradation of polymer-based materials used in packaging, agriculture, and consumer goods. Furthermore, integration with bio-based polymer carriers or immobilization matrices could improve stability and reusability, fostering circular bioeconomy principles. Our findings bridge the gap between wastewater remediation and polymer degradation, offering an interdisciplinary and practical solution for environmental and climate protection. These strategies support the long-term vision of designing smart, adaptable microbial systems not only for pollutant removal but also for advancing the biodegradation of polymer materials in line with emerging ecological and regulatory goals.

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[2] Wu, H., Wang, R., Yan, P. *et al.* Constructed wetlands for pollution control. *Nat Rev Earth Environ* **4**, 218–234 (2023).

POLY(2-ISOPROPENYL-2-OXAZOLINE) BRUSHES GROWN FROM SILICA SUBSTRATES VIA SURFACE INITIATED PHOTOCHEMICALLY INDUCED ATOM TRANSFER RADICAL POLYMERIZATION (SI-PHOTOATRP)

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Keywords:

poly(2-isopropenyl-2-oxazoline), antibiofouling, photoATRP, surface modifications

Recent advances in surface modifications have emerged novel methods for preparing uniform, densely grafted polymer brushes through surface initiated photochemically induced atom transfer radical polymerization (SI-photoATRP) [1,2]. This innovation places a considerable emphasis on reducing both financial and environmental impacts. Specifically, SI-photoATRP reactions enable the use of simple polymerization setups, operation under limited or even fully open-air conditions, and minimized catalyst concentrations.

In the present work, SI-photoATRP is employed to graft poly(2-isopropenyl-2-oxazoline) (PIPOx) brushes from silica substrates with considerable control over the brush dry thickness. Since similar studies have highlighted the sensitivity of the polymerization rate and control to the catalyst concentration and the reactivity of the employed ligand, here the influence of the previous is investigated in detail[1]. Furthermore, the stability of the novel brushes is examined by immersion of the modified substrates in buffer solutions with pH values of 7.4 and 4.0. Finally, our study feauters a detailed study of the enhanced antibiofouling properties derived from PIPOx, by examining the adhesion of 3T3 fibroblast model cells on the substrates with varying PIPOx dry thickness.

Acknowledgement:

The authors thank the grant agencies for financial support through projects VEGA 2/0137/23 and APVV-23-0534.

References:

[1] Pathiwada, D.; Annušová, A. H.; Machata, P.; Shaalan, M.; Halahovets, Y.; Mosnáček, J. Fully Open-Air Surface Initiated Photochemically Induced Atom Transfer Radical Polymerization of Renewable α-Methylene-γ-Butyrolactone with Potential in Biomedical Applications via Post–Functionalization. *Eur Polym J* **2025**, *234*.

[2] Abdul-Karim, R.; Kroneková, Z.; Pippig, F.; Popelka, A.; Mičušík, M.; Kleinová, A.; Pathiwada, D.; Kasák, P.; Mosnáček, J. Facile Fabrication of High Thickness Hydrophilic Polymer Brushes via Surface-Initiated Microliter-Scale Copper Mediated PhotoATRP toward Antifouling Surfaces. *Eur Polym J* **2024**, *209*.

APPLICATION OF BACTERIAL CELLULOSE DEVELOPED FROM WASTE MATERIALS, AS MULCH FILM FOR SUSTAINABLE AGRICULTURE

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Keywords:
Biodegradable polymer, bacterial cellulose, waste valorization, sustainable agriculture, mulch films

Mulching is an agricultural practice that involves spreading material onto the surface of the soil to protect plants from biotic and abiotic stresses. Polyethylene plastic is the most common mulching material because of its low cost and desirable physical properties. However, during application microplastics are generated in the soil which exacerbate plastic pollution [1]. Following the United Nations SDGs, research has been done to find out biodegradable polymers that can be used as mulch films [2]. Our research work focuses on the production and characterization of bacterial cellulose (BC) for potential use as biodegradable mulch film. In this study, *Gluconacetobacter xylinus* was used for BC production using household and industrial waste as substrate. The produced BC films were characterized using Fourier Transform Infrared spectroscopy (FT-IR), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). All waste materials were analysed using high-performance liquid chromatography (HPLC). After 21 days of incubation, the highest BC yield was obtained from potato peel medium (PPM) supplemented with brewer's yeast as nitrogen source. FT-IR analysis confirmed the presence of characteristic functional groups in all BC films. TGA confirmed that BC films were stable with decomposition starting at 300°C, whilst SEM microscopy indicated that the type of waste material used, affected the formation of the microfibril network of cellulose. Additionally, to improve physical and mechanical properties of BC films, composites of BC with glycerol were developed and characterized. In the next step, BC films, with and without glycerol as well as controls (commercial plastic and commercial cellulose mulch) were spread on the surface of pots growing cowpea plants. The effect of mulching was checked in terms of weed control, impact on soil pH, soil moisture and plant growth parameters of cowpea. It was found that BC films produced from PPM or HS media (with and without glycerol) effectively functioned as mulch and prevented weed growth. It was also observed that the application of BC mulch film had a significant impact ($p=<0.01$) on plant growth when compared to commercial plastic and commercial cellulose mulch. However, it was found that whilst the addition of glycerol to BC improved its tensile strength and water retention, it had an inhibitory effect on plant growth as the cowpea plants showed symptoms of chlorosis and stunted growth subjected to BC films coated with glycerol.

Acknowledgement: Thanks to the University of Wolverhampton and the Commonwealth Scholarship Commission in the UK.

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[1] Dong, H., Yang, G., Zhang, Y., Yang, Y., Wang, D. & Zhou, C. (2022) Recycling, disposal, or biodegradable-alternative of polyethylene plastic film for agricultural mulching? A life cycle analysis of their environmental impacts. *Journal of Cleaner Production*, *380(1)*, 134950.
[2] Cárcamo, L., Sierra, S., Osorio, M., Velásquez-Cock, J., Vélez-Acosta, L., Gómez-Hoyos, C., Castro, C., Zuluaga, R. & Gañán, P. (2021) Bacterial nanocellulose mulch as a potential greener alternative for urban gardening in the small-scale food production of onion plants. *Agricultural Research*, *10*, 66-71.

PHOTOCURABLE DOUBLE DYNAMIC POLYESTER RESINS WITH CIRCULAR END-OF-LIFE

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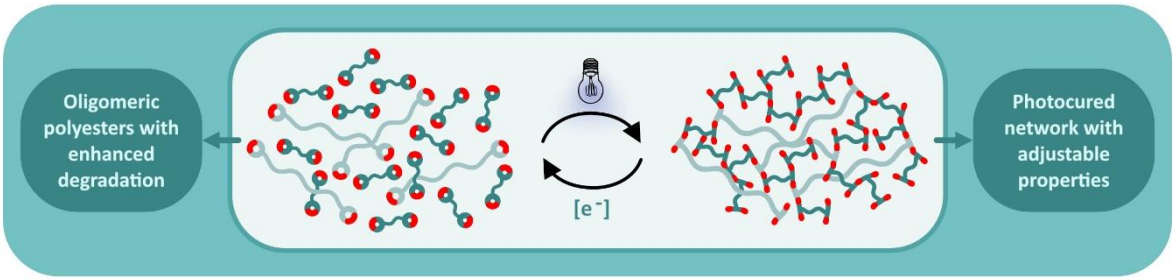
Keywords:
Double dynamics, aliphatic polyesters, disulfides

To tackle the problem of plastic waste accumulating in nature, new approaches to material design is needed. By designing plastics with recyclability or degradability from the start, materials can be tailored not only to specific properties but also with their end-of-life in mind.
Aliphatic polyesters are good candidates for the synthesis of both chemically recyclable and biodegradable plastics due to the presence of hydrolyzable bonds in the polymer backbone. However, chemical recycling can still require harsh conditions and harmful chemicals, while the biodegradation rate is highly dependent on physical factors, chemical structure and environmental parameters. [1] [2] To promote recyclability under mild conditions and to increase the biodegradation rate, while keeping the stability of materials during service-life, we have developed a double dynamic system combining aliphatic polyesters with disulfides. Lipoic acid is a biobased compound that contains a ring-strained disulfide capable of crosslinking under UV irradiation. By end-functionalizing oligomeric polyesters with lipoic acid and combining with a low molecular weight crosslinker, a UV-curable network is formed which can be rapidly degraded under reductive conditions. By varying the structure and amount of polyester in the networks, material properties can be adjusted for different applications.



Acknowledgement:
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MODIFIED SILICA FUNCTIONALIZED WITH 1,3,5-TRIONE AS A POTENTIAL INORGANIC CATION CATCHER

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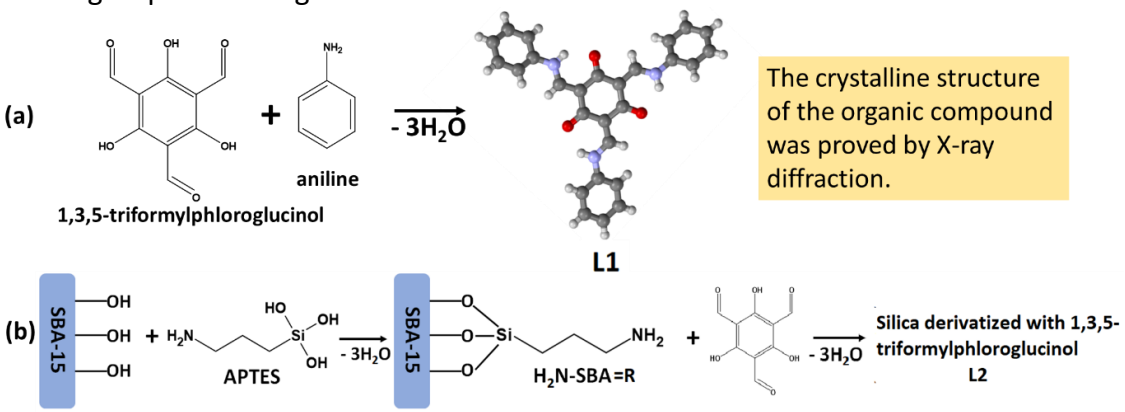
Keywords:
Inorganic polymers, triones, mesoporous silica, cations.

The paper approaches the synthesis of a model low molecular weight product, namely 2,4,6-tris(phenylimino(methyl))cyclohexane-1,3,5-trione (L1), obtained by the coupling reaction between 1,3,5-triformylphloroglucinol with aniline, ***Scheme 1 (a).*** L1 serves as a comparison compound since it was already tested as a cation catcher.
Mesoporous silica of interest, due to it`s large specific surface areas, organized pore architectures, SBA-15, was also functionalized with (3-aminopropyl)triethoxysilane (APTES), to anchor amino groups on the surface of the mesoporous material. The modified SBA-15 was afterwards functionalized with 1,3,5-triformylphloroglucinol, to obtain the L2 ligand, as presented in ***Scheme 1 (b).***
Both L1 and L2 could be promising materials for use in cation adsorbtion processes, because of the reactive groups that are grafted on their surface.



Scheme 1. (a) Reaction of 1,3,5-triformylphloroglucinol with aniline, ***(b)*** SBA-15 functionalized with APTES and post-functionalized with an organic ligand.

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CHARACTERIZATION AND EXPOSURE ASSESSMENT OF INDOOR MICROPLASTICS IN HOSPITAL INDOOR SETTLED DUST: FIRST INSIDES FROM INDIA

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Keywords:
Microplastic, Indoor, Settled dust, Hospital, FTIR, Human Health

Indoor microplastics (MPs) are emerging contaminants with potential human health risks [1]. MPs are synthetic particles <5 mm, are increasingly found in indoor environments, where humans spend ~ 90% of their time Hospitals, with their unique microenvironments and use of synthetic materials, are particularly vulnerable yet understudied in this context. This study presents the first comprehensive assessment of MPs in hospital indoor settled dust in India, focusing on quantification, morphological and chemical characterization, spatial distribution, and human exposure. Dust samples were collected from various zones (e.g., OPD, ICU, corridors) in two hospitals (public and private) in Rajkot, India. Samples underwent organic digestion and density separation, followed by optical microscopy and FTIR spectroscopy. Statistical analyses included Kruskal-Wallis tests and Principal Component Analysis (PCA). Human exposure was assessed using Estimated Daily Intake (EDI) models. The study found high levels of microplastics (MPs) in hospital dust, averaging 65–80 MPs/g. Fibers were the most common shape (52–69%), with red and blue colors linked to synthetic textiles and medical items. PET and PE were the dominant polymers. Most particles measured 200–500 µm, though smaller, potentially more harmful MPs were likely underestimated. Infants faced the highest exposure, up to 0.82 MPs/kg/day in high-traffic zones. While overall distribution appeared uniform, zones like ICUs had lower levels, indicating that hospital activities and materials influence MP presence. Indian hospitals are significant hotspots for indoor MP pollution, with exposure risks influenced by institutional practices. This baseline study urges targeted mitigation strategies—reducing synthetic textiles, improving air filtration, and minimizing single-use plastics. Future research should standardize methodologies, address sub-50 µm MPs and nanoplastics, and employ advanced techniques like Raman spectroscopy and pyrolysis-GC–MS to better understand exposure dynamics.

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EXPLORING CONDUCTIVE BIOPOLYMER COMPOSITES: FROM ENVIRONMENTAL REMEDIATION TO BIOMEDICAL POTENTIAL

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Keywords:
Bacterial cellulose, Polypyrrole, Chromium (VI) ions

Biopolymers are increasingly recognized for their sustainability and versatility across different fields. Our work focuses on bacterial cellulose (BC), a naturally derived polymer known for its excellent mechanical properties and biocompatibility. When combined with conductive polymers like polypyrrole (PPy), BC forms composites with enhanced electrical conductivity and structural integrity.

Polypyrrole is a well-known conductive polymer, but its powder form limits practical applications. Embedding it into biopolymer matrices such as BC and polyhydroxyalkanoates (PHA) improves its processability. Interestingly, BC also acts as a surface modifier for PHA, improving its compatibility with conductive polymers and expanding its application potential. These BC–PHA–PPy composites are promising in environmental technologies, flexible electronics, and medical applications such as biosensors or tissue engineering scaffolds.

In this seminar, I will present our recent findings on using BC–PPy composites for environmental remediation, explicitly targeting the removal of toxic chromium (VI) ions from water [1]. We characterized the composites in terms of their morphology, rheology, and electrical properties. Notably, the materials adsorbed chromium (VI) effectively and facilitated its photocatalytic reduction to the less toxic chromium (III), demonstrating their multifunctional potential [1].

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MECHANICAL IMPACT OF YERBA MATE WASTE FILLERS IN PHBV BIOCOMPOSITES

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Keywords:
Biodegradable Polymers, Biocomposites, PHBV, Natural Fillers, Yerba Mate.

The increasing environmental impact of synthetic plastic trash has encouraged the hunt for sustainable alternatives. This study investigates the processing, mechanical characterization of biocomposites made from biodegradable polymers, specifically poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) reinforced with waste yerba mate as a natural filler. We examined the impact of waste fillers containing 5 and 10% yerba mate in the PHBV matrix on mechanical performance. Mechanical testing revealed that both filler loadings preserved the composites structural integrity, with Young's modulus values of around 0.461 ± 0.056 GPa and 0.506 ± 0.051 GPa at 5 and 10%, respectively. The final tensile strengths remained greater than 32 MPa, with slight variations amongst compositions. The elongation at break values were low (3.5-4%), indicating a stiff material profile appropriate for semi-structural applications. These findings indicate that using biodegradable waste fillers can result in biocomposites with desirable mechanical characteristics while also providing a sustainable method of waste valorisation. Further degradation studies will disclose the environmental outcome and breakdown dynamics of these composites in natural environments.

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INTEGRATED EXPERIMENTAL AND MATHEMATICAL APPROACHES FOR EXPLORING CHEMICAL MODIFICATIONS OF FURAN-BASED POLYESTERS

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Keywords:

poly(trimethylene 2,5-furandicarboxylate); poly(trimethylene glutarate); copolyesters; experimental analysis; mathematical analysis

Polyesters have become an integral part of our daily lives, surrounding us in various forms. They are utilized in packaging, textiles, the automotive industry, medical applications, and many more. There are many types of polyesters; among them, one of the most widely used is poly(trimethylene terephthalate) (PTT). However, its disadvantages include non-biodegradability and the fact that it is primarily produced from petroleum-based monomers. One potential replacement for PTT is poly(trimethylene 2,5-furandicarboxylate) (PTF), a fully bio-based polymer with properties comparable to those of PTT. PTF is a relatively new polymer, and the outcomes of chemical modifications, such as copolymerization, have not been yet extensively investigated. Thus, there is significant potential for applying mathematical modeling and predictive analysis to estimate key thermal and structural properties of these materials. The combination of theoretical tools and experimental techniques applied in this study provides new insights into the design and characterization of bio-based polyesters and copolyesters, validating the applicability of established methods to novel polymer systems. This study underlined the successful synthesis of two series of bio-based copolymers, i.e. poly(trimethylene terephthalate-co-trimethylene glutarate) PTT-co-PTG and poly(trimethylene 2,5-furandicarboxylate-co-trimethylene glutarate) (PTF-co-PTG) via melt polycondensation. The ^{1}H NMR was conducted to characterize the chemical structure and for the estimation of the number-average molecular weight (M_n). The values of the glass transition temperature were calculated using the Van Krevelen and Hoftyzer group contribution method and the Fox and Gordon-Taylor equations. The thermal properties and stability of materials were investigated using Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA).

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ABSTRACTS OF POSTERS

COMPARATIVE ANALYSIS OF FIVE SYNTHETIC APPROACHES FOR POLY(GLYCEROL SEBACATE) (PGS)

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Keywords:

Poly(glycerol sebacate), Polycondensation, *Candida Antarctica lipase B*, Amberlyst-15

The constant search for new materials in medicine focuses on those that exhibit high biocompatibility with the human body, good biodegradability, and low toxicity. The polyester poly(glycerol sebacate) (PGS), which is typically obtained *via* the polycondensation of glycerol and sebacic acid, represents a promising candidate that meets these criteria [1]. These properties, among others, have led to PGS being considered a highly promising biomaterial for applications in hard and soft tissue engineering, controlled drug delivery, and wound healing [2]. Despite extensive research on the synthesis and biomedical potential of PGS, there are very few studies that compare different synthetic strategies for this polyester within a single laboratory. The aim of this work was to compare various PGS synthesis methods in order to determine their impact on the properties of the resulting prepolymer.

The obtained PGS prepolymers were characterized using techniques such as ^{1}H and ^{13}C NMR, GPC, FTIR, ESI-MS, TGA, and DSC. These physicochemical analyses enabled the evaluation of how the reaction pathway influenced the chemical structure and thermal properties of the resulting PGS prepolymer. Additionally, the impact of the catalyst choice on the properties of the obtained PGS prepolymer was determined. For this, either the *Candida Antarctica lipase B* (CALB) enzyme or the strongly acidic, heterogeneous Amberlyst-15 resin was applied. These findings provide insight into the polycondensation process and support the selection of an appropriate PGS synthesis route for biomedical applications, particularly as a drug carrier.

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DEVELOPMENT OF POLY(VINYL ALCOHOL)-BASED COPOLYMERS DESIGNED FOR OPTICAL SENSING APPLICATIONS

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Keywords:
biodegradable polymers, poly(vinyl alcohol), brush copolymers, acetone sensing, humidity sensing

Poly(vinyl alcohol) (PVA) is a synthetic hydrophilic polymer exhibiting good mechanical and thermal properties, together with excellent film-forming ability and high optical transparency. PVA is also known as one of the very few ecologically tolerant vinyl polymers - biocompatible and biodegradable under both aerobic and anaerobic conditions [1]. In this aspect, development of PVA-based copolymers of diverse macromolecular architectures can provide sustainable, green alternatives to some conventional polymers used as optical sensors.

Amphiphilic copolymers comprising hydrophilic PVA main chain grafted with hydrophobic methylacrylate (MA) side chains were synthesized aiming at optical sensing of acetone vapors [2]. The grafting reaction took place by redox polymerization in aqueous PVA solution generating *in situ* aqueous dispersions with nanosized copolymer colloidal particles with narrow size distribution. The dispersions were further used for deposition of thin films on silicon substrates. The potential of the obtained films for the optical sensing of acetone vapors was confirmed by reflectance measurements before and during their exposure to acetone vapors.

Another type of copolymer architectures - brush copolymers build of PVA main chains grafted with hydrophilic poly(N,N-dimethylacrylamide) (PDMA) side chains of different lengths and grafting densities were synthesized and examined for potential use in optical humidity sensing. These double hydrophilic copolymers were obtained in aqueous solution at environmentally friendly reaction conditions. Nanosized thin films were prepared by spin-coating of 2 wt% copolymer solution in mixed water/methanol solvent (volume ratio of 20:80) on silicon substrates and tested for humidity sensing application. Considerable change in the film thickness when changing the relative humidity level was demonstrated and discussed.

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ANTIFOULING SURFACES WITH STAR POEGMA NANOLAYERS

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Keywords:
star polymers, antifouling, nanolayers, POEGMA, surface modification

Biofouling, driven by nonspecific adsorption of biomolecules, presents a significant challenge in the development of polymeric materials for biomedical use. In this study, we report the synthesis and surface immobilization of star POEGMA polymers designed to resist protein fouling. Polymers with 4 and 12 arms were synthesized via atom transfer radical polymerization (ATRP), with controlled arm length and overall molar mass. The materials were covalently grafted onto silicon substrates and quartz crystal microbalance (QCM) sensors using silane-based surface modification, resulting in dense, hydrophilic nanolayers. Antifouling performance was assessed via adsorption studies with model proteins - fibrinogen and lysozyme. QCM measurements confirmed significantly reduced protein adhesion on POEGMA-coated surfaces compared to unmodified silicon, with fouling resistance influenced by polymer architecture. These findings demonstrate the potential of star POEGMA polymers as efficient antifouling coatings for applications in biomedical interfaces and analytical platforms.

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COMPARISON OF FREE VOLUMES BY PALS METHOD BETWEEN 3D PRINTED POLYMER SAMPLES AND RECYCLED POLYMER SAMPLES

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Keywords: PALS, polymers, recycling, 3D printing

The aim of this work is to investigate the free volumes in two recycled polymers and compare their properties. In this research, materials from resources such as plastic bottles and packaging made of PET (polyethylene terephthalate) and PP (polypropylene) were used. The recycled samples were prepared in pairs by cutting out discs, subjecting them to a cleaning and drying procedure and pressing 4 discs to create two plates. The 3D printed samples were designed in the same shape and printed from filaments made of recycled PET and PP. The materials were examined using the PALS method (positron annihilation lifetime spectroscopy), which is non-destructive and particularly sensitive to the presence of free volumes in the polymer. The study aimed to determine the size and share of unfilled areas in the atomic structure. As a result of the measurements, a series of data was obtained for each of the tested samples, which were analyzed using the LT ver. 9.2 program. As a result, the components of positron lifetimes were obtained, of which the component with the longest lifetime was assigned to the annihilation of orthopositronium (o-Ps) in the free volumes. Based on the measured data, the sizes of free volumes were calculated using the Tao-Eldrup model assuming their spherical shape and compared between each material.

THE FORMATION OF SMART POEGMA NANOGELS: THE ROLE OF MEDIUM-DEPENDENT ASSEMBLY

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Keywords:
POEGMA, self-assembly, nanogel, thermoresponsiveness, drug release

A critical aspect in the design of nanogels for biomedical applications is their behavior in different physiological conditions. In numerous studies, the impact of dissolved salts, in environments mimicking the biological fluids, was not fully examined, particularly for thermoresponsive systems above their phase transition temperature (T_{CP}). These parameters strongly influence polymer thermoresponsiveness by affecting the T_{CP}, triggering aggregation, and altering morphology and stability[1]. The poly[oligo(ethylene glycol) methacrylates] (POEGMA) have been identified as a promising candidates for nanogels in biomedical applications due to their biocompatibility and non-toxicity[2]. Further research is needed to understand how buffer pH affects nanogel properties, as environmental conditions critically influence their formation and thermoresponsive behavior. Understanding environmental effects on formation and responsiveness is key to nanogels biomedical design.

This study focuses on the development and characterization of hydrolytically degradable nanogels derived from POEGMA-based copolymers. The thermoresponsive behavior of these copolymers, characterized by their T_{CP}, ranged from 30°C to 50°C in both aqueous and saline environments and could be precisely tuned by adjusting the copolymer composition. These copolymers formed nanogels, via a two-step process involving thermally induced aggregation of POEGMA into mesoglobules, followed by covalent crosslinking via Steglich esterification in water, citric acid buffer and PBS. In order to adapt the system for potential biomedical applications, particular attention was given to ensuring nanogel stability in biologically relevant media while minimizing aggregation. The protocol was subjected to systematic optimization, a process which yielded nanogels with hydrodynamic diameters ranging from 170 to 1000 nm in dependence upon the type of low-molecular-weight substances. Additionally, the nanogels demonstrated the ability to encapsulate and release a model therapeutic compound (doxorubicin) in a controlled manner under physiological conditions.

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GREENER ATRP PATHWAYS: STAR-POLYMER SYNTHESIS

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Keywords:
ATRP, enzymes, star-polymers, green chemistry, POEOMA

Contemporary assisted atom-transfer radical polymerization (ATRP) research focuses on greener routes, including visible-light organocatalysis at sub-ppm levels and aqueous enzyme-mediated redox cycles, which minimize energy input, metal residues, and waste while preserving architectural precision.[1][2] Aligned with these principles, star-shaped poly(oligo(ethylene oxide) methyl ether methacrylate)s (POEOMA 300/500) were synthesized through enzymatically assisted ATRP initiated from cyclodextrin-based cores. Scale-up from 10 mL to 40 mL, accompanied by an increase in oligomacromonomer feed from 0.5 mL to 2 mL, preserved control of reaction progress. The resulted 8-armed polymers were characterized by narrowed molecular distributions (1.23–1.34) and variable length of arms (19-71 units per one arm). UV–Vis analysis established cloud-point transitions of representative polymers in range of 60-70^{o}C, whereas atomic-force microscopy detected nanoscale aggregates with star-shape morphologies, which were distinguished as free fractions with diameter sizes of 120-250 nm, 300-610 nm, and 500-900 nm. These findings demonstrate that enzymatically assisted ATRP combines reproducibility with ecological compatibility in the fabrication of advanced polymer nanostructures.

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TECHNO-ECONOMIC AND THERMODYNAMIC MODELLING OF BIOFUEL PRODUCTION FROM BIOMASS (SEWAGE SLUDGE) VIA FISCHER-TROPSCH SYNTHESIS

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The European Commission's Energy Union agenda calls for a major transformation of the energy sector, emphasizing renewable energy, smart energy systems, and circular economy principles [1]. Among renewable alternatives, liquid biofuels derived from biomass have emerged as crucial solutions for decarbonizing the transport sector, which remains heavily reliant on fossil fuels. These biofuels, such as synthetic **gasoline, jet fuel,** and **diesel**, offer high energy density and compatibility with existing infrastructure, making them a promising substitute for conventional fossil fuels. In this context and aligned with the rising interest in the hydrogen economy [2], this work proposes an integrated polygonation system for sustainable fuel production.
The proposed system enables the production of liquid biofuels via Fischer–Tropsch synthesis, using electricity derived from renewable energy sources such as solar power and biomass, which is first converted into biogas through anaerobic digestion. The required thermal energy is supplied by combusting tail gases in a dedicated combustion chamber. During the process, carbon dioxide is separated through carbon capture technologies and stored, contributing to a reduction in greenhouse gas emissions.

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RHEOLOGICAL ANALYSIS OF CARBON-ENHANCED PLA NANOCOMPOSITES FOR SUSTAINABLE SMART PACKAGING APPLICATIONS

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Keywords:
PLA nanocomposites, rheology, carbon nanofillers, sustainable smart packaging

Processability is a key determinant of sustainable and efficient smart packaging manufacturing, particularly when using extrusion and 3D printing methods. This study investigates the rheological behaviour of polylactic acid (PLA) nanocomposites reinforced with graphene nanoplatelets (GNP), carbon nanotubes (CNT), cellulose nanocrystals (CNC), and their hybrids, with a focus on how filler type, concentration, and synergistic effects influence viscoelasticity and processability.

Oscillatory shear tests at 190 °C showed that neat PLA exhibits low storage modulus (G') and complex viscosity (|η*|), with viscous-dominant behaviour. The addition of CNC slightly increased G' but reduced |η*|. In contract, carbon nanofillers significantly enhanced both G' and loss modulus (G''), promoting more elastic, solid-like characteristics. Hybrid systems such as PLA/1%CNC/2%GNP/2%CNT demonstrated high modulus (10^4 – 10^5 Pa) and moderate viscosity (10^4 – 10^6 Pa·s), offering a balance between structural integrity and flowability. All systems exhibited shear-thinning behaviour, favourable for extrusion and 3D printing.

At low filler concentration, viscosity decreased slightly. While higher concentration (4 wt%) of CNT or GNP formed percolated networks and gel-like rheology (G' ~10^5 Pa, |η*| ~10^4 – 10^7 Pa·s), which may reduce suitability for processing due to excessive stiffness. These findings show that careful tuning of PLA-to-filler ratios enables the development of nanocomposites with tailored rheological profiles, adaptable for flexible-to-rigid smart packaging solutions capable of withstanding the demands of transport and use.

Acknowledgement:
This research was supported by the University of Wolverhampton Faculty of Science and Engineering and the EU Horizon 2020 MSCA RISE Project ReACTIVE Too (Grant No. 871163).

ANTIMICROBIAL AND COPPER REMOVAL PROPERTIES OF PES MEMBRANES MODIFIED WITH SILVER-EXCHANGED ZEOLITE NANOPARTICLES

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Keywords: Ze-AgNPs, polyethersulfone, nanocomposite, antimicrobial activity

This study explores the development of multifunctional polyethersulfone (PES) membranes with improved antimicrobial properties and metal ion removal efficiency by incorporating silver-exchanged zeolite nanoparticles (ze-AgNPs) at 1, 3, and 5 wt.%. The zeolite modified with silver structure was analyzed by FTIR, XRD, and SEM, confirming the successful integration of silver. Thermal analyses (DSC and TGA) showed that adding 1 wt.% ze-AgNPs raised the glass transition temperature and thermal stability, suggesting good dispersion of nanoparticles and strong interaction with the polymer matrix. However, higher filler amounts caused a decrease in Tg, likely due to plasticizing effects or nanoparticle clumping. All membranes, including pure PES, demonstrated high Cu(II) removal efficiency (>95%) based on UV-Vis spectroscopy. Antibacterial tests against *Escherichia coli* and *Staphylococcus aureus* revealed notably improved activity in membranes containing ze-AgNPs. These findings highlight the promise of PES/ze-AgNPs membranes as dual-function materials for water treatment, capable of removing heavy metals while providing effective antimicrobial protection.

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STUDIES ON THE EFFECT OF ACID DOPING OF THIN FILMS OF POLY(3,4-ETHYLENEDIOXYTHIOPHENE) POLYSTYRENE SULFONATE ON THEIR OPTICAL AND ELECTRICAL PROPERTIES

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Keywords:
PEDOT:PSS, acid doping, electrical conductivity, percolation theory, Hall effect measurements

Poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) is a conductive polymer, commercially available in the form of an aqueous dispersion, widely used in organic electronics. It is known, among others, as a thermoelectric material due to its good electrical conductivity and low thermal conductivity [1], and is also used as transparent electrodes and antistatic coatings. The electrical conductivity of PEDOT:PSS layers is very diverse and can be modified in a wide range by changing the deposition conditions and chemical and physical modifications of the layers after deposition, e.g. by adding solvents, doping the aqueous dispersion or the deposited layers [1–3]. However, the key factor is the quantitative ratio of the well-conducting PEDOT to PSS, which is an insulator [4]. Despite many years of intensive research on the microstructure-property relationship of these layers, there are still gaps in knowledge, especially with respect to the detailed understanding of the charge transport mechanism in thin-film organic semiconductors. In this work, we investigate the effect of acid doping of aqueous PEDOT:PSS dispersion on the electrical conductivity of thin films obtained on its basis. The results of optical and electrical investigations including the Hall effect measurements are analyzed based on a model of the conductivity of composite materials. This model is based on the generalized effective medium theory and uses the percolation theory equation to describe the electrical conductivity of a mixture of two materials. In our implementation, we assume that the conductivity of the strongly conductive component is due to the intrachain conductivity of PEDOT, the quantitative contribution of which is determined based on the optical Drude-Lorentz model. The weaker interchain conductivity is attributed to the weaker conductivity component and is determined based on electrical measurements and coherent composition-dependent analysis.

Acknowledgement: The authors would like to thank all those who contributed to this work.

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EFFECT OF THE ANTICANCER ACTIVE COMPOUND INCORPORATED INTO THE ELECTROSPUN NONWOVEN ON DEGRADATION OF POLY(D,L-LACTIDE-CO-GLYCOLIDE)

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Keywords:
PLGA, degradation, electrospun nonwoven, drug delivery, anticancer drug

PLGA-based electrospun nonwovens are a promising area of research, especially as a drug delivery system. The FDA has approved PLGA for clinical applications, and it is the most commonly used synthetic material in the development of fibrous scaffolds [1]. The properties of PLGA depend on the molar ratio of its constituent lactide and glycolide co-monomeric units. However, lactide exists in two isomeric forms resulting in a semi-crystalline polymer when L-lactide monomer is used in the synthesis process and an amorphous polymer when racemic D,L-lactide monomer is used, thereby determining its properties [2].
The type of drug is an important factor affecting polymer degradation and drug release profile. Therefore, the aim of this study was to evaluate the effect of three different anticancer drugs incorporated into electrospun PLGA fibrous mats on the rate and profile of degradation using scanning electron microscopy (SEM), gel permeation chromatography (GPC), and differential scanning calorimetry (DSC).

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STRATEGIC SIMULATION DRIVEN OPTIMIZATION OF MODIFIED POLYMER BASED SOLAR CELLS

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Keywords:
Organic solar cells (OSCs), Band gap tuning, Back contact work function, Bulk heterojunction active layer (BHJ), Power conversion efficiency (PCE).

Organic solar cells (OSCs) are emerging as promising next-generation photovoltaic technologies, offering unique advantages such as flexibility and light in weight. However, achieving commercially viable efficiencies still requires strategic tuning of both device architecture and electronic parameters. In this study, a comprehensive simulation-based investigation was conducted to analyze the impact of various physical and electronic factors on OSC performance. The examined device structure consists of FTO as the front contact, PFN-Br as the electron transport layer (ETL), a PBDB-T-2F:BTP-4F bulk heterojunction active layer, Cu_2FeSnS_4 (CFTS) as the hole transport layer (HTL), and platinum was used as the back contact. Initially, the HTL thickness was optimized, followed by variation of the active layer thickness from 10 nm to 150 nm. The simulation results showed that at an active layer thickness of 70 nm, the open circuit voltage (Voc) and fill factor (FF) decreased, while current density (Jsc) and power conversion efficiency (PCE) increased. Beyond 130 nm, all photovoltaic parameters declined and analyze that 130 nm as the optimal active layer thickness. At optimum thickness, the device achieved a Voc of 1.049 V, Jsc of 23.05 mA/cm², FF of 65.98%, and a power conversion efficiency (PCE) of 15.96%. Further investigations include the effects of active layer defect density, band gap tuning, electron affinity modification, charge transport layer doping, and back contact work function. This detailed parametric analysis offers valuable insights into optimizing polymer-based active layer and device interfaces, providing a strategic framework for designing high-performance OSCs.

EPOXY COMPOSITES REINFORCED WITH IO/RGO HYBRIDS: INFLUENCE OF THE MAGNETIC FIELD ON STRUCTURE AND CONDUCTIVITY

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Keywords:
Epoxy composites, hybrid fillers, reduced graphene oxide, iron oxide nanoparticles

Conductive polymer composites (CPCs) are an attractive topic for both academic and industrial communities due to their easy processing, adjustable electrical properties (ranging from 10^{-8} to 10^{6} S/m), improved mechanical strength, and relatively low production costs. A simple way to induce electrical conductivity and, as a result, create CPCs is by incorporation conductive fillers, such as metal compounds or carbon particles, into an electrically insulating polymer matrix. In recent years, the use of hybrid fillers has gained attention because these combinations offer superior properties compared to single-component fillers. Hybrid fillers can be metal-metal, metal-carbon or carbon-carbon and particularly interesting are hybrid fillers that have magnetic properties. When exposed to a magnetic field these hybrid fillers can be aligned in a preferred orientation to enhance performance, both for thermal and electrical characteristics.

In this study, epoxy composites with hybrid filler based on reduced graphene oxide nanoplatelets coated with iron oxide nanoparticles were prepared and characterised for their structure, thermomechanical properties and electrical conductivity. The characterization of these fillers was determined by using techniques such as X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM-EDS), and transmission electron microscopy (TEM), which gave us detailed information about their morphology. Two types of the composites were prepared for this study: with random distribution of the hybrid filler in the polymer matrix and partially oriented distribution of the hybrid filler in the polymer matrix by applying an external magnetic field. The influence of filler content and structure on the electrical percolation threshold was evaluated. In addition, the composites' thermal stability, glass transition temperature, and dynamic elastic modulus were investigated. The magnetic field-treated composites demonstrated enhanced conductivity and mechanical strength, making them ideal candidates for advanced applications. This research highlights the potential of epoxy composites with graphene-iron oxide hybrid fillers as multifunctional materials. Their properties under the influence of the magnetic field suggest promising applications in electronics, sensors, and other areas requiring high-performance conductive materials.

ENERGY-EFFICIENT ULTRASONIC DEPOSITION OF POLYMER COATINGS ON CATHETERS FOR BIOMEDICAL AND ENVIRONMENTAL BENEFIT

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Keywords:
Ultrasonic deposition; Biocompatibility; antimicrobial coatings; Eco-friendly approach

In response to the growing global demand for sustainable materials and processes, this study presents an environmentally conscious strategy for functionalizing biomedical devices using advanced technology. We report the development and application of a biocompatible, antimicrobial polymer coating on catheters via ultrasonic deposition technique “Sonotek” that significantly reduces energy consumption compared to conventional methods such as dip or spray coating. The selected polymer, poly-vinyl alcohol along with various ratios of antimicrobial peptide “poly-L-Lysine” were specifically chosen to ensure both patient safety and long-term device performance. Ultrasonic coating enabled uniform, thin-film application with minimal material waste, reduced solvent usage, and lower energy input. The performance of the coatings was evaluated through surface morphology analysis, roughness values, and preliminary biocompatibility and antimicrobial assays. The results demonstrated that the coating produced a uniform layer with excellent biocompatibility and effective infection resistance. This infection-free biocompatible catheter is expected to reduce associated infections and maintain catheter performance, resulting in reduced public health expenses spent on regular catheterization and medications. These findings lay the groundwork for future research focused on developing advanced antimicrobial catheter coatings to prevent catheter-associated infections.

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STRUCTURE AND PROPERTIES OF MG-ZN-CA ALLOYS CONTAINING AG AND AU OBTAINED BY MECHANICAL ALLOYING

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Keywords:
Mg-based alloys, mechanical alloying, SEM

In recent years, there has been a growing interest in biodegradable materials for medical applications, especially in temporary orthopedic implants and stents. Among them, magnesium alloys attract special attention, which are characterized by favorable mechanical properties, good biocompatibility, and the possibility of controlled degradation in the body environment. Modifying the chemical composition of magnesium alloys by adding noble elements, such as silver (Ag) or gold (Au), can improve their physicochemical properties, including microstructure, corrosion resistance, and biological properties. This work aimed to obtain $Mg_{65}Zn_{30}Ca_4Ag_1$ and $Mg_{65}Zn_{30}Ca_4Au_1$ alloys by mechanical alloying, where the elements were milled for 13 h, and their characterization using XRD, SEM/EDS, and DSC techniques.

The $Mg_{65}Zn_{30}Ca_4Ag_1$ and $Mg_{65}Zn_{30}Ca_4Au_1$ alloys were prepared by mechanical synthesis. The powders were milled for 13 h. The crystalline phases were identified by X-ray diffraction (XRD) allowed for determining the phase composition and assessing the effect of mechanical alloying parameters on microstructure refinement. The particle morphology and their homogeneity were analysed using scanning electron microscopy (SEM) (Fig. 1,2), while the chemical composition of individual areas was assessed using energy dispersive spectroscopy (EDS). Thermal properties were analysed by differential scanning calorimetry (DSC), identifying the temperatures of phase transformations.

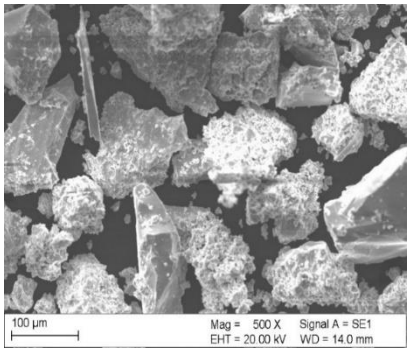

Figure 1. Morphology of $Mg_{65}Zn_{30}Ca_4Ag_1$ powders after 13 h of milling time

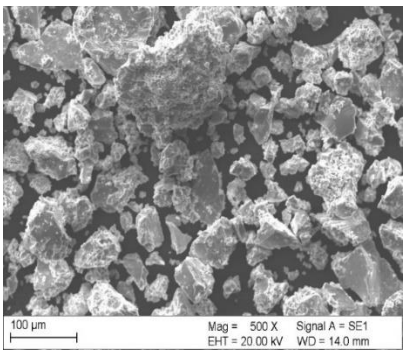

Figure 2. Morphology of $Mg_{65}Zn_{30}Ca_4Au_1$ powders after 13 h of milling time

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BIOBASED HYDROGELS FROM TULIPALIN A

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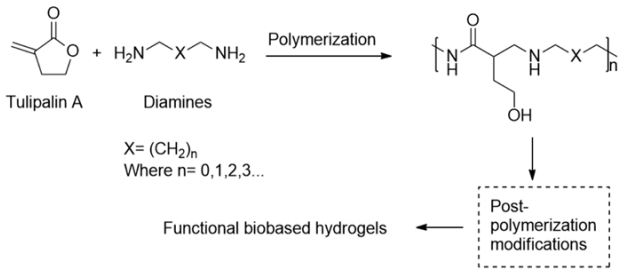
Keywords:
Renewable Monomer, Poly(amidoamine)s, Biobased Hydrogels

Poly(amidoamine)s or PAAs are polymers synthesised through the reaction of carbonyl group with amines. PAAs can be modified based on the application requirements; one such example is hydrogel synthesis [1]. Hydrogels are three-dimensional hydrophilic polymer networks extensively swollen with water. One of the major disadvantages of these PAAs are their fossil-based origins. One such way to avoid those is to use biobased or renewable monomers for the polymerization. Renewable monomers sourced from plants and bio-feedstocks can be used as a suitable substitute for the synthesis of chemicals, building blocks, and biopolymers in this context [3].
In the present work, novel hydrogels were synthesized by post-modification of a bio renewable Tulipalin A (α-methylene-γ-butyrolactone or MBL)- based polymer. This involves the polyaddition step-growth polymerization of MBL and diamines, resulting in the formation of poly(amidoamine)s (PAAs), followed by post-polymerization modifications into hydrogels. Prepared hydrogels with various compositions were investigated for their swelling, morphology, cytotoxicity, mechanical, and thermal properties.



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OPTICAL DETECTION OF PFAS IN WATER USING A PVDF-COATED FABRY–PÉROT SENSOR

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Keywords:
Fiber-optic chemical sensor, Fabry–Pérot interferometer, Per- and polyfluoroalkyl substances (PFAS), Environmental detection, Polyvinylidene fluoride (PVDF).

Per- and polyfluoroalkyl substances (PFAS) pose a significant threat to aquatic environments due to their exceptional chemical stability, high mobility, and proven biological toxicity. Conventional analytical techniques such as LC-MS/MS, while highly sensitive and selective, are costly and unsuitable for field deployment or continuous monitoring. To address these limitations, a prototype fiber-optic sensor based on a Fabry–Pérot interferometer (FPI) was developed for PFAS detection in water. The sensor employs a single-mode optical fiber, chemically etched to enhance adhesion of a polyvinylidene fluoride (PVDF) thin film. PVDF exhibits high sorptive affinity toward PFAS, leading to measurable spectral shifts. Laboratory tests confirmed sensitivity to selected PFAS compounds, with spectral responses correlating to analyte concentration. The impact of cavity geometry and PVDF layer thickness on sensor performance was also evaluated. Due to its compact, passive design, the sensor shows promise for miniaturization and integration into portable in situ monitoring systems. These results form a basis for further work on improving selectivity, broadening the detection range, and adapting the sensor for real-world environmental applications.

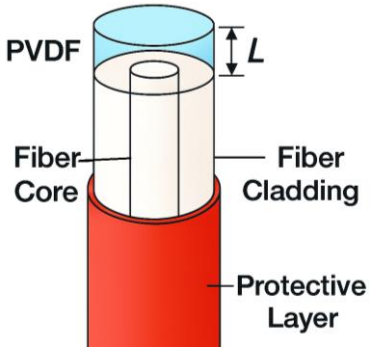

Figure: Schematic of the Fabry–Pérot sensor

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SYNTHESIS, SPECTROSCOPICAL EVALUATION AND ELECTROCHEMICAL POLYMERISATION OF *N*-SUBSTITUTED PERIMIDINE DERIVATIVES

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Keywords:
Perimidine, Electropolymerization, *N*-alkylation, Sodium pyrosulfite

Perimidine, a versatile nitrogen-containing heterocycle containing two reactive amine groups, holds significant promise in both medicinal chemistry and optoelectronic applications. In this study, we report the synthesis and characterization of a series of novel and known derivatives of 2,3-dihydro-1*H*-perimidine, 1*H*-perimidine, and 1-ethyl-1*H*-perimidine. The synthetic route involves a three-step sequence: condensation of naphthalene-1,8-diamine with aromatic aldehyde, oxidative dehydrogenation using sodium pyrosulfite, and *N*-alkylation. The resulting compounds were purified and characterized by ^{1}H and ^{13}C NMR spectroscopy, along with CHN elemental analysis. Their photophysical and electrochemical properties were systematically investigated to highlight the crucial role of free –NH groups in electropolymerization processes and underscore the potential of perimidine-based scaffolds as tunable building blocks for organic electronic materials.

Acknowledgement:
The work was supported by National Science Centre, Poland, research project no. 2021/41/B/ST5/03221.

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INVESTIGATION OF DEGRADATION PROCESSES OF NOVEL POLYMER BLENDS BASED ON MASS LOSS, SURFACE MORPHOLOGY, AND ACTIVE SUBSTANCE RELEASE

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Keywords:
Blends; Degradation; Active Substance

In response to the growing need to reduce the environmental impact of plastics, intensive research is being conducted to develop biodegradable functional materials that can serve as carriers for active substances in agrochemistry. Particularly promising are polymer blends that enable the controlled release of fertilizers and pesticides, while simultaneously degrading under environmental conditions [1].

This study presents the results of (bio)degradation and active substance release from novel polymer blends: poly(vinyl alcohol)/polymethylene-co-cyanoguanidine/urea (PVA/PMCG/U) and polyhydroxybutyrate/polypropylene carbonate/polylactide (PHB/PPC/PLA) with metazachlor. The polymer films were incubated in soil and water, and changes in surface morphology (optical microscopy, SEM), mass loss, and active substance release (UV-Vis) were analyzed.

The PVA/PMCG/U samples underwent faster degradation, showing more pronounced surface damage and greater mass loss than the PHB/PPC/PLA + metazachlor films. In water, morphological changes were less noticeable, but mass loss still occurred. The more rapid degradation of the PVA/PMCG/U films correlated with a more intensive release of urea, while in the case of PHB/PPC/PLA, the process was more prolonged over time.

The results suggest that the developed polymer blends may have potential applications in agriculture.

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A REVIEW OF CARBON NANOTUBE POLYMER COATINGS FOR CLIMATE-RESILIENT ANTI-ICING AND DEICING APPLICATIONS

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Keywords:
Carbon nanotubes, anti-icing, deicing, coating

Ice accumulation is a growing concern in industrial settings, affecting aircraft, power lines, roads, telecommunications facilities, and wind-turbine blades.[1] Polymer-based coatings offer passive operation, durability, cost-effectiveness, safety enhancements, environmental benefits, versatility, and efficiency in ice management.[2] Carbon nanotubes (CNTs) emerge as a promising nanofiller for coatings that prevent or remove ice.[3]
The analysis of the literature reveals that existing solutions are divided into categories: phobic, photothermal, electrothermal coatings, and their hybrids. Among the categories, both single- and multiwalled CNTs are applied in a pristine or modified form. Various polymers were studied, e.g., polydimethylsiloxane, epoxy and silicone resin, and fluorinated polymers. The preparation of coatings considers dispersing CNTs by ultrasonication, mechanical stirring, or grinding, and applying them mostly by spray-coating. Due to the diversity of applications, various substrates were examined, such as glass, paper, metals and alloys, polymers, wood, cement, and asphalt. The review also discusses methods of indicating anti-icing and deicing properties - freezing and melting time, ice accumulation tests, frosting and defrosting time, and flow environment experiments.

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