ABSTRACT BOOK

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Keynote Presentations:

Transformative, Waste Plastics Recycling & Measurement Technologies

Prof. Amit Goyal

New York State (NYS) Center for Plastics Recycling Research & Innovation and Department of Chemical & Biological Engineering (CBE), University at Buffalo, Buffalo, NY 14260.

Abstract:

Details on three platform technologies developed at the New York Center for Plastics Recycling Research & Innovation will be presented. These include: (a) Advanced cost-effective, sorting technology that can also sort black plastics titled Three-Dimensional Transient Thermal Barcode for Waste Plastic Identification [1]; (b) At present, there is no method that can accurately determine the percentage of recycled plastic content in a plastic product. We have developed a multi-modal, multi-physics approach that integrates triboelectric properties, dielectric/impedance spectroscopy, capacitance measurements, mid-infrared spectroscopy, combined with machine learning and artificial intelligence to quantify the recycled content in plastics [2]; and (c) Nanoplastics (of sizes 1nm – 100nm) are now considered the new emerging contaminant with nanoplastics being found in almost all organs of the human body including the brain, with increasing evidence of deleterious health effect. Yet, there is no method to determine their compositions, amounts present, toxins absorbed on their surfaces, etc. We have developed a novel microcantilever-based platform that integrates dielectrophoretic preconcentration with photothermal cantilever deflection spectroscopy to enable capture, mass measurement, and chemical identification of nanoplastics within a single unified microsystem.

References:

(1) Singh, K., Thundat, T. & Goyal, A. Three-dimensional transient thermal barcode for waste plastic identification. Nature Commun Eng 5, 119 (2026). https://doi.org/10.1038/s44172-026-00703-7.

(2) Zhao, Y., Adhivarahan, C., Jyothula, C.L. et al. Determining the percentage of recycled plastic content in a plastic product. Nature Commun Eng 5, 51 (2026). https://doi.org/10.1038/s44172-026-00639-y.

(3) Jannabhatla, N. K., Singh, K., Thundat, T. & Goyal, A. Capture–Weigh–Fingerprint Nanoplastic Characterization on a Dielectrophoretic Microscale Platform, Under Review, for publication in Nature Commun. Sustainability.

Degradable and Functional Aliphatic Co-polyesters: Chemical Strategies for Synthesis and Recycling

Daniela Pappalardo*

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Abstract:

Climate change alarms are driving industry and academia to reduce fossil fuel dependence. As a sustainable alternative, aliphatic polyesters – such as polylactide (PLA)- are emerging, due to their natural origin and biodegradable properties. Copolymerization may allow to fine tuning the material properties by varying composition, molecular weight and architecture.

This contribution will highlight synthetic strategies for the preparation of co-polyesters with controlled composition and architecture: the ring-opening polymerization (ROP) of lactones and lactides and the

chemo-selective ter-polymerization of cyclic esters, epoxides, and anhydrides. The focus will be on the use of aluminum alkyl complexes bearing salicylaldiminato ligands as versatile catalysts for the ROP of various cyclic esters, including the ROP of 'non-conventional' monomers, such as macrolactones and thiol-functionalized monomers.

The use of mono- and bimetallic aluminum complexes bearing phenoxyimine and salen-like ligands for the preparation of semi-aromatic polyesters by the alternating ring-opening co-polymerization (ROCOP) of different epoxides, including limonene oxide, and various anhydrides, will be discussed.

Finally, a mention will be given to the chemical recycling strategy and repurposing of PLA wastes, which afforded unsaturated PLA oligomers, which were exploited as building blocks for the production of cross-linked materials.

Short Biography:

Daniela Pappalardo is full Professor of Inorganic Chemistry at the University of Sannio, Department of Science and Technology, in Benevento, Italy. Her core research in polymer chemistry focuses on the synthesis of novel polymeric materials, functionalization of natural and synthetic polymers, microstructural characterization, and the study of applications.

Her research aligns with competitive grants where she served as the local principal investigator at the University of Sannio. On an international level, she was the project leader for a tissue engineering materials project at the KTH Royal Institute of Technology in Sweden, funded by VINNOVA and Marie Curie Actions (2014–2017).

Luminescent Sensing Materials for Real-Time Monitoring

Helen Willcock

Department of Materials, Loughborough University, Loughborough, Leicestershire, UK

Abstract:

Globally, water pollution is rapidly increasing, destroying aquatic ecosystems, endangering human lives, and costing billions. The limitations of current water monitoring technologies, including inconsistencies, high costs, and practical limitations, restrict spatial coverage and reduce high-temporal data, which are both crucial for effective pollution detection. We have developed a hydrogel based sensing material that fluoresces when in contact with target pollutants (e.g., phosphate), allowing for accurate, real-time, onsite quantification without requiring multiple reagents or complex preparation. This novel sensing platform is reusable, has a rapid and easy-to-interpret signal and offers multi-analyte detection capabilities. The material can be integrated into existing instrumentation and engineered for different pollutants. This presentation will show the reusability, stability over time, and the detection and quantification of bicarbonate as a model system. [1] Highlights of the development of this and polymeric imaging agents will be shown, including novel synthetic methods allowing exquisite control over size, shape and composition. [2] [3]

1. S. E. Bodman, C. Breen, A. R. Hambleton, S. J. Butler and H. Willcock. Chemical Communications, 2024, 60, 284-287. Europe (EP3844241A1), United States (US2021230479A1) and Australia (AU2019328725A1).

2. T.R. Berki, J. Martinelli, L. Tei, H. Willcock, S.J. Butler. Chemical Science, 2021, 12, 3999-4013.

3. C. J. Marsden, C. Breen, J.D. Tinkler, T.R. Berki, D. W. Lester, J. Martinelli, L. Tei, S. J. Butler, H. Willcock. Polymer Chemistry, 2022, 13, 4124-4135.

Biography:

I am a Reader within the Department of Materials at Loughborough University, leading a diverse and multidisciplinary group focused on the control of polymer properties by tuning architecture and functionality, particularly stimuli-responsive polymer particles. Much of our research is focussed on the development of responsive systems, for applications including sensing in water and soils to monitor climate change and polymeric scaffolds for medical imaging. I currently supervise a group of 2 PDRAs and 7 PhD students.

I have secured over £2.5 million funding, have given 27 invited lectures, and have extensive experience working with Industry to deliver applications-based research.

Exploring Strategies for More Sustainable Polymer-based Composites Across their Life Cycle

Alberto Jiménez Suárez, Universidad Rey Juan Carlos, Spain

Valorization of HoReCa Waste for the Development of Food Packing Materials

Marina P. Arrieta Dillon, Universidad Politécnica de Madrid (ETSII-UPM), Spain

Understanding Anion-Exchange Membranes in Dry-Cathode Water Electrolysis

Liliana A. Díaz Palacios[a*] and Borja Espadiña Osorio[a], José A. Coca-Clemente[a] and Rodrigo García-Muelas[a]

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Abstract:

Anion-exchange membranes (AEMs) are primarily evaluated for hydroxide conductivity, ion-exchange capacity, and stability under alkaline conditions. In anion-exchange membrane water electrolysis (AEMWE), their role extends beyond OH^- transport, particularly under dry-cathode conditions, when alkaline solution is supplied only to the anode and the membrane must transport water to the cathode.

The chemical architecture of AEMs, including the nature and distribution of fixed cationic groups along the polymer backbone, governs membrane hydration and ion-conducting domains, and may consequently affect the coupled transport of OH^- and water. To assess how these polymer-related properties translate into electrolyser performance, we evaluated commercial AEMs based on different polymer chemistries and cationic functionalities in a 5 cm^2 dry-cathode AEMWE cell. We investigated Sustainion, PiperION, Orion, and Fumasep membranes with NiFe-based anodes and NiFeCo cathodes in 1 M KOH. We compared catalyst layers containing membrane-compatible AEM ionomers with directly electrodeposited electrodes without added ionomer. Electrochemical performance was evaluated using galvanostatic polarisation measurements and chronopotentiometric durability testing.

Clear differences emerged under dry-cathode conditions, with Sustainion-based cells exhibiting the lowest operating voltages. These differences were more notable in ionomer-containing catalyst layers, while electrodeposited electrodes without ionomer showed lower operating voltages and reduced variability among membranes. The findings suggest that AEMWE performance is influenced not just by the membrane's hydroxide conductivity, but also by hydration, water transport, and the interfacial environment with the ionomer-catalyst assembly. This emphasizes the need for designing AEM materials that address both ionic conduction and water management, especially in dry-cathode applications.

Short Biography:

Liliana A. Diaz leads the Low-Temperature Electrolysis and Fuel Cells research line at the Iberian Centre for Research in Energy Storage (CIIAE). She has over 14 years of experience in hydrogen production and utilization, spanning laboratory research, materials and membrane development, electrochemical component validation, and pilot-scale systems. Her expertise particularly covers ion-exchange membranes and materials for low-temperature water electrolysis, bridging materials development with their validation under relevant operating conditions. Her experience also includes renewable gas transport, H_2/CH_4 blends, and technical assessment of hydrogen refuelling infrastructure.

Oral Presentations

CFD-Assisted Development of Reactive Extrusion Polymerization: From Lab-Scale Formulations to Industrial Extrusion Systems

Elham Delvar[*a,b], Cláudia Silvaa,[b], Margarida Britoa,[b], Inês Oliveiraa,[b], Filomena Barreiro[c], Aran Arantzazu Santamaria[c], Ricardo Santosa,[b]

[a] *ALiCE - Associate Laboratory in Chemical Engineering, Faculty of Engineering, University of Porto, Portugal*

[b] *Laboratory of Separation and Reaction Engineering – Laboratory of Catalysis and Materials (LSRE-LCM), Faculty of Engineering, University of Porto, Portugal*

[c] *Laboratory for Sustainability and Technology in Mountain Regions, Polytechnic Institute of Bragança, Portugal*

Abstract:

The development of product formulations for the Reactive Extrusion Process (REX) typically occurs at the laboratory scale. However, replicating the mixing conditions used in industrial machinery poses a significant challenge, and these conditions affect material properties in reactive processes.

This work proposes a product development method for REX based on rotational devices, a cone-plate rheometer, and Computational Fluid Dynamics (CFD) tools to introduce a sustainable polyurethane performance process of interest to the footwear industry. An experimental protocol to assess reactive polymerization has been developed based on CFD simulations and linked to conditions in an industrial reactive extruder. This work integrates multiphase flow modelling for two immiscible fluids (i.e., isocyanate and polyol), reaction engineering, and polymer processing to better understand mixing mechanisms and support industrial scale-up of reactive extrusion processes. This work aims to bridge fundamental research with industrial applications by developing predictive models that assist in product formulation and process design. Despite extensive CFD-based modeling of mixing in REX, it remains challenging due to the intricate interplay among mixing, heat transfer, chemical reactions, and non-Newtonian fluid behavior under high shear rates and temperature gradients. These challenges are further intensified by multiphase flows and the complexity of extruder geometries. Future advancements should enhance simulation accuracy, incorporate multiphase flow models, and use real-time sensor data for adaptive modeling.

Short Biography:

Elham Delvar is a PhD student in Chemical and Biological Engineering at the University of Porto and an FCT-funded doctoral grant holder. My research focuses on the development of sustainable bio-based polyurethane systems through reactive extrusion, combining experimental rheology with advanced Computational Fluid Dynamics (CFD) simulations using ANSYS Fluent.

Thermal History-Driven Crystallization in Thermoplastic Composite Thermoforming: Linking Process Conditions to Microstructure and Performance

Adrian Pedrosa Valbuena[a*], Mattia Mazzeschi[a] and Esteban Cañibano Alvarez[a]

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Abstract:

The performance of thermoplastic composite structures is governed by their microstructure, which is highly sensitive to the thermal history experienced during processing. In thermoforming, rapid heating, transfer, and controlled cooling generate transient, non-uniform temperature fields that directly influence crystallization kinetics and structural evolution across the laminate thickness.

This work investigates the relationship between process-induced thermal histories and crystallization behavior in thermoplastic composite laminates during thermoforming through a combined experimental-numerical approach. Transient thermal fields are predicted to use a finite element model implemented in

PAM-FORM, accounting for heat transfer during heating, transfer, mold contact and cooling. These simulated temperature-time histories, validated against embedded thermocouples and infrared thermography measurements, serve as input for a post-processing framework based on Avrami-type crystallization kinetics to estimate local crystallinity distributions.

The study considers representative laminate architectures (woven and unidirectional) and multiple thickness configurations, highlighting the role of anisotropy and through-thickness thermal gradients in driving heterogeneous crystallization. The predicted crystallinity fields are correlated to differential scanning calorimetry (DSC) measurements and mechanical properties, establishing quantitative relationships between thermal cycle, microstructure, and performance.

Results show that variations in cooling rate and mold temperature lead to spatial differences in crystallinity, directly impacting mechanical response and dimensional stability. Beyond process understanding, this correlation framework enables real-time process control and predictive models, enabling the adjustment of thermoforming parameters to achieve targeted microstructures and properties in advanced thermoplastic composites.

Biography:

R&D Engineer specialized in advanced composite materials and numerical simulation, with experience in automotive and aerospace applications. Currently at CIDAUT (Advanced Materials, Product and Process), contributing to industrial-oriented R&D projects. His work focuses on the integrated design and optimization of composite components, covering the full development cycle from modeling to experimental validation. He has strong expertise in structural analysis and manufacturing process simulation (RTM, forming, injection) using advanced CAE tools. He is also pursuing a PhD in Industrial Engineering on multiscale and physics-informed machine learning methods for efficient and industry-ready simulation of CFRP structures.

Enhancing Foaming Behavior of Biobased PHBV Through Chain Extension

Malvina Boutigny[a*] and Holger Ruckdäschel[a]

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Abstract:

In 2025, global primary plastic production reached approximately 450 million metric tons, with only about 0.5% derived from biobased polymers. Given the environmental drawbacks of fossil-based plastics, developing sustainable alternatives has become a priority. Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) is a bacterially synthesized polyester considered a promising substitute for conventional plastics, particularly in packaging due to its excellent oxygen barrier properties. Even though the foam packaging market keeps increasing, research on PHBV foams remains limited because of their low melt viscosity and thermal sensitivity.

This project aimed to modify PHBV using two chain extenders, multifunctional epoxide (ME) and polycarbodiimide (PCD) at different concentration (1, 2 and 4 wt%) to enhance molecular weight, increase viscosity, and improve stability during processing. Reaction was first investigated in a µ-compounder by monitoring force over residence time. The viscosity of the modified PHBV was evaluated and correlated with the stabilization effect. PHBV was then modified and physically foamed with CO_2 as a blowing agent in a twin-screw extruder. Blowing agent and chain extender content were varied. Foam morphology was analyzed by SEM, and foam density was determined.

Results showed that ME chain extender effectively stabilized PHBV and increased its molecular weight due to branching while PCD helps compensate degradation. This was shown as well on the viscosity curves. Lower CO_2 content favored reduced foam density. The lowest density achieved was 0.270 $g \cdot cm^{-3}$ for PHBV containing 1 wt% ME and 0.6% CO_2.

Biography:

I have been working as a research assistant at the Department of Polymer Engineering in the Polymer Foams Division since October 2023. My scientific work is focused on the foaming behavior of biobased and biodegradable polymers.

From 2020 to 2023, I studied Material and Sustainable Development at ESIREM Engineering School (France). During those three years, I did first an internship at the Lehrstuhl für Kunststofftechnik (LKT) in Erlangen and focused on the thermoforming of recycled polypropylene. I did a second internship focusing on the elaboration of biobased chitosan resins for micro-electronic applications, at the Institute of polymer materials (IMP) (France).

Synergistic Effects of and Low-content $CaCO_3$ and LDH on the Melt Stability and Thermomechanical Performance of PLA Composites

Erika Varga[a*], Gergely Tóth[a], Péter Gerse[a]

[a]John von Neumann University, GAMF Faculty of Engineering and Computer Science, Department of Innovative Vehicles and Materials, 6000-Kecskemét, Hungary

Abstract:

Poly (lactic acid) (PLA), despite its strong potential as a sustainable industrial polymer, remains challenged by the simultaneous optimization of stiffness, toughness, thermal resistance, and processability. This study identifies morphology-dependent competing mechanisms of 0.5-1 wt.% layered double hydroxide (LDH) and different sized calcium carbonate ($CaCO_3$) fillers in PLA across multiple loading and thermal conditions. Scanning electron microscopy (SEM) revealed weak interfacial adhesion and increased water uptake with a dependence on the hydrophilic-barrier balance of the fillers. Thermogravimetric analysis (TGA) showed char formation and filler-enhanced degradation. Differential scanning calorimetry (DSC) confirmed inherently amorphous structure, and a complex behavior during cold crystallization was revealed resulting in 50-70% Xc with different a'/a crystalline ratios between 50-90%. Heat deflection temperature (HDT) results indicated that low filler content decreased thermal resistance due to stress concentration by a maximum of 2.8 °C, while higher concentration improved it via restriction of chain mobility, in which LDH provided greater stability. However, LDH reduced tensile properties (sm from 63.1 to 53.7 MPa) and promoted brittle behavior, whereas $CaCO_3$ improved energy absorption, particularly under prolonged loading. In the molten state, the storage and loss moduli, and complex and zero-shear viscosities decreased more significantly in the presence of weakly interacting lamellar LDH, while all the fillers stabilized PLA under prolonged oscillatory force at 230 °C. Hybrid systems exhibited competing effects, depending on the test conditions.

The findings provide new insights into the morphology-dependent structure–property relationships of PLA hybrid composites and support the design of thermally and mechanically balanced biodegradable materials.

Biography:

Dr. Erika Varga obtained her PhD in Chemistry in 2016 specializing in catalyst surface studies related to hydrocarbon and hydrogen production. She gained industrial experience in the automotive as well as in the chemical industry at departments of quality assurance and R&D. At the moment she is an associate professor at the Department of Innovative Vehicles and Materials at John von Neumann University (Hungary), where her work focuses on hydrogen technology and polymer material developments.

Geometric Effects on the Bond Performance of CFRP-Strengthened Polyethylene Joints: A Parametric Study

RAPHAEL W. [a*], HACHEM G.[a] and FADDOUL R.[a]

[a]*Saint-Joseph University of Beirut, School of engineering ESIB, Beirut, Lebanon*

Abstract:

Polyethylene storage tanks are lightweight and corrosion-resistant; however, their relatively low mechanical strength and weak adhesive compatibility create challenges for externally bonded fiber-reinforced polymer repair systems. This study presents an analytical parametric extension of a previously published experimental programme on carbon fiber-reinforced polymer (CFRP)-strengthened linear low-density polyethylene (LLDPE) joints. The original experiments considered 4 mm-thick polyethylene specimens with widths of 25 and 45 mm, strengthened on both sides with CFRP laminates. The measured CFRP–polyethylene bond strengths ranged from 0.064 to 0.091 MPa, while anchorage lengths exceeding approximately 450 mm shifted the governing failure mode from interfacial slippage to polyethylene substrate failure.

Using the force-equilibrium model calibrated against the experimental results, additional configurations with widths up to 60 mm and thicknesses up to 6 mm were analytically evaluated. Increasing the polyethylene cross-section from 45 × 4 mm to 60 × 6 mm increased the nominal substrate yield capacity from 2.88 to 5.76 kN. Increasing the specimen width raised the substrate tensile resistance and available bond area proportionally and therefore did not directly affect the theoretical anchorage-length requirement. Conversely, increasing the substrate thickness from 4 to 6 mm increased the force transferred through the bonded interfaces and resulted in an estimated 50% increase in the required anchorage length. These findings indicate that substrate thickness has a greater influence than width on the anchorage requirements of CFRP–polyethylene joints. The proposed parametric framework supports the preliminary design of externally bonded CFRP repairs for polyethylene tanks with different wall geometries, while further experimental testing is required to validate the predicted configurations.

Biography:

Dr. Raphael is a Professor of Civil Engineering and the current Dean of the Faculty of Engineering – ESIB, at Saint-Joseph University of Beirut. He graduated as a civil engineer from ESIB. He got his PhD from Ecole Centrale Paris, France and the HDR form niversité Blaise Pascal France.

His research and teaching activities concentrate on design and behavior of concrete structural systems, structural integrity, materials, reliability approaches, dynamic programming, road safety, etc.

Prof. RAHAEL has numerous research publications in prestigious international journals and conference proceedings, and has accumulated an outstanding record of outreach activities and services in government and non-government organizations.

Development of Conductive Filament for 3D Printing

Jan Sezemský[*], Zdeňka Jeníková, Petr Špatenka[a]

[a]*Czech Technical University in Prague, Faculty of Mechanical Engineering, Department of Materials Engineering, Prague, Czech republic*

Abstract:

This work focuses on the research and development of an electrically conductive filament designed for fused deposition modeling (FDM) 3D printing. The primary objective was to optimize the concentration of conductive fillers in the polymer matrix to achieve a synergistic balance between enhanced mechanical properties and electrical conductivity. This effect was attained by using carbon fibers and carbon black. Particular attention was paid to achieving enhanced strength and processability suitable for additive manufacturing applications. Based on the optimized material composition, samples with different infill orientations and densities were fabricated using 3D printing technology, and their electrical and heating

characteristics were evaluated. To demonstrate the practical viability of the developed conductive filament, a functional object was designed and printed. The experimental results confirmed that the optimized material provides a reliable thermal response when subjected to an electric current, and is thus suitable as a functional heating element. The developed material represents a promising approach for multifunctional 3D-printed components, particularly in applications requiring integrated heating functionality and tailored material performance. This study highlights the potential of conductive composite filaments for advanced additive manufacturing applications.

Short Biography:

Jan Sezemský has obtained the doctoral degree in materials and production engineering at the Czech Technical University in Prague in 2024. He currently works as an assistant professor and a researcher in the Department of Materials Engineering in the field of non-metallic materials. His major research focus is on sandwich materials produced by rotational molding and functional materials for 3D printing.

Effect of Plasma Treatment of Carbon Nanofibers on Cure Inhibition, Thermal Stability and Mechanical Performance of Elium Nanocomposites

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[a]Depatment of Materials Engineering, Faculty of Mechanical Engineering, Czech Technical University, Prague, Czech Republic

Abstract:

Recently, infusible thermoplastic resin Elium® has gained attention due to recyclability, weldability and ease of processability as compared to its thermoset counterparts. Carbon nano fibers (CNFs) are widely employed as nano-reinforcements in polymers to improve mechanical performance while simultaneously imparting multifunctionality. This study is the first systematic investigation on effect of low-pressure air plasma treatment of CNFs as a strategy to improve dispersion and reduce radical scavenging in Elium-based nanocomposites. It comprehensively characterises the effects of treatment on cure behaviour, thermal stability and mechanical performance using DSC, TGA and flexural testing. CNFs are observed to inhibit the curing process, resulting in reduced barcol harness (25%), glass transition temperature (Tg) at second heating (12%) with increased mass loss at heating till 250 °C (4.8%), as compared to pristine resin. Plasma treated CNF, when dispersed in resin show improvements as compared to untreated CNFs while increasing barcol hardness (13%), Tg (6%), flexural strength (7%) with reduction in mass loss at 250 °C (1.2%). Although, plasma treated CNFs, effectively reduce agglomeration and improve curing behaviour but mass loss remain lower and Tg remain higher for pristine Elium than any of the CNF dispersed resin. Moreover, flexural strength improvement is observed in CNF dispersed resin as compared to pristine resin (10%), which is further enhanced with Plasma treatment of CNFs (18%). Hence, air plasma treatment introduces oxygen-containing functional groups on CNF surfaces, improving wettability in Elium resin, promoting uniform dispersion, reducing radical-scavenging-induced cure inhibition and consequently improving mechanical and thermal properties.

Biography:

PhD researcher at the Czech Technical University in Prague, specializing in polymer and composite materials. My research focuses on advanced fiber-reinforced composites, thermoplastic acrylic resins, nanocomposites, and ballistic impact protection. Currently, I am working on infusible thermoplastic resin Elium for development of sustainable and repairable eco-friendly thermoplastic composites for impact loadings. Current work investigates the mechanical and thermal performance of nanofiber reinforced Elium based nano composites to be used in future applications for impact protection in Kevlar fibre reinforced polymer composites.

Numerical Assessment of Thermal and Electromagnetic Performance of Polymeric Enclosures for Automotive Battery and Power Electronics Applications

Lourenço Bastos[a*], Ângelo Marques[a], Rui Oliveira[a], Luciano Rietter[a], David Serrão[a] and Filipa Carneiro[a]

[a]PIEP - Innovation in Polymer Engineering, Guimarães, Braga, Portugal

Abstract:

The increasing electrification of the automotive industry is driving the development of lighter and more compact battery packs and power electronics systems, creating new challenges in the design of their protective enclosures. The replacement of conventional metallic components by polymeric materials offers significant opportunities for weight reduction and functional integration, but requires careful assessment of thermal, mechanical and electromagnetic performance. This work presents an approach based on multiphysics numerical simulations for the design and evaluation of polymeric enclosures for battery packs and high-power electronic systems intended for refrigerated commercial vehicles. Particular attention is given to two critical performance areas: thermal management and electromagnetic (EM) shielding. Computational fluid dynamics (CFD) and thermal simulations were performed to evaluate heat dissipation and temperature distribution within the system, considering different cooling strategies, including air- and water-based cooling, as well as variations in cooling-channel geometry and dimensions. In parallel, electromagnetic simulations were conducted to predict the propagation and intensity of electromagnetic fields and to assess the shielding performance of the enclosure under external electromagnetic interference. The use of a polymeric enclosure introduces a complex balance between thermal performance, electromagnetic protection, weight reduction and design constraints. The results demonstrated the potential of numerical multiphysics tools to support the development and optimization of polymeric enclosures for automotive electrification, providing a methodology for assessing their suitability for demanding battery and power electronics applications

Short Biography:

Master's degree in Polymer Engineering (2015) from University of Minho, specialized in material science, material modelling, polymer processing and numerical simulation. Currently working as a research and development engineer at PIEP – Innovation in Polymer Engineering and mainly focused in Computer Aided Engineering, with 8+ years of experience in research and development working for different industries, namely automotive, medical, civil, and others.

Silicone Rubber Self-Fusing Material With a TFP-Enabled interconnected Dual-Dynamic Network

Aadil Rasoliwala[*a], Abhijit P.Deshpande [a] and Susy Varughese [a]

[a]Indian Institute of Technology Madras, Chennai, 600036 India

Abstract:

Self-fusing silicone elastomers are promising materials for electrical insulation, sealing, cable protection, and repair, where mechanical strength must be combined with reversible interfacial bonding. In this work, a dual-dynamic-network silicone elastomer was developed by combining a permanent Vinyl Methyl Siloxane (VMQ) silicone network with two dynamic components: a boron-containing silicone network and an amine-functional silicone network. The study explores a multifunctional aromatic aldehyde architecture to introduce greater dynamic connectivity than conventional difunctional aldehydes.

Using an isophthalaldehyde-based formulation as the reference, a tensile strength of 2.66 MPa was obtained, whereas the developed formulations achieved an average tensile strength of approximately 3.91 MPa, corresponding to a 47.0% improvement. These improvements were obtained within a controlled hardness range of 40 ± 5 Shore A, together with enhanced tear resistance. The improved mechanical performance is attributed to increased network functionality and dynamic interconnection between the silicone phases.

Notably, a formulation with comparatively lower imine-network contribution still demonstrated improved mechanical and interfacial performance, indicating that overall network architecture and multifunctionality, rather than imine content alone, govern the resulting properties.

FTIR analysis showed a C=N band at ~1612 cm^{-1}, supporting imine formation, and a Si–O–B-related band at ~1345 cm^{-1}, supporting boron–oxygen interactions. FTIR and NMR analyses support investigation of the mechanisms underlying the observed mechanical improvements. Contact-angle measurements confirmed the hydrophobic nature of the silicone surface, demonstrating its potential for water-repellent behavior under rainwater exposure and applications in high-voltage cable insulation and protection.

Melt electrowriting for Flexor Tendon Repair: Introducing α-amino Acid Poly(ester amide)s

Brebels J.[a], [*],Saraiva S.[b], Agten H.[a], Smet M.[c], Fonseca A. [C.b], Bloemen V.[a] and Mignon A.[a]

[a]*Department of Materials Engineering, Surface, and Interface Engineered Materials (SIEM), KU Leuven, Belgium*

[b]*CEMMPRE, ARISE, Department of Chemical Engineering, University of Coimbra, Portugal*

[c]*Department of Chemistry, Laboratory of Organic Material Synthesis, KU Leuven, Belgium*

Abstract:

In the biomedical field, scaffolds engineered by electrospinning (ES) and melt electrowriting (MEW) are promising for mimicking the hierarchical structure of native tendon and surrounding tissue. However, most strategies rely on poly(ε-caprolactone) (PCL), which suffers from slow biodegradation linked to possible inflammatory responses long-term due to acidic degradation products. This study explores α-amino

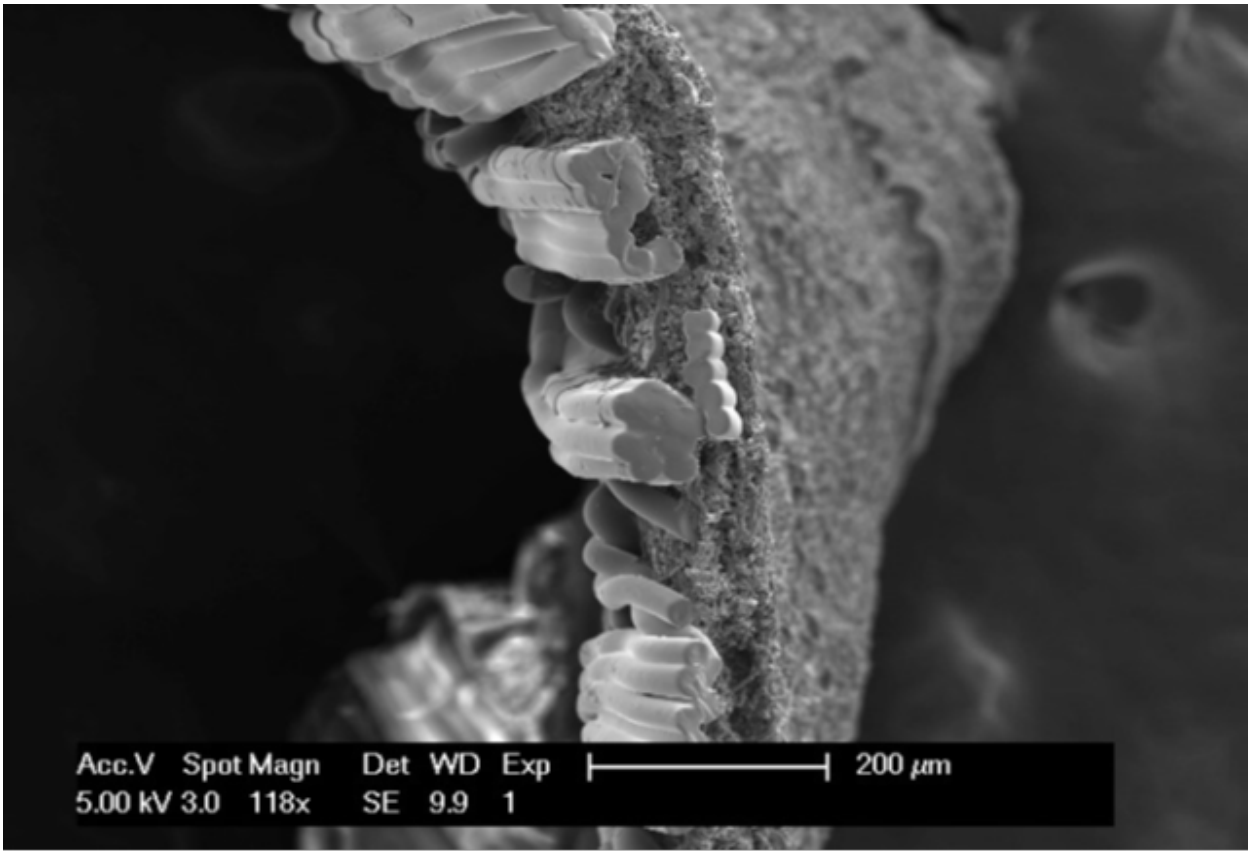


Figure 1. Double-layered tubular scaffold combining ES and MEW from Phe-PEA44.5k

acid–based poly(ester amide)s (AAA-PEAs), specifically, L-phenylalanine-derived PEA (Phe-PEA44.5k), as alternative to PCL for flexor tendon repair. The polymer was synthesized and characterized, then processed via ES and MEW into fibrous sheets and aligned multilayered constructs. It showed reduced hydrophobicity compared to PCL, suggesting improved cell interaction. ES produced high-quality fibers (~1.54 µm ± 0.40 µm diameter), and MEW enabled stable fabrication up to 15 layers. In vitro degradation studies in phosphate buffered saline solution indicated >80% mass remaining after 8 weeks, faster than PCL, yet sufficiently stable for flexor tendon healing. Mechanical testing revealed high elasticity (strain >400%) and strength (>30 MPa). Biocompatibility assays demonstrated >95% cell viability and 450–550% proliferation after 5 days indirect incubation. A proof-of-concept double-layered tubular scaffold was fabricated by combining MEW (inner aligned layer) and ES (outer random layer) using a reduced winding angle design (See Figure 1). Ongoing work includes in vitro tenocyte studies and ex vivo mechanical testing. Overall, Phe-PEA44.5k shows improved biodegradation, mechanical performance, and cytocompatibility compared to PCL, supporting its potential as a biomaterial for flexor tendon repair and expanding the MEW-compatible materials library.

Acknowledgements:

This work was supported by the Research Foundation – Flanders (FWO), grant: 1SH1D24N, fellow: J.B.

Biography:

Jef earned his master's degree in Chemical Engineering at KU Leuven, focusing on the characterization of precious metals in pharmaceutical waste streams in collaboration with industry (Indaver, Antwerp). While completing his master's, his interests shifted toward the biomedical field. He is now pursuing a PhD (1SH1D24N) at KU Leuven under Prof. A. Mignon and Prof. V. Bloemen. Combining expertise in polymer synthesis and processing, he explores electrospinning and melt electrowriting to develop flexor tendon repair strategies. During a research stay at the University of Coimbra, Portugal, he further strengthened his expertise in polymer synthesis and expanded his international research network.

Melt-Flow and Crystallization Trade-offs in Extruded HDPE/MWCNT-OH Nanocomposites

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Abstract:

Nanotube addition can change the flow and crystallization behavior of high-density polyethylene (HDPE), but these responses need not improve together. This study evaluates their balance in an Omani HDPE grade compounded with hydroxyl-functionalized multi-walled carbon nanotubes (MWCNT-OH). Formulations containing 0-5 wt.□% MWCNT-OH were prepared by twin-screw extrusion and compression molding. Melt flow rate (MFR) was measured at 190 °C under a 5 kg load, and differential scanning calorimetry was performed at heating and cooling rates of 10 °C/min. MFR decreased from 0.38 to 0.14 g/10 min across the series, corresponding to a 63.2% reduction at 5 wt.□%. The melting-peak temperature remained between 129.24 and 130.53 °C, while the crystallization peak increased from 114.32 °C for unfilled HDPE to 118.36 °C at 5 wt.□%. A composition-screening map combined relative melt-flow retention with crystallization-peak shift. At 1 wt.□%, the formulation retained 73.7% of the reference MFR with a 2.55 °C peak shift; at 3 wt.□%, it retained 63.2% with a 3.50 °C shift. Increasing the loading from 3 to 5 wt.□% reduced MFR by a further 41.7% for only 0.54 °C additional peak shift. These point-value comparisons identify 1-3 wt.□% as a useful range for subsequent processing trials, rather than establishing a universal optimum. The study demonstrates why a higher crystallization temperature should be assessed alongside flow loss, not treated alone as evidence of improved manufacturability. The contribution provides a focused screening basis for melt-processed HDPE nanocomposites.

Keywords: High-density polyethylene; hydroxyl-functionalized carbon nanotubes; melt flow rate; differential scanning calorimetry; melt compounding; formulation screening.

Biography:

Houda Al Farsi is a researcher at the Oil and Gas Research Center, Sultan Qaboos University, Oman. She completed her MSc under the supervision of Dr. Farooq Al-Jahwari. Her research concerns polyethylene-based nanocomposites, melt processing and the characterization of polymer properties.

Biobased Copolyesters as Precursors to UV-induced Thermoset Networks

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[b]*University of Alcalá (UAH), Alcala de Henares, Madrid, Spain*

[c]*BI-QEM SPECIALITIES S.P.A, Buccino, Salerno, Italy*

Abstract:

The increasing demand for environmental sustainability has driven the development of innovative strategies for the design of biobased thermosetting materials as alternatives to fossil-derived polymers. Thermosets are extensively used in industrial applications due to their outstanding mechanical performance, strength, and thermal stability. However, their permanent crosslinked networks hinder recyclability and limit reusability, raising significant sustainability concerns.

In this work, biobased copolymers derived from different macrolactones were designed, synthesized, and characterized via solvent-free ring-opening copolymerization using titanium-based catalyst. The resulting copolymers contain functionalizable double bonds that can be exploited via UV induced photopolymerization. This strategy leads to fully biobased thermosetting materials exhibiting promising mechanical properties, demonstrating their potential as sustainable alternatives to conventional thermosets.

Biography:

She graduated in Chemistry from the University of Basque Country (EHU) in Leioa, completing her bachelor thesis on biobased NIPUS materials in the group of Prof. J.L. Vilas Vilella and later completed a Master's in Biomaterials at the Complutense University of Madrid (UCM), where she trained in cardiac matrix decellularization at the Gregorio Marañón Hospital in the group of Prof. Maria Eugenia Fernandez Santos, earning highest honors. Moreover, she developed theranostic nanoparticles for triple-negative breast cancer during her master´s thesis work in the group of Prof. Marco Filice in UCM. After contributing to a European project on biopolymers from limonene-based industrial residues at the UAH in the group of Prof. Marta E. G. Mosquera, she is following an international industrial PhD with Dr. Valentina Sessini (UAH), with Prof. Daniela Pappalardo (UNISANNIO) and the multinational BI-QEM, focusing on next-generation biobased thermosets with advanced properties.

Molecular Dynamics Simulation of High-Performance Resins

Gregory M. Odegard

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Abstract:

Polymer composite materials are used extensively in the global aerospace industry because of their high stiffness- and strength-to-weight ratios. As more aerospace vehicles are being designed and built for more demanding applications, such as space travel and atmospheric re-entry, there is a need for more resilient composites that can withstand extreme temperatures. The development of these high-performance composites can be accelerated using process modelling and Integrated Computational

Materials Engineering (ICME) approaches, both of which depend on Molecular Dynamics (MD) simulation to provide molecular-level structure-property relationships of the curing resin. MD modelling of high-performance resins is challenging in terms of force field accuracy, methodology, parameter optimization, and computational resources.

The objective of this research is to develop MD simulation tools and methods for the accurate and efficient prediction of mechanical, thermal, and physical properties of a range of high-performance resins used in aerospace composite materials. A suite of publicly-available tools has been recently developed by our team to greatly facilitate MD simulation of polymers. These tools have been used to simulate a wide range of materials, including PAN, Cellulose, PEEK, epoxy, cyanate ester, polybenzoxazine, phenolic, and furan resin. A summary of these new tools and the results they generate for these material systems will be presented along with our vision of the future of MD simulation of high-performance polymers.

Biography:

Prof. Gregory Odegard is the John O. Hallquist Endowed Chair in Computational Mechanics in the Department of Mechanical and Aerospace Engineering at Michigan Tech. He is also the Executive Director of the FRONTIERS Research Institute at Michigan Tech. Before joining the faculty at Michigan Tech, Greg was a researcher at NASA Langley Research Center from 2000-2004. His research is focused on computational modeling of advanced composite systems. He is the recipient of the NASA Outstanding Public Leadership Medal, is a Fellow of ASME and ASC, and an Associate Fellow of AIAA.

Viscoelastic Signatures of Polymeric Solids in Sliding Contacts-Discovery of a Phenomenon

Padmanabhan Krishnan

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Abstract:

Polymer viscoelasticity is an evolving subject field. Viscoelastic response signature waves were observed due to friction of polymeric solids in very slow sliding contact conditions and analysed for the first time with respect to the sliding speeds of around 0.5 to 1 mm/sec, material composition and geometry. Viscoelastic frictional signatures matched with the retardation and relaxation times of the polymer or polymer composites. A demonstration of proof of existence of viscoelasticity and self-organization in these materials under very slow sliding contact conditions was presented earlier in a book chapter with respect to the retardation and relaxation phenomena by the invited speaker. The factors influencing he characterization of the viscoelastic properties of polymeric solids in sliding contacts will be discussed during the presentation. The stress relaxation signature

implies that the stress is time dependent and varying as a metallic or ceramic polished pin or ball moves on the polymer surface, causing the stress to increase and decrease due to a very slow contact sliding velocity. Normally, the mechanical relaxation time for a glassy polymer (below its glass transition temperature ranges from seconds to minutes. Since there is time ($t >> \tau$) for viscous reaction to take place at a low sliding speed of 0.5 to 1 mm/sec , the time dependent stress , σt , drops and rises depending on the relaxation and recovery times when the pin or ball moves on the polymer surface. This is not a stick slip behaviour but a sinusoidal frictional stress wave as a result of viscoelasticity of the polymeric material that is polished at the surface. The frictional aspect at a very slow sliding speed could produce relaxation and retardation times slightly different from the DMA extractions. This discovery of viscoelastic signatures leads to applications in evaluation of mechanical properties, identifying polymers and blends with respect to their structure and the design and development of a new characterization test for polymers and blends.

Biography:

Dr. Professor Padmanabhan Krishnan, FIIPE, FIE, CE(I), SLFISME, FIA Struct E, FSIESRP, FASc (Chennai) MInSiS, took his M.Sc [Engg] and PhD [Engg] in the field of fibre reinforced composites from the Department of Materials Engineering, Indian Institute of Science, Bangalore, in the years 1991 and 1995, respectively with

distinction. He has rich post-doctoral experience from The University of Delaware, USA, NTU, Singapore and the Singapore-MIT Alliance. He has more than 30 years of experience and 280 publications in International Journals, International Conference Proceedings, Project Documents and Reports, Books and Chapters, in the area of composite materials, polymers, fracture and Failure analysis and 3D printing.

Rationally Designed Smart PolymersTM for Viral Vector Bioprocessing

Emma L. Daniels[a*], A. Guerreiro[a], D. Broomhead[a], F. Canfarotta[a], J. Czulak[a], A. Thomson[a], A. Sufan[a], A. Groves[a], P. Santosa.

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Abstract:

Access to cell and gene therapies remains constrained by low process recoveries and high manufacturing costs, which limit the commercial scalability of these modalities. These challenges are exacerbated by the scarcity of highly specific purification reagents for emerging viral vectors and other complex biological targets. Developing novel capture reagents is therefore essential to improving downstream purification efficiency.

We present a platform for the rapid design and development of synthetic affinity polymers targeting defined biological target epitopes. By integrating in silico predictive modelling, machine learning, high-throughput ligand screening, and optimisation of application conditions, our systematic platform approach has achieved selection of Smart PolymerTM candidates with tuneable affinity for both purification and analytical use, with hit rates of up to 70%. We demonstrate this with the development of Smart PolymersTM for the quantification and purification of VSVG-pseudotyped lentivirus (LV) and a range of adenovirus (AAV) serotypes.

Candidates used for quantification were assessed using bio-layer interferometry (BLI), demonstrating concentration-dependent binding responses to LV in the range of E5 – E8 VP/mL and to AAV in the range of E10 – E12 VP/mL. Furthermore, 27% of our AAV-targeting Smart PolymersTM displayed serotype-independent binding. In parallel, ligands intended for purification were immobilised and assessed on a range of hromatographic scaffolds including membranes and resins. Our Smart PolymersTM enabled functional elution under physiological buffer conditions, avoiding harsh or denaturing steps.

This scalable, cost-effective platform technology overcomes a major industry bottleneck and offers a transformative solution for improving the purification and analytics of novel viral and biologics targets.

Biography:

Emma gained a PhD in Sustainable and Circular Technology from the University of Bath where she focused on the development and application of sustainable polymers. At Tozaro, she leads the Development Chemistry team to drive the development of Smart Polymers to improve the efficiency and quality of AAV and lentiviral manufacturing.

Extrusion of Active LDPE Films Containing Essential Oils for Food Packaging Applications

Nusrat Sharmin[*] and Dejan Knezevic

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Abstract:

The incorporation of natural bioactive compounds into polymeric packaging materials represents a promising approach for developing active food packaging systems. This study aimed to produce active low-density polyethylene (LDPE) films containing oregano, thyme, and rosemary essential oils using conventional melt extrusion technology. Due to the volatile and heat-sensitive nature of essential oil components, two incorporation strategies were investigated. Essential oils were either added directly to the polymer matrix

or first encapsulated within starch and β-cyclodextrin carriers prior to extrusion. The latter approach was designed to evaluate whether these carriers could protect the active compounds from thermal degradation and volatilization during processing and enhance their retention within the extruded films. LDPE films were manufactured under industrially relevant extrusion conditions and subsequently characterized to assess the influence of essential oil type and incorporation method on film properties. The physical, mechanical, and thermal characteristics of the films were evaluated alongside their antimicrobial and antioxidant potential. In addition, the retention and release of essential oil components were investigated to better understand the effectiveness of starch and β-cyclodextrin as protective carriers during processing and storage. By comparing films containing directly added essential oils with those containing encapsulated essential oils, this work provides insight into strategies for improving the incorporation of natural bioactive compounds into thermoplastic packaging materials. The study contributes to the development of active packaging solutions based on conventional polymer processing technologies and supports the use of natural essential oils as functional additives for food packaging applications.

Biography:

Dr. Nusrat Sharmin, PhD in Materials Engineering and Materials design, is currently working as a scientist in the Norwegian Institute for Food, Fisheries and Aquaculture Research. She has more than 15 years of experience in basic and applied research on the modifications of functional properties of fossil fuel and biobased polymers, active packaging, sustainable packaging, and nanotechnology. She has been involved in several national and international research projects, including food packaging material, active packaging and modification of packaging material at the capacity of project leader, work package leader and task leader.

Experimental and Numurical Simulation of High Pressure Torsion Process Effect on Polypropylene Behavior

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[5] Faculty of Engineering, Mechanical Design and Production Department, Zagazig University, P.O. Box 44519, Zagazig, Egypt.

[6] Faculty of Engineering, Mechanical Engineering Department, King Abdulaziz University, P.O. Box 80204, Jeddah, Saudi Arabia.

Abstract:

SPD technology, also known as NanoSPD, is the most efficient way of producing nanomaterials. However, two processing methods have been investigated more intensively: high-pressure torsion (HPT) and equal channel angular pressing (ECAP). Today, the high pressure torsion is one of the most promising methods for producing large shear strain, and has been the subject of widely investigations as a new processing method for nanostructured materials due to their capability to apply infinitely large strains to the material and to deform materials to very high plastic deformations without significantly altering the cross-section of the sample. In this paper, a phenomenological elastic-viscoplastic constitutive model was experimentally identified, and, coupled with the three-dimensional finite element method (FEM) to examine the different processing parameters governing the deformation behavior of polypropylene (PP) during HPT process. The plastic deformation behavior of polypropylene (PP) resulting from HPT process was investigated.

To this end, the impact of various HPT process parameters, such as phases enchainment or choice of sequence, imposed compressive displacement (pressure), torsion angle, angular velocity angle and sample dimensions, is presented. Based on the numerical results obtained, recommendations on process conditions were formulated at the end of this work.

Biography:

Professor Ahmed DRAI, born on January 21, 1973, in Thiersville, Mascara, Algeria, I'm an Algerian academic and researcher specializing in Materials Science and Mechanical Behavior of Advanced Materials. I'm currently a faculty member at the University of Mustapha STAMBOULI of Mascara, where I have been serving as a lecturer and researcher since 2006. My research interests cover a broad range of topics in Materials Science, including:

- Static and dynamic characterization of polymers materials.
- Polymers behavior under severe plastic deformation.
- Modeling and Numerical simulation of Advanced materials such as composite materials, Functionally Graded Materials (FGMs), Carbon Nanotubes (CNTs).
- Programming using Matlab and in finite element numerical simulation (ABAQUS and MARC.MSC.

Structure–Performance Insights into Hyper-Crosslinked Polymer Catalysts for the Oxygen Reduction Reaction

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Abstract:

The oxygen reduction reaction (ORR) is a pivotal process in energy conversion technologies such as fuel cells and metal–air batteries. However, the reliance on precious metal catalysts, particularly platinum-based materials, has hindered the large-scale implementation of these systems due to high costs and limited durability.[1] This work addresses the critical need for sustainable and cost-effective electrocatalysts by exploring a new class of phthalocyanine-based hyper-crosslinked polymers (HCPs) tailored for ORR electrocatalysis.

We report the synthesis of two distinct HCPs via a Friedel–Crafts alkylation strategy [2], using metalated (cobalt) and metal-free phthalocyanine precursors. This design enables a systematic investigation of the central metal atom effect on ORR performance, while maintaining a persistent polymer backbone. It also provides a unique opportunity to compare the role of molecular structure, and porosity within a controlled framework. Both materials exhibit high surface areas (>1000 m2g-1) and interconnected porous networks, facilitating O2 transport and charge mobility.

Electrochemical analysis revealed that the insertion of cobalt into phthalocyanine ring increases onset potential, and current density. Still metal-free HCP also demonstrated appreciable ORR activity. This is attributed to the nitrogen-rich framework, and microporous structure of the polymer. These structural features likely promote oxygen adsorption and facilitate electron transfer, highlighting the intrinsic electrocatalytic potential of the polymer framework, even in the absence of a metal center. Tafel slope analysis and rotating ring-disk electrode (RRDE) experiments allowed to quantify the number of electrons transferred per oxygen molecule. These findings underscore the importance of structure–function relationships in organic electrocatalysts and highlight phthalocyanine-derived HCPs as a promising platform for developing next-generation, low-cost, and metal-efficient ORR catalysts. This comparative strategy not only advances the understanding of non-precious metal ORR electrocatalysts but also opens avenues for rational design of hybrid materials where polymeric backbones play a synergistic role with or without metal centers.

Biography:

Dr. Shumaila Razzaque is a researcher, primarily known for her work in polymer science and environmental sustainability. She is currently an Assistant Professor at the Institute of Physical Chemistry of the Polish Academy of Sciences (PAS) in Warsaw, where her research focuses on mitigating the effects of global warming.

Redox-active coordination polymers: locating lithium in the structure of high energy iron-anilates

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[d]*Physics Department, Science and Technology Faculty, University of the Basque Country (UPV/EHU), 48940, Leioa, Spain*

[e]*School of Metallurgy and Materials, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK*

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Abstract:

Achieving high battery performance from low-cost, easily synthesisable electrode materials is crucial for advancing energy storage technologies.1 Coordination polymers (CP) combining inexpensive transition metals and organic ligands are promising candidates for high-capacity cathodes.2 Iron-anilate frameworks (anilate = (C6X2O4)2-, with X = F, Cl, Br, H) are herein reported to be produced in aqueous media under mild conditions. Water removal from known [Fe2(Cl2An)3(H2O)4]·4H2O yields a new 2D honeycomb-like CP, [Fe2(Cl2An)3].3 Whereas extensively studied metal-anilates with the formula (NRy)2[Fe2(Cl2An)3] (R = methyl, butyl) follow a parallel stacking of anionic layers stabilised by electrostatic interactions with counterions, [Fe2(Cl2An)3] adopts the unusual ABC stacking of neutral layers, as determined using a combination of ab initio random structure searching, electron diffraction, and Rietveld refinement of PXRD. The new CP shows reversible (de)insertion of >5 Li+/f.u. at average 2.8 V vs Li+/Li lending 200 mAh/g at C/10, and being able to retain 146 mAh/g at 1C, thus delivering specific energy (563 Wh/kg) and power (446 W/kg) in Li half-cells competitive with conventional LiFePO4 (~580 Wh/kg and ~450 W/kg). Despite increasing interest in metal-anilate frameworks as electrode materials, little is known about the ion insertion mechanisms and potential degradation pathways. To elucidate this, we carried out operando XRD studies on

lithium batteries of this system at the MSPD beamline @ ALBA synchrotron. Besides changes in intensities and shifts in the reflections of the pristine material [Fe2(Cl2An)3], new peaks arise during alkali ion insertion. Based on these experiments a possible mechanism is proposed for the new [Fe2(Cl2An)3] material.

Biography:

[1] Abakumov, A. M. et al. Nat Commun 2020, 11, 4976.

[2] J. Wang, et al. ACS Energy Lett 2022, 7, 668–674.

[3] V. Durán-Egido et al. Angew. Chem. Int. Ed. 2025, e202424416.

[4] M. E. Ziebel et al. JACS. 2020, 142, 2653–2664.

Conductive Polymers: Green Synthesis and Applications in Environmental Remediation

Ermelinda Falletta[a*], Cristina Della Pina[a], Daniela Meroni[a] and Claudia L. Bianchi[a]

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Abstract:

Conductive polymers are emerging as strategic materials for environmental technologies, combining redox activity, tunable conductivity, chemical stability and processability. Recent literature highlights polyaniline, polypyrrole and polythiophene-based systems as promising adsorbents and photocatalytic platforms for the removal of dyes, heavy metals, volatile organic compounds and emerging contaminants from water and air matrices. Among them, polyaniline (PANI) is particularly attractive owing to its acid/base doping–dedoping chemistry, affinity toward organic and inorganic pollutants, and ability to act either as an active sorbent or as a photosensitizer in semiconductor-based composites.

However, conventional PANI synthesis still relies on hazardous oxidants and may generate toxic by-products and large amounts of inorganic waste. In this contribution, we present our recent advances toward sustainable conductive polymers prepared through green oxidative polymerization routes using molecular oxygen, hydrogen peroxide and light-driven processes under mild conditions. Catalyst-assisted strategies based on Au, Cu, Fe_3O_4, $CoFe_2O_4$ and TiO_2 enable the synthesis of conductive polymers and multifunctional nanocomposites with controlled morphology, porosity, magnetic response and surface chemistry.

The resulting materials were successfully applied to environmental remediation, including VOC adsorption, hydrocarbon removal from water, dye sorption/photodegradation and Cr(VI) abatement. Particularly, PANI/TiO_2 systems combine adsorption and photocatalysis, while floating solar-light-active composites offer easy recovery and reuse, addressing one of the major limitations of powdered photocatalysts.

Overall, this work demonstrates how green chemistry and conductive polymer design can converge into scalable, recyclable and high-performance materials for next-generation environmental remediation.

Biography:

Ermelinda Falletta is Assistant Professor at the Department of Chemistry of the University of Milan and co-founder and CTO of VisioNing SRL a spin-off of the University of Milan.

Her research interests include:

- Advanced materials for emerging pollutants' abatement in both the aqueous and gaseous phases
- Piezophotocatalytic materials for the degradation of aqueous pollutants using ultrasound
- Sunlight-driven materials for the abatement of aqueous pollutants
- Advanced systems for wastewater treatment and material recovery
- Advanced adsorbents for waste valorization

Hydrogel Evaporators for Interfacial Solar Desalination and Brine Management

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Abstract:

Interfacial solar evaporation (ISE) has emerged as a promising technology for freshwater production, brine management, and resource recovery. However, hydrogel evaporators remain constrained by limited accessible evaporative interfaces, ineffective salt regulation under hypersaline conditions, and reduced performance in realistic water matrices. Here, we present a polymer design framework in which hydrogel architecture regulates internal interfaces and coupled heat, mass, and ion transport for solar-driven separation and purification. First, a single-component amphiphilic PEG-P3HT hydrogel was designed to induce spontaneous microphase separation between hydrophilic and hydrophobic domains, generating dynamic internal air-water interfaces that enable volumetric evaporation beyond the external surface. This material achieved an evaporation rate of 6.24 kg m−2 h−1 under one sun and maintained effective purification performance in lake sewage, oily wastewater, and laundry effluent. Second, a hierarchically structured PVA-biochar hydrogel with a central vertical channel and radially aligned gradient pores was engineered to decouple outward water evaporation from inward salt migration. This architecture enables multistage water delivery, self-adaptive salt rejection, and internal heat redistribution, supporting stable operation in hypersaline brines. The system delivered evaporation rates above 12 kg m−2 h−1 in 20 wt% brine, operated for 15 h without surface salt accumulation, and achieved 67.2 L m−2 day−1 outdoor freshwater production. Together, these studies establish hydrogel evaporators as a polymer-based platform for solar desalination and resource-recovery-oriented brine concentration.

Biography:

Yihan Shi is a PhD candidate in Environmental Engineering at the University of Technology Sydney. Her research focuses on polymer-based hydrogel materials for interfacial solar evaporation, desalination, and brine management under realistic saline conditions. She develops hydrogel systems that regulate internal interfaces and coordinated heat, mass, and ion transport to improve solar-driven water purification and separation. She has published 10+ peer-reviewed papers, including recent work in Advanced Materials and EES Solar. She is a recipient of the Membrane Society of Australia Student Award.

Comparative Performance of Three Nanofiltration Membranes (NF270, NF90, NP010) for Multicomponent Ion Transport: Material and Pore Size Effects.

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[3]Department of Physics, Sultan Qaboos University, Muscat, Oman

[4]Water Management, Petroleum Development Oman LLC, Muscat, Oman

[5]Corporate environment, Petroleum Development Oman LLC, Muscat, Oman

[6]Occupational Health, Petroleum Development Oman LLC, Muscat, Oman

Abstract:

Membrane selection strongly affects nanofiltration performance. Yet few studies compare different membrane materials and pore sizes under the same conditions. This work compares three commercial nanofiltration membranes: NF270 and NF90 (polyamide) and NP010 (polyethersulfone). The membranes were characterised by FTIR and pure water permeability. The reflection coefficient (σ) and solute permeability (Ps) were determined for four salts: NaCl, $MgCl_2$, Na_2SO_4 and $AlCl_3$. Concentrations ranged from 5000 to 40000 ppm. The Spiegler-Kedem model was applied, with osmotic pressure corrected for concentrated solutions. Polyamide membranes gave higher rejection than the PES membrane for all ions. This was attributed to the amide functional groups identified by FTIR. NF90 had the smallest pore size. It gave the highest reflection coefficients but the lowest flux. NP010 gave the highest flux but the lowest rejection. For all membranes, σ increased with ion valence in the order $AlCl_3$ > $MgCl_2$ > Na_2SO_4 > NaCl. The reflection coefficient followed the order NF90 > NF270 > NP010, whilst solute permeability followed the reverse order. These findings help match membrane choice to the balance required between rejection and flux.

Biography:

Dr. Amal Al Saadi is currently a Faculty member in the Chemical Engineering department at Sohar University. She received a PhD in Chemical Engineering from Sultan Qaboos University in Oman. Her significant experience in a municipal wastewater treatment facility has given her a comprehensive understanding of the industrial sector. Dr. Al Saadi is a highly motivated and imaginative academic who specializes in environmental research fields such as nanofiltration, solid waste management, and water and wastewater treatment.

In addition to her academic and scientific duties, Dr. Al Saadi serves on the board of the Jusoor Foundation, a non-profit organization. She is committed to establishing an independent research enterprise that is internationally recognized, as well as developing cooperation across disciplines. She is the Principal Investigator (PI) on a proposal to PDO titled "Synergistic Remediation: Integrated Forward Osmosis and Adsorption System for Natural Radioactive Materials Mitigation." She is also an active Co-PI on a project proposal presented to Be'ah for the quantification and characterization of waste electrical and electronic equipment (WEEE).

Sustainable Photocatalytic Degradation of Imidacloprid using a Ferrite-based Tungstate Nanocomposite for Environmental Remediation

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Abstract:

Imidacloprid (IMI), the commonly used neonicotinoid pesticide, has emerged as a persistent aquatic contaminant due to its high solubility and stability, posing risks to non-target organisms and ecosystem health. In this study, a $MnZnFe_2O_4/SrWO_4$ ferrite–tungstate nanocomposite was synthesized via a hydrothermal process and its ability to photocatalytically degrade IMI under UV light was assessed. SEM, XRD and FT-IR were used to characterize the composite to confirm its structural and morphological features. Photocatalytic performance was systematically investigated by examining the effects of operational factors, including initial pollutant concentration, catalyst dosage, pH and irradiation time. The $MnZnFe_2O_4/SrWO_4$ nanocomposite exhibited significantly enhanced activity, achieving up to 87% degradation of IMI within 30 min at pH 9, outperforming individual components ($SrWO_4$: 37%; $MnZnFe_2O_4$: 75%) under identical conditions. The degradation kinetics followed a pseudo-first-order model consistent with the Langmuir–Hinshelwood mechanism. Effective charge transfer between the ferrite and tungstate phases, which suppresses electron-hole recombination and increases the production of reactive species, is responsible for the enhanced performance. Furthermore, the composite demonstrated good stability and reusability across several cycles, indicating its practical applicability. Overall, the results demonstrate the potential of $MnZnFe_2O_4/SrWO_4$ nanocomposites as efficient and sustainable photocatalysts for removing imidacloprid and similar organic contaminants from aqueous systems.

Biography:

Irum Jamil is a PhD Chemistry Scholar at the University of Wah, Pakistan, and an MS Gold Medalist in Organic Chemistry. Her research focuses on organic synthesis, heterogeneous catalysis, nanomaterials, photocatalysis, and sustainable environmental technologies, particularly pollutant degradation, fuel cells, and green chemical transformations. At the 7th International Conference on Advanced Polymer Science & Engineering, she will present "Sustainable Photocatalytic Degradation of Imidacloprid Using a Ferrite-Based Tungstate Nanocomposite for Environmental Remediation". She has contributed to several research publications and a book chapter, and has presented at the Pak-Turk International Conference on Emerging Technologies.

Valorization of low-cost carbon sources for the Production of Biopolymers using Paraburkholderia xenovorans LB400

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Abstract:

There is a need to replace conventional plastics with sustainable and cost-effective biopolymers, motivating circular economy indifferent industrial applications.

This study investigates the production and characterization of polyhydroxyalkanoates (PHAs) synthesized by Paraburkholderia xenovorans LB400 using low-cost carbon sources, selected as alternative to pure carbon substrates, that often limit the economic feasibility of PHAs production.

Culture media were supplemented with orange peel (OP), cochayuyo (Durvillaea antarctica; DA), avocado peel (AP) and coffee spent grounds (CSG). Glucose (Glu) was used as the reference substrate and ammonium chloride was used as a limiting nitrogen source to promote PHAs production. Biomass and PHAs yields obtained were 0.7 g L^{-1} from AP (31.8% PHAs), 2.6 g L^{-1} from DA (46.2% PHAs), 1.7 g L^{-1} from CSG (52.9% PHAs), and 3.98 g L^{-1} (36.2% PHAs) from OP.

The characterization by FTIR exhibited the characteristic carbonyl stretching bands at 1720 cm-1 and C-O stretching at 1278 cm-1. SEM-EDS analysis showed a smooth, non-porous surface morphology of PHAs from Glu, DA and OP. High elemental carbon-to-oxygen ratios were also observed in all PHAs. The thermal analysis does not register residual solvent and indicates two-step degradation profiles with 50% mass decomposition at temperature around 304°C suggesting high thermal stability. Results confirmed the structural integrity of the extracted biopolymers. Overall, these findings demonstrate that Paraburkholderia xenovorans LB400 can produce PHAs with suitable properties from low-cost alternative carbon sources, reinforcing their potential for sustainable, cost-effective biomaterials for industrial or biomedical applications.

Biography:

Rodrigo Navia is Chemical Engineer from Technical University Federico Santa María, Valparaíso, Chile and Ph.D. in Mining Sciences from University of Leoben, Austria. His research is related to waste to energy and resource technology, biomaterials and biorefinery processes. He is associate editor of Waste Management & Research and executive editor of Journal of Biobased Materials and Bioenergy. He worked five years in Tresmontes Lucchetti, a Chilean relevant food company. He has published more than 100 papers in reputed journals, and he is currently full professor and dean of the faculty of engineering at Universidad San Sebastián in Santiago, Chile.

New Powder Polymer For 100% Bio-based Cosmetic Formulations

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Abstract:

This study addresses the increasing market demand for natural and environmentally friendly cosmetic formulations. Current industry trends emphasize the use of responsible excipients sourced from bio-based raw materials, produced through sustainable exploitation and low-energy processing. A major challenge in this area is the development of bio-based rheology modifiers that can match the performance of synthetic polymers, such as polyacrylates or polyacrylamides. Although natural polymers like hydrocolloids, polysaccharides, and proteins offer thickening and stabilizing capabilities, they often exhibit lower thickening power and formulation difficulties compared to petroleum-based polymers [1].

To address this performance gap, strategies are explored to improve the properties of natural polymers through chemical structure modification, thereby improving their functionality in cosmetic formulations. Various academic studies explore the chemical functionalization of natural polymers, including cross-linking and grafting various chemical moieties onto the polymer backbone, to optimize their characteristics for specific applications.

The present work investigates the cross-linking of polysaccharides using environmentally friendly reactants and processes [2]. A novel method of chemical cross-linking is presented that enables the isolation of the functionalized biopolymer in a highly concentrated powder form (exceeding 90%), thereby enhancing its applicability for cosmetic formulations. Furthermore, the functionalized biopolymer presents good thickening properties and is readily biodegradable.

The impact of various process parameters on the final product properties is examined.

Biography:

[1] Glass J.E.; Advances in Chemistry series 223, American Chemical Society, Washington D.C, 1989.

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Synthesis of novel Levulinic acid based-plasticisers derived from sugarcane bagasse

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Abstract:

Plasticisers are key additives used to address polymer brittleness and enhance flexibility, durability, and processability. A wide range of chemicals, including phthalates, fatty esters, and phosphate esters, are available as plasticisers. Phthalate plasticisers are the most widely used plasticiser type in the market, due to their versatility and low cost. Nevertheless, they are primarily derived from petroleum and tend to migrate and leach, creating significant human health and environmental hazards, which have led to regulatory restrictions worldwide. This establishes a clear market, and research is needed for safer alternatives. Consequently, over the past few years, numerous studies have focused on biomass-derived levulinic acid (LA), and derivatives constitute a significant class of promising bioplasticisers dueue to their renewable origin, non-toxic nature, and potential biodegradability. These compounds are actively being developed as sustainable alternatives to conventional, petroleum-derived plasticisers such as phthalates. In this study, we developed several innovative bio-based plasticisers using levulinic acid. Levulinic acid was synthesised by the hydrolysis of 5-chloromethylfurfural (CMF), which was derived from sugarcane bagasse. The plasticisers consist of monoesters and diesters and the synthesis was conducted under mild conditions using a simple

workup procedure. The newly obtained bioplasticisers were evaluated by introducing them to two different biopolymers: poly(lactic acid) (PLA) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBv) via the solvent casting and melt pressing method. The prepared films were comprehensively tested to assess their suitability potential for food packaging applications.

Biography:

Suleshi Gedara holds a Master of Philosophy in Material Science from the University of Peradeniya, Sri Lanka, and is a PhD student at the Queensland University of Technology (QUT), Australia with a focus on sustainable polymer packaging. Her research focuses on developing new bio-based plasticisers for biopolymers deriving from sugarcane bagasse. She has experience in the preparation of plasticised polymer films in the laboratory using different techniques and is a specialist in characterisation of plasticised polymer films. In addition to her academic work, she is applying her research experience and knowledge to real-world applications through her work at the sustainable packaging startup, Earthodic.

High performance recycled CFRP composites based on reused carbon fabrics through sustainable mild solvolysis route

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Abstract:

A novel environmentally friendly recycling method is developed for large carbon-fibers reinforced-polymers composite panels whose efficiency is demonstrated through a proof-of-concept fabrication of a new composite part based on recycled fibers. The recycling process relies on formic acid as separation reagent at room temperature and atmospheric pressure with efficient recycling potential of the separating agent. Electron microscopy and thermal analysis indicate that the recycled fibers are covered by a thin layer of about 10wt.% of residual resin, alternating with few small particles, as compared to the smooth virgin fibers. The recycled composites show promising shear strength and compression after impact strength, with up to 93% retention of performance depending on the property as compared to the reference. The recycled carbon fibers can thus be reused for structural applications requiring moderate to high performances. The loss of properties is attributed to a lower adhesion between fresh epoxy resin and recycled carbon fibers due to the absence of sizing, partly compensated by a good interface between fresh and residual cured epoxy thanks to mechanical anchoring as well as chemical reactions. The room temperature and atmospheric pressure operating conditions combined to the recyclability of the forming acid contribute to the sustainability of the entire approach.

Biography:

Wael Ballout made his PhD at the "Université Paul Cézanne" (Aix-Marseille III-France) in partnership with CATALYSE Company (2010), and studied the microencapsulation and self-healing polymers for aerospace application. He is now a senior research assistant at the "UCLouvain" (Belgium). He has 12-years' experience in carbon fiber reinforced polymer composites (CFRP) field. He took part to various research projects funded by the Walloon Region (E_COM, ECOTAC, TECCOMA, Viscos, MACOBIO and PLANUM...). His works focused on the development of new composite materials generation for aircraft applications and study of their physico-chemicals and mechanicals properties (rheological, spectroscopy, thermal, thermomechanical, Mechanical and morphological...).

Closed-Loop Mechanical Recycling of Biopolyesters for Food Packaging: Relationships Between Polymer Structure and Decontamination Efficiency

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[c]*UMR 7635 CEMEF, Université PSL - Mines Paris, Sophia Antipolis, Alpes-Maritimes, France*

Abstract:

Biodegradable plastics are increasingly considered as alternatives to conventional food packaging materials. However, biodegradation is often perceived as opposed to recycling, although mechanical recycling represents a complementary end-of-life route that can reduce the use of virgin raw materials [1]. In the case of closed-loop recycling of food-contact materials, food safety must be ensured by efficiently eliminating contaminants from post-consumer packaging [2]. Such processes are subject to specific regulatory requirements for PET bottle recycling and rely on EFSA challenge tests for approval [3]. In contrast, contaminants transfer during contamination and decontamination steps remains poorly understood for biodegradable polyesters.

This study investigates contaminant transfer behaviour in four structurally distinct biopolyesters: polybutylene adipate-co-terephthalate (PBAT), polybutylene succinate (PBS), polycaprolactone (PCL) and polylactic acid (PLA). Each polymer was spiked with surrogate contaminants defined by EFSA for post-consumer PET recycling: benzophenone, chlorobenzene, lindane, methyl salicylate, methyl stearate, phenyl cyclohexane and toluene [3]. Contamination kinetic experiments were conducted to determine surrogate uptake rates and transfer kinetics in each studied material. Thermal decontamination was performed at temperatures below the melting point of each polymer, and decontamination efficiency was quantified by measuring residual concentration by gas chromatography (GC). The contamination and decontamination behaviors were related to polymer structure.

This approach highlights how both polymer characteristics and contaminant physicochemical properties govern the sorption/desorption phenomena and, as consequence, the rate and extent of contaminant uptake and removal. Results provide mechanistic insight into mass transfer in biodegradable polyesters and support the development of safe closed-loop recycling strategies for biodegradable food packaging materials.

Biography:

I'm a second year PhD student at UMR IATE from INRAE Montpellier. I was born in Curitiba, Brazil. I moved to France in 2018 to join the engineering school INSA Lyon, graduating in 2024 with a degree in Materials Science and Engineering. During my masters, I specialized in the domain of polymers.

Driven by a strong personal commitment to environmental causes, I chose to continue my academic journey with a PhD focused on the development of recycling technologies for biobased polymers. Through this work, I aim to contribute to the advancement of sustainable development and circular economy.

References:

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Stakeholder Governance and Reverse Logistics in Urban Fuel Infrastructure Decommissioning: The El Beaterio Case, Quito, Ecuador

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Abstract:

This study analyzes the closure, decommissioning, and abandonment (CDA) of a fuel storage and distribution facility in southern Quito, Ecuador, conceptualizing the process as a socio-technical urban transition embedded within territorial governance dynamics. Although infrastructure decommissioning has traditionally been addressed from a predominantly technical perspective, limited research integrates reverse logistics design, material recovery and recycling considerations, stakeholder influence structures, and territorial development within a unified analytical framework, particularly in Latin American metropolitan contexts. Using a mixed-methods case study approach, the research combines documentary analysis, operational data, and 34 semi-structured interviews with public authorities, engineers, fuel marketers, business owners, and community representatives. Thematic analysis was employed to reconstruct the decommissioning logistics chain and develop a stakeholder influence matrix assessing actor positions, economic interdependencies, and legitimacy claims. The findings reveal that decommissioning functions as a structured reverse logistics system embedded within asymmetric governance configurations, where economic dependence, risk perceptions, material recovery and recycling opportunities, and urban redevelopment expectations generate competing visions for future territorial use. Technical feasibility alone is insufficient to guide decision-making; rather, legitimacy emerges through the alignment of engineering planning, institutional coordination, and community expectations. The study proposes an integrated socio-technical framework combining Engineering Management, Social Management, and Territorial Development, positioning decommissioning as a governance-driven transition rather than a purely technical operation. The results provide practical guidance for managing urban hydrocarbon infrastructure closure while promoting resource efficiency, recycling opportunities, and sustainable redevelopment aligned with circular economy principles.

Biography:

Paúl D. Villagómez is a PhD candidate in Technology Management at Escuela Politécnica Nacional (Ecuador), researching the socio-technical dimensions of hydrocarbon infrastructure decommissioning and sustainable transition processes. He holds an MSc in Financial Management, an MBA in Business Management, and is a PMP-certified Electrical Engineer. With over 25 years of experience in the energy, oil and gas, and industrial sectors, he has led major infrastructure and organizational transformation projects. He is also a university lecturer and consultant, with interests in project management, technology management, logistics, leadership, and sustainability.

Valorization of Saccharum munja Fibers for Sustainable HDPE Composite Development

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Abstract:

Natural fiber-reinforced thermoplastics offer an opportunity to develop lightweight and sustainable composite materials while utilizing renewable resources. However, the performance of these composites is strongly influenced by fiber surface characteristics and fiber–matrix compatibility. In this study, Saccharum munja, an abundantly available and under-utilized natural fiber, was explored as a reinforcement for high-density polyethylene (HDPE). Untreated and alkali-treated Munja fibers were incorporated into HDPE at 5, 10, and 20 wt% loadings through melt processing followed by injection molding. The influence of fiber treatment and loading on the chemical, thermal, morphological, mechanical, and dimensional characteristics of the developed composites was investigated. FTIR, DSC, TGA, SEM, and four-dimensional X-ray microscopy (FDXM) were employed to examine the effects of fiber modification on the composite structure, thermal behavior, morphology, and internal fiber distribution. Thermal expansion measurements were also performed to evaluate dimensional stability. The composites exhibited notable changes in thermal and mechanical behavior with increasing fiber content, while treated-fiber composites generally demonstrated improved performance compared with their untreated counterparts. The tensile properties showed improvements at optimized fiber loading, with the developed composites achieving up to approximately 24% improvement in tensile strength and 45% improvement in tensile modulus compared with pristine HDPE. Overall, the study demonstrates the potential of Saccharum munja fibers as a sustainable reinforcement for HDPE and provides a pathway for developing value-added natural fiber-reinforced thermoplastic composites for engineering applications.

Biography:

Nitin Kumar Arya is a PhD Scholar at the Indian Institute of Technology Bombay (IIT Bombay), India. His research focuses on natural fiber-reinforced polymer composites, with particular emphasis on Saccharum munja fiber-reinforced thermoplastic composites and sustainable composite materials. He has contributed to several research publications and has multiple patents related to natural fiber-reinforced polymer composites, high-density polyethylene composites, and additive manufacturing. His work primarily focuses on developing sustainable, high-performance composite materials for advanced engineering applications.

Encapsulation of iron with pectin: a challenge for the industry

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Abstract:

The valorization of agri-food by-products has been explored for decades, but it has gained renewed attention in recent years due to the increasing demand for sustainable food systems and the recovery of valuable bioactive compounds. Despite this progress, incorporating these compounds into functional foods or nutraceuticals aimed at specific health conditions remains challenging. Among these compounds, pectin stands out as a promising heteropolysaccharide derived from fruit and vegetable residues, known for its excellent techno-functional and bioactive properties.

Iron deficiency anemia remains one of the most widespread public health concerns globally, particularly affecting vulnerable populations such as children, women of reproductive age, pregnant women, and the elderly. Beyond its hematological effects, it is linked to impaired cognitive development, neurodevelopmental

alterations, and adverse psychological outcomes. Current strategies to address this condition mainly rely on oral iron supplementation and food fortification. However, their effectiveness is often limited due to the low bioavailability of iron, influenced by its instability during gastrointestinal digestion and various dietary and physiological factors.

Improving iron bioavailability is therefore a key objective in developing more effective nutritional interventions. In this context, this work evaluates the potential of pectin as an encapsulation agent for iron delivery. Special attention is given to the type of encapsulation system, as well as the source and structural characteristics of pectin, and the factors affecting iron release and absorption in the gastrointestinal tract. Low methoxyl pectin with relatively low molecular weight is identified as a promising option due to its strong mucoadhesive properties, which may enhance iron absorption.

Biography:

Director of CIAL and leader of PREBIOIN research group at CIAL. Lines of research, contributions: i) Selection of indicators for the control of processes in the agri-food industry. ii) Development and optimization of sustainable methodologies for food preservation and the extraction of bioactive compounds. iii) Obtainment, structural characterization and technological and biological evaluation of functional carbohydrates derived from agri-food by-products. iv) Establishment of in vitro models of digestion of functional carbohydrates. Participation in 72 projects and 34 contracts with companies. Author of 7 patents. More than 200 scientific publications, h-index 50 (WoS) and 20 book chapters. Participation in 17 invited conferences, round tables, and 157 presentations at conferences. Supervision of more than 50 Theses. Recognition of research activity with 10 awards.

Nanosized Block Copolymer Carriers of Natural Bioactive Substances and Fluorogenic Dyes for DNA Analysis

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Abstract:

Polymeric nanocarriers (PNCs) obtained by self-assembly of amphiphilic block copolymers in aqueous media have attracted increasing interest for biomedical applications. PNCs can improve significantly the solubility of hydrophobic substances, such as drugs and dyes, thereby increasing their bioavailability and efficacy. Another key feature of advanced PNCs is their ability to deliver drugs in a sustained or triggered manner, in response to internal or external stimuli, such as pH, temperature, glutathione, enzymes, etc., to a targeted area/organ in the human body. In addition, properly designed PNCs can be co-loaded with active molecules possessing different properties, for example a bioactive substance and a contrast agent, offering tools for simultaneous diagnosis and therapy (known as theranostics).

The present contribution describes the synthesis of biodegradable amphiphilic block copolymers with well-defined composition and properties and their use for developing advanced micellar nanocarriers of bioactive substances of different nature. Systems designed for (co)delivery of anticancer and anti-inflammatory drugs and proteolytic enzymes, characterized by enhanced structural stability, high loading efficiency and precise control of the drug release process will be discussed. The advantage of using micellar nanocarriers to increase the solubility in aqueous solution of new styryl dyes, intended for DNA labelling and cell imaging will be demonstrated as well.

Acknowledgments: Part of this work was supported by the Bulgarian National Science Fund (Grant KP-06-H89/2024).

Biography:

Professor P. Petrov is the Director of the Institute of Polymers of the Bulgarian Academy of Sciences. He obtained his PhD in Macromolecular Chemistry in 2001 from the University of Chemical Technology and Metallurgy, Bulgaria. Currently his work is focused on the synthesis and (co)assembly of amphiphilic block copolymers, photochemical crosslinking of natural and synthetic polymers, hydrogels and cryogels, nanoparticles and nanocomposites. P. Petrov (H-index 26) has co-authored 148 publications, 3 patents and 4 utility models. He is a fellow of the Alexander von Humboldt foundation and recipient of "Pythagoras" award for distinguished scientist in Natural Science and Engineering by the Ministry of Science and Education of Bulgaria in 2019.

Artificial Nano-Fingerprints from Self-Assembled Block Copolymers

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Abstract:

Counterfeiting is a growing global threat to economic security and public health. Traditional deterministic methods, such as holograms and barcodes, are increasingly vulnerable to sophisticated forgery. Physical Unclonable Functions (PUFs) offer a robust alternative by leveraging stochastic physical processes. In this work, we demonstrate that self-assembled lamellar block copolymer (BCP) patterns—typically viewed as "defective"—can be leveraged to produce "artificial fingerprints" for nanoscale PUFs [1]. To this goal, we introduce a strategy for the user-independent extraction of genuine nanopatterns from SEM micrographs, free from imaging artifacts. By exploiting local structural features, we encode these patterns into unique binary code matrices characterized by high bit uniformity, uniqueness, and entropy. Furthermore, we propose and test a computer vision-based approach for robust authentication/identification through artificial fingerprints in real-world scenarios. Both approaches were enabled by the creation of a specific database in which the fabrication process parameters, structural properties and microscope information were all included in the SEM images metadata by an automated algorithm for image analysis.[2] Furthermore, we demonstrate a high stability of the PUF against aging and thermal stability, an aspect often neglected, providing evidence of long-term reliable operation and robust authentication/identification in the thermal range from -196 °C to 500 °C. These results can shed new light on the realization of PUFs embracing the inherent stochasticity of self-assembled BCPs.

[1] F. Ferrarese Lupi, G. Milano et al. Nature Communications, 15, 10576 (2024)

[2] F. Ferrarese Lupi, G. Milano et al. Scientific Data, 12, 1055 (2025)

Biography:

Federico Ferrarese Lupi earned a degree in Physics at the University of Turin (2008) and a Ph.D. cum laude from the University of Barcelona (2012). After a postdoctoral fellowship at CNR-IMM on block copolymer nanostructures, he joined INRiM in Turin, where he is a Senior Researcher in the Advanced Materials and Life Sciences Division. His work focuses on nanofabrication using polymer self-assembly for metamaterials and optical neuromorphic systems. He is a member of the Italian Macromolecules Association, has authored over 70 peer-reviewed papers, and holds four patents.

Novel Redispersible Polymer-Graphite Composites as a Greener and Sustainable Alternative in EMI shielding

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Abstract:

The 5G-6G transition is accompanied by a rapid escalation in the density of electronics and communication systems, which is the cause of an ever-increasing electromagnetic background in the microwave region. To protect sensitive electronics in medical devices, communication, automotive, aerospace systems from this electromagnetic interference (EMI) shielding materials are required. Considering the volume of shielding expected globally, green formulations with low environmental impact, and sustainable product development are imperative. With this aim, in this study we chose the Redispersible Polymer (RDP) as a matrix with Graphite filler to fabricate EMI shields using simple mixing and compaction. Though RDP is well explored in construction industries, its functional electrical properties are not yet studied. The RDP-Graphite composites with varying graphite concentration were systematically investigated. XRD identified the presence of coexisting carbonate phases - primarily dolomite. FTIR absorbance indicated the functional groups of its polymeric constituents. SEM imaging with EDX revealed crystalline morphology and confirmed the constituent elements. The RDP-Graphite composites showed a high upward tunability of ac electrical conductivity at the rate of 10 S/m per 5 wt% increase in graphite. Electrical percolation effects noted beyond 20 wt% were analyzed. The dielectric constant reached 104. Microwave shielding effectiveness of 30 dB, meeting industrial standards, was achieved in the X-band for 40 wt% graphite. A maximum of 40% absorption was obtained, which is highly desirable in a scenario where EMI shields are mostly reflection dominant. The mechanical properties of standalone shields and the development of the composites as a coating are being investigated and improved.

Biography:

Priyanka Verma is a doctoral research scholar in the Department of Physics at Sri Sathya Sai Institute of Higher Learning, India. Her research in the area of material sciences, focuses on the development of advanced materials for electromagnetic interference (EMI) shielding, and systematic investigation of their structural, electrical, and magnetic properties. She has three publications. Her work aims to contribute to the design of functional materials with potential applications in medical, aerospace and defence sectors. Alongside her research, she is actively involved in academic, cultural, and service-oriented initiatives within the institute, contributing to the overall campus community and scientific environment.

Redox-Responsive Self-Immolative Poly(dithiothreitol)-Nanocellulose Hybrids for Smart Release Applications

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[b]*Drug Delivery, Disposition and Dynamics, Monash Institute of Pharmaceutical Sciences, Monash University, Parkville, VIC 3052, Australia*

Abstract:

Integrating stimuli-responsive polymers with sustainable biopolymers represents a major frontier in advanced materials engineering. While nanocellulose provides an exceptional high-surface-area, biocompatible backbone, its native hydrophilic surface lacks the dynamic gatekeepers required for smart, trigger-dependent cargo delivery. This study addresses this limitation by establishing a redox-responsive surface grafting matrix onto cellulose nanofibers (CNFs) utilizing self-immolative poly(dithiothreitol) (pDTT). Unlike conventional responsive polymers, self-immolative polymers offer a paradigm shift by undergoing complete, head-to-tail depolymerization upon a single trigger.

First, the pDTT polymer was synthesized via a sustainable, catalyst-free step-growth polymerization in bio-based solvents, integrated with an eco-friendly, closed-loop purification and monomer recovery cascade. To optimize interfacial architecture, both grafting-to and grafting-from strategies were successfully deployed on TEMPO-oxidized cellulose nanofibers (TOCNFs). The grafting-to approach was executed via DCC/DMAP-mediated esterification to couple pre-formed pDTT. Conversely, the grafting-from strategy was achieved through a two-step method: an initial DCC-mediated aqueous thioesterification, followed by the controlled disulfide exchange polymerization of DTT directly from the TOCNF surface. Both pathways successfully yielded a functional hybrid composite material with a gatekeeper layer (pDTT) covalently anchored to the polysaccharide backbone.

Upon redox triggering, disulfide cleavage initiates an automated cascade unzipping of the polymer, releasing chemically attached hydrophobic molecules. This disassembly subsequently exposes the underlying hydrophilic nanocellulose core, facilitating a secondary, diffusion-driven release of entrapped hydrophilic payloads. Efficacious functionalization, Interfacial changes and dual-release kinetics were systematically validated via 1HNMR, FTIR, CHNS Analysis, XPS, and TGA. This grafting strategy offers a versatile platform for fabricating advanced biosensors, smart coatings, and multi-functional controlled release platforms.

Biography:

Asifa Nadeem is a PhD Candidate in Chemical and Biological Engineering at Monash University (BioPRIA), supervised by Prof. Gil Garnier and A/Prof. John Quinn. Her research focuses on the precision surface engineering of sustainable biopolymers, specifically grafting redox-responsive, self-immolative polymers onto nanocellulose for smart controlled release applications. Previously, she earned an M.Phil. in Biotechnology from Quaid-e-Azam University and gained seven years of academic and industrial research experience. Her work on eco-friendly polymer-biomaterial hybrids won the Outstanding PhD Presentation Poster Prize at the 2025 Australian Green Chemistry Conference.

Controlling Polyphenol Release through Engineered Bio-Based Materials for Sustainable Agriculture Applications

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Abstract:

Agro-industrial residues, specifically hazelnut shells and grape pomace, were used to extract lignin- and polyphenol-rich fractions and to engineer four PHB/PCL scaffold architectures via electrospinning/electrospraying. The systems differed in polymer phase, lignin incorporation, co-location of lignin with polyphenols, and the distribution of the extracted substances between fibres and bead-like depots. Comprehensive characterisation included spectroscopic, morphological, hydrophobic, and water-absorption analyses. The results showed that all scaffolds generated multimodal release profiles over two weeks at ~25 °C and 37 °C, with distinct initial, intermediate, and late-tail phases, resembling controlled-release fertiliser behaviour but with a less pronounced burst effect. Performance strongly depended on scaffold design and temperature. At about 25 °C, the PHB/PCL architecture, with lignin in PHB fibres and polyphenols in PCL beads, achieved the highest overall release. By contrast, the scaffold in which lignin and polyphenols were co-located in both fibres and depots provided a combined high cumulative output with sustained delivery during the late phase. Under thermal stress at 37 °C, the differences became even more evident.

The scaffold co-locating lignin and polyphenols outperformed all other systems, achieving the highest total release and the most effective late-tail delivery. This behaviour indicates superior structural stability and release resilience under conditions simulating Mediterranean hot spells1. Overall, these findings highlight the successful valorisation of agro-industrial waste and identify lignin-polyphenol co-located PHB/PCL scaffolds as the most advanced and temperature-resilient carriers, capable of ensuring sustained polyphenol delivery and offering strong potential for environmentally sustainable crop management in Mediterranean agriculture2,3.

Biography:

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4. Verdugo-Gaxiola, S.E., Diaz-Rubio, L., Montaño-Soto, M.T., Castro-López, L.d.R., Castillo, G., Córdova-Guerrero, I. Advances in Biostimulant Applications for Grapevine (Vitis vinifera L.): Physiological, Agronomic, and Quality Impacts. Horticulturae, 2025, 11, 1261, https://doi.org/10.3390/horticulturae11101261.

Additive-Modified Polyurethane Foams: Effects on Mechanical and Thermal Properties

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Abstract:

The growing concern over the environmental impact of conventional construction materials has led to increased interest in alternatives that contribute to lowering carbon dioxide emissions. Among these, bio-based materials have attracted significant attention due to their renewable, biodegradable, and environmentally friendly nature. This study focuses on bio-based polyurethane foams (PUFs), commonly used for thermal and acoustic insulation, and evaluates how their properties are affected by the incorporation of various fillers at different concentrations. By employing the same polyurethane formulation as a common material platform, the study enables a direct and consistent comparison of the effects of different filler types and contents on foam performance. Key characteristics, including morphology, mechanical strength, and thermal behavior, were analyzed. The findings reveal that both the type and amount of filler have a notable influence on foam structure and overall performance. In particular, excessive filler content was found to promote particle agglomeration, leading to structural weaknesses and a measurable decline in the mechanical and thermal performance of the foams. These results highlight the importance of optimizing formulation parameters and provide a comparative basis for selecting suitable fillers in the development of sustainable insulation materials for construction applications.

Biography:

Abdeslam Skoudarli is a PhD student specializing in sustainable and bio-based materials for construction applications. His research interests include bio-based polymers, polyurethane foams, natural and mineral fillers, composite materials, and low-impact insulation systems. He focuses on the relationship between material formulation, structure, and thermal and mechanical performance, with particular interest in developing efficient and environmentally responsible materials for sustainable construction.

Rapid-Curing Hybrid Polymer Coatings: A Biobased and PFAS-free Strategy for Advanced Corrosion Protection

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Abstract:

The development of sustainable polymer coatings that combine rapid processing, environmental compatibility, and long-term corrosion resistance remains a significant challenge. In this work, rapid-curing hybrid polymer coatings were synthesized using a vegetable oil as the renewable precursor. Surface-engineered nanofillers were incorporated into the polymerizable matrix at varying concentrations to construct multifunctional hybrid networks with enhanced performance. The formulations were UV cured within seconds to form robust coatings, while free-standing films were prepared to evaluate their thermal and structure property relationships. The mechanical durability of the coatings was assessed through adhesion, abrasion resistance, and pencil hardness measurements, demonstrating excellent coating integrity and substrate adhesion. To overcome the environmental concerns associated with per- and polyfluoroalkyl substances (PFAS), a PFAS-free strategy was employed to enhance surface hydrophobicity. Instead of fluorinated additives, silsesquioxane based materials were incorporated into the hybrid matrix, resulting in a water contact angle of 107°, indicative of improved hydrophobicity and barrier performance. Electrochemical investigations revealed outstanding anticorrosive behavior, with the optimized coating maintaining an impedance modulus on the order of 105 Ω.cm2 after approximately 40 days of immersion. The synergistic combination of all biobased processing, nanofiller integration and PFAS-free design enables the design of multifunctional polymer networks for advanced coating applications.

Biography:

Mr. Siddhartha Shankar Kashyap is a final-year Ph.D. researcher and CSIR-Senior Research Fellow (CSIR-SRF) in the Polymers and Functional Materials Division at CSIR-Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad. His current research focuses on the design and development of advanced polymeric materials for functional coatings, with particular emphasis on sustainable coating technologies, direct-to-metal (DTM) coatings, and vitrimer-based materials. He has authored 12 scientific publications, 1 book chapter, and has 1 patent filed to his credit.

Unravelling Hydrocarbon Microseepage: Evidence of Petroleum Systems in a Semi-Arid Rift Setting

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[2]*Petroleum Upstream Regulatory Authority, Dar es Salaam, Tanzania*

Abstract:

The persistence of hydrocarbon microseepage on the surface creates a reducing environment that causes mineralogical alterations. This study focuses on identifying zones affected by such microseepage-related mineral alterations to support the potential presence of an active petroleum system in a semi-arid region within the East African Rift System. To achieve this objective, the study employed an integrated methodology that combined Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) image processing, amplified geochemical imaging (AGI), and potential field data analysis. The analysis enabled the mapping of six optimal signatures consistent with either gas-condensate or oil in the area of interest (AOI). From the study, the mapped prospects are in proximity to the major faults and a basin depth of around 4 km, which is considered sufficient for hydrocarbon generation. Although no wells have been drilled to date, the mineralogical changes identified through processed satellite imagery, which include ferrous from ferric

(red bed bleaching), increased kaolinite concentration and carbonate mineral precipitation, suggest the potential presence of hydrocarbon microseepage and a functioning petroleum system. The result supports further exploration investments, enhances the AOI value and attracts external funding that may expedite hydrocarbon discovery.

Biography:

He is presently employed as a Geophysicist at the Tanzania Petroleum Development Corporation (TPDC). Mussa earned his BSc from the University of Dar es Salaam, an MSc in Geophysics from the University of Aberdeen in Scotland, and a Master of Engineering Management from the University of Dar es Salaam. Earlier in his career, he worked with the Tanzania Civil Aviation Authority (TCAA). His research focuses on hydrocarbon exploration and digital image processing, and he is currently involved in hydrocarbon exploration within the East African Rift System (EARS) and Tanzania's coastal basins.

Copper Nanoparticles Obtained from Mixed Lactobacilli Culture

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2Dept. Microbiology, Faculty of Biology, Sofia University "Saint Kliment Ochridski", Sofia, Bulgaria

Abstract:

Copper nanoparticles were synthesized using supernatant from lactic acid bacteria isolated from Bulgarian yogurt. Their physicochemical characteristics were investigated using Scanning and Transmission Electron Microscopy and their elemental composition was determined by Energy Dispersive X-ray Spectroscopy (EDX/EDS). Their antibacterial effect was tested against Escherichia coli, Staphylococcus aureus, Bacillus cereus and Pseudomonas aeruginosa. Copper nanoparticles showed a synergistic effect with an antibiotic and their minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined. The ecological effect of these new synthesized nanoparticles was investigated on Daphnia magna (OECD 202). The Daphnia magna acute immobilization test is a standard ecotoxicity bioassay that measures the 48-hour median effective concentration (EC_{50}) of chemical samples by recording the inability of young water fleas to swim.

Biography:

Gala Arsovska is a second-year Molecular Biology student at the Faculty of Biology, Sofia University "St. Kliment Ohridski". Driven by curiosity in different fields of research, she is involved in two scientific projects funded by the Bulgarian Ministry of Education and Science, synthesizing bionanoparticles with antimicrobial, antitumor and environmental effects. She demonstrated her research at the Kliment Days scientific session, at the Faculty of Biology, presenting a poster on the biological effects of nanoparticles on microorganisms and Daphnia magna. She is determined in advancing bionanomaterial synthesis and making it more reachable and sustainable.

Poster Presentations:

Structurally Complex, Multifunctional Smart Polymers: Synthesis and Characterisation, and their Potential as Innovative Active Substance Carriers

Agnieszka Gola*, Zuzanna Majewska and Witold Musiał

Department of Physical Chemistry and Biophysics, Pharmaceutical Faculty, Wroclaw Medical University, Borowska 211, 50-556 Wroclaw, Poland

Abstract:

Smart polymers can support the development of controlled and targeted drug delivery systems, enhancing efficacy and safety while overcoming key challenges in modern pharmacotherapy. Particularly attractive are nanoparticles that can respond reversibly to multiple environmental stimuli. Their multifunctionality makes them useful therapeutic tools for controlling drug release, maintaining concentrations, and reducing side effects.

Modification of smart polymers during synthesis via spatial cross-linking enables the formation of highly biocompatible, biodegradable, and low-toxicity 3D polymer networks. Variations in network architecture affect size, colloidal stability, phase transition behaviour and thermal stability. In particular, cross-linker chain length determines chain mobility, network flexibility, and responsiveness to environmental stimuli.

This study aimed to synthesise cross-linked polymer nanoparticles responsive to both pH and temperature and to evaluate the effect of cross-linker (PEGDMA) chain length on their morphology, stability, and phase transition behaviour. Polymers were prepared by surfactant-free precipitation polymerisation, using 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPS) as the monomer and 2,2′-azobis(2-methylpropionamidine) dihydrochloride (AMPA) as the initiator.

Stable nanoparticles with reversible temperature and pH responses were obtained Hydrodynamic diameter, polydispersity index, zeta potential, and phase transition temperature were measured over a temperature range of 18–45 °C and at pH values from 2.6 to 7.6.Chemical structure and cross-linking degree were confirmed by NMR and ATR-FTIR spectroscopy. Morphology was examined by SEM, thermal properties by TG/DTA and DSC, and crystallinity by PXRD.

The results provide valuable insight into the relationship between cross-linker structure and the physicochemical properties of stimuli-responsive polymer networks.

Acknowledgement:

This research was supported by a grant SUBK.D060.26.001 from the Wroclaw Medical University, Poland.

Biography:

Agnieszka Gola is PhD in Pharmaceutical Sciences and a graduate of the Faculty of Chemistry, University of Wrocław. Her research focuses on the physicochemical aspects of polymerization and the kinetics of synthesizing new drug carriers, including pH- and temperature-sensitive polymers.

Amphiphilic Gradient Copolymers for Improved Particle Size Control in Dispersion Polymerization

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[2]*Kitasato University, Sagamihara, Kanagawa, Japan*

[3]*SHOFU INC, Higashiyamaku, Kyoto, Japan*

[4]*Ritsumeikan University, Kusatsu, Shiga, Japan*

[5]*Ritsumeikan University, Kusatsu, Shiga, Japan*

Abstract:

Dispersion polymerization is widely used to prepare polymer particles, in which monomers and initiators are dissolved in a solvent that is a good solvent for the monomer but a poor solvent for the resulting polymer. It is known the issue that the particles obtained from the polymer precipitates aggregate then form agglomerates when polymerization has been proceeding. In previous work, it is reported that polymer stabilizers such as poly(vinylpyrrolidone) have been able to prevent these types of aggregation. Conventional stabilizers such as polyvinylpyrrolidone are often employed, but their relatively weak adsorption and limited interfacial stability can result in insufficient particle stabilization. In contrast, polymeric surfactants are expected to provide enhanced stabilization due to their strong adsorption and steric barrier formation at particle interfaces.

In this study, amphiphilic diblock copolymers, PSt-b-PHEMA, and amphiphilic gradient copolymers, PSt-(grad)-PHEMA, were synthesized via ARGET-ATRP (atom transfer radical polymerization) and applied as stabilizers in dispersion polymerization. Their effectiveness in controlling particle size and suppressing coalescence was systematically investigated. Both copolymers effectively suppressed particle coalescence during polymerization. Notably, analysis of the coefficient of variation (CV) of particle size distributions revealed that the gradient copolymer system exhibited a lower CV value, indicating more uniform particle formation. These results demonstrate that gradient copolymers provide superior control over particle size distribution compared to conventional diblock systems.

Biography:

Hyoma Yamamoto graduated from the Department of Applied Chemistry, College of Life Sciences, Ritsumeikan University. He is currently a graduate student in the Organic Materials Chemistry Laboratory, Graduate School of Life Sciences, Ritsumeikan University, Japan. His research field is polymer chemistry and materials science. He is engaged in the synthesis of amphiphilic copolymers using controlled radical polymerization and their application as stabilizers in dispersion polymerization. His research aims to improve particle size control, suppress particle coalescence, and enhance polymerization efficiency. He is particularly interested in the relationship between polymer structure and interfacial properties.

Preparation of a Chitosan/Silica/CaO Organic-Inorganic Hybrid via IPTS Modification and TEOS Sol–Gel Processing

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[a]*Department of Dental Biomaterials Science, School of Dentistry, Seoul National University, 101 Daehak-ro, Jongno-gu, Seoul 03080, Republic of Korea*

Abstract:

A chitosan/silica/CaO organic-inorganic hybrid was prepared by IPTS modification and TEOS-mediated sol-gel processing for potential bone graft applications. Chitosan was first modified with 3-isocyanatopropyltriethoxysilane (IPTS), and the resulting precursor was then reacted with tetraethyl orthosilicate (TEOS) in the presence of calcium nitrate to produce an 80/15/5 wt% chitosan/silica/CaO hybrid. The in vitro bioactivity of the material was evaluated in simulated body fluid (SBF). After 1 week

of immersion, a low-crystalline apatite layer was observed on the surface, demonstrating apatite-forming ability. This bioactive behavior is attributed to silanol groups generated within the silica-containing hybrid network together with the incorporated calcium component, which promoted apatite nucleation. The results indicate that this hybrid is a promising candidate for biodegradable and bioactive bone graft materials.

Biography:

SangHoon Rhee is a Professor in the Department of Dental Biomaterials Science, School of Dentistry, Seoul National University. His research focuses on the development of bioactive and biodegradable biomaterials for bone regeneration. His interests include calcium phosphate-based materials, organic-inorganic hybrids, surface modification, and bone graft substitutes. His current work involves the design and characterization of hybrid biomaterials for hard tissue repair and regenerative applications.

Acknowledgements:

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (RS-2025-16068676).

Synthesis and Properties of Polymethacrylate/Cellulose Nanocomposites Prepared by In Situ Polymerization in the Green Solvent Dihydrolevoglucosenone

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Abstract:

Driven by green chemistry principles, this study investigates the in situ radical polymerization of polymethacrylate homopolymers and functional copolymers using the sustainable, bio-based solvent dihydrolevoglucosenone. To develop eco-friendly materials with a reduced share of synthetic components, cellulose nanocrystals (CNCs) were incorporated as a renewable filler, successfully yielding composites with high CNC mass fractions (up to 50 wt.%). Four distinct matrix systems were evaluated: poly(methyl methacrylate) (PMMA), alongside copolymers featuring varying alkyl chain lengths, hydroxyl/benzyl functionalities, and nitrogen-containing groups. Successful synthesis and high monomer conversions (generally >85%) were confirmed via NMR, revealing high molecular weights (Mn > 80,000 g/mol). Differential scanning calorimetry (DSC) revealed a distinct increase in glass transition temperature; for instance, the Tg of PMMA shifted from 98.9 °C to 129.2 °C at 50 wt.% CNC. Thermogravimetric analysis confirmed slightly improved thermal stability, while tensile testing indicated a substantial increase in Young's modulus and matrix stiffness. SEM imaging verified uniform CNC dispersion at low-to-medium filler loadings (1–15 wt.%), which also preserved optical transparency. Conversely, higher loadings (20–50 wt.%) induced minor agglomeration, increasing opacity and brittleness. This work demonstrates a highly viable, green-solvent pathway for manufacturing bio-content polymer nanocomposites with balanced, composition-dependent properties.

Biography:

Professor Ante Jukić earned his PhD in Chemical Engineering in 2004, focusing his research on functional and nanostructured polymer materials. He has published over 80 research papers and managed numerous large-scale research and infrastructure projects. He extensively collaborates with the industry on product and process development.

Tailoring Poly(N-Vinylamide) as Binders for Silicon Anodes

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Abstract:

Lithium-ion batteries have become the dominant energy storage solution in applications for their high energy density and long cycle life, from portable electronics to electric vehicles. Silicon, with its high theoretical lithium storage capacity, is pivotal for next-generation Li-ion batteries, offering an 11 times higher energy density than conventional graphite-based electrodes (4200 mAh g−1 in a composite of Li4.4Si vs graphite: 372 mAh g−1).1

However, changes in silicon volume during cycling can compromise stability and accelerate degradation. Polysaccharides, such as carboxymethyl cellulose1 and sodium alginate1, are commonly used as water-based binders for silicon anodes in Li-ion batteries due to their high mechanical strength and environmental benefits. Nevertheless, limited chemical modifiability constrains tuning of adhesion, flexibility, and electrochemical stability, particularly under silicon's volumetric expansion. A suitable binder for silicon anodes should improve structural stability, interfacial adhesion, and mechanical integrity of the electrode.

Previously, partially hydrolyzed and PEGylated Poly(N-Vinylamides) were used to develop strong dispersing for carbon black, showcasing their ability to adhere to polar surfaces and potential for further molecular engineering.5 The polymer is fully hydrophilic, and hydrolysis yields versatile amine groups enabling further modification. Its nucleophilic reactivity enables diverse functionalization, allowing precise tuning to improve binder performance for silicon anodes.

The study focuses on structure-property relationships, examining effects of hydrolysis degree and polymer molecular weight. Furthermore, the study investigates polymer functionalization with polyethylene glycol (PEG), cyclic carbonate moieties, and perfluoropolyether, assessing their impact on silicon anode performance.2 These modifications aim to improve electrochemical stability and mechanical integrity during cycling.4

Biography:

I was born in Kazakhstan, but I have lived in Germany for more than 23 years. It was during my school years that I first became interested in chemistry. This early enthusiasm led me to study for a Bachelor's degree in Chemistry at the University of Bonn, followed by a Master's degree at RWTH Aachen University. Now I am doing my PhD in battery research at the Max Planck Institute for Medical Research in Stuttgart. My research as chemist focuses on developing next-generation energy storage materials.

Detection of Biomolecular Interactions Using Polyfluorine Tracers in Diffusion Ordered Spectroscopy

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Abstract:

Biosensor technology has emerged as a significant contributor across various sectors, including military applications and healthcare. Nonetheless, these fields encounter numerous challenges, such as the detection of low-concentration protein complexes in biological samples and an insufficient understanding of protein interaction properties. To tackle these challenges, we have introduced an alternative method that involves calculating the diffusion coefficient using Diffusion Ordered Spectroscopy (DOSY) as a transducer. This technique facilitates the detection of interactions between molecules, such as proteins, by assessing

the diffusion coefficient before and after their interaction, using a tracer molecule. A polyfluorine tracer, specifically pentadecafluorooctanoyl, was employed to investigate the avidin–biotin interaction through DOSY, enabling the calculation of the diffusion coefficients for biotin-pentadecafluorooctanoyl before the interaction and for the avidin–biotin-pentadecafluorooctanoyl complex following the interaction. The measured diffusion coefficients were 1.937 × 10−8 m^2 s−1 (unbound) and 1.12 × 10−11 m^2 s−1 (bound). As expected, the unbound species exhibited a significantly higher diffusion coefficient than the bound complex, consistent with the larger size and slower motion of the macromolecular assembly. Thus, the differences in these diffusion coefficients are attributed to changes in molecular weight and size, thereby confirming the avidin–biotin interaction. Additionally, the hydrodynamic radius of the avidin–biotin-pentadecafluorooctanoyl complex was determined from its diffusion coefficient, yielding a radius of 23 Å, which closely aligns with the radius of native avidin reported in existing literature. This demonstrates the method's capability to ascertain structural parameters. The application of polyfluorine tracers facilitated the acquisition of accurate and specific results without the need for a secondary antibody or further purification steps.

Biography:

Dr. Abdulrahman M. Alazemi, Assistant Professor, Chemistry Department, Faculty of Science, Kuwait University.

This work has resulted in a granted U.S. patent (US 12,332,249 B1) and has been published in Analytical Methods (2025, 17, 9422–9431).

Computationally-Guided Design of a Molecularly Imprinted Polymer for the Detection of Psilocybin in Unregulated Mushroom Drug Products

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[b] *Department of Pharmaceutics, Virginia Commonwealth University*

[c] *Department of Medicinal Chemistry, Virginia Commonwealth University*

Abstract:

Psilocybin, a major compound in hallucinogenic mushrooms, has been identified in unregulated mushroom drug products like gummies and chocolates. As these products have been associated with numerous hospitalizations and deaths, an analytical method capable of selectively quantifying psilocybin and identifying potential adulterants is urgently needed. Molecularly imprinted polymers (MIPs) offer a selective and economically feasible approach for sample preparation and analysis. Furthermore, quantum mechanical (QM) modeling can improve MIP design by optimizing component and solvent selection, thereby reducing solvent consumption and laboratory waste. Density functional theory calculations were performed with ORCA software at the B3LYP 6-31G(d) level to calculate the interaction energies of each pre-polymerization complex with implicit solvent models of either ethyl acetate, acetone, or acetonitrile. Serotonin, baeocystin, and aeruginascin were investigated as dummy templates to mimic psilocybin while mitigating template leakage, which can lead to false-positive results and reduced analytical accuracy. Methacrylic acid, acrylamide, and 4-vinylpyridine were tested as functional monomers at template-to-functional monomer ratios ranging from 1:1 to 1:5. Among the complexes examined, 1:5 molar ratios of baeocystin to methacrylic acid, aeruginascin to methacrylic acid, and aeruginascin to acrylamide displayed the most negative interaction energies, indicating the greatest stability. Ethyl acetate also produced a greater number of highly stable complexes, suggesting it may be a promising solvent for polymerization. This novel MIP can advance the selectively of psilocybin detection, provide further information on the implementation of QM in MIP development, and present valuable insight on the risks attributed to consuming unregulated drug products.

Biography:

Driven by a longstanding interest in substance use disorder research, I earned dual bachelor's degrees in

Forensic Science and Chemistry from Virginia Commonwealth University, graduating summa cum laude. As an undergraduate, I was elected president of the Forensic Science Student Club and significantly contributed to research investigating the role of psilocybin in the opioid reward pathway. I am now a second-year Ph.D. student in Pharmaceutical Engineering at VCU, recently elected president of the Pharmaceutical Engineering Graduate Student Association, and am working toward the development of a novel molecularly imprinted polymer.

Rationally Designed Smart PolymersTM for Affinity Purification of AAV and Lentiviral Vectors

A. Guerreiro[a], D. Broomhead[a], F. Canfarotta[a*], J. Czulak[a], E. Daniels[a], A. Groves[a], A. Peon[a], P. Santos[a], A. Thomson[a], A. Shephard[a], A. Sufana.

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Abstract:

Manufacturing bottlenecks continue to limit patient access to cell and gene therapies, with low recovery and high costs of viral vector bioprocessing hindering commercial viability. A major constraint is the lack of robust, scalable, and cost-effective affinity reagents tailored to viral vectors.

Here, we present a platform for the rapid design and development of synthetic Smart PolymersTM as pseudo-affinity ligands targeting defined viral epitopes. The platform integrates in silico epitope modelling, predictive monomer screening, high-throughput in vitro validation, and application-specific optimisation to generate ligands with tuneable binding properties for both analytical and purification workflows.

Using this approach, Smart PolymersTM were developed against VSV-G pseudotyped lentivirus and multiple AAV serotypes. Bio-layer interferometry confirmed concentration-dependent and target-specific binding across relevant titre ranges, while up to 77% of AAV-targeting candidates exhibited pan-serotype recognition. For lentivirus, 38% of screened polymers demonstrated functional binding following synthesis.

When immobilised on chromatographic membranes, Smart PolymersTM enabled efficient capture and recovery of lentiviral particles, achieving >80% recovery of bound virus under mild, physiologically relevant elution conditions. High levels of impurity clearance were also observed, including significant reductions in host cell proteins and DNA.

These results demonstrate that Smart PolymersTM represent a versatile and scalable alternative to traditional affinity ligands, enabling improved purification performance and offering a cost-effective route to enhanced downstream processing of viral vectors.

Biography:

Dr Francesco Canfarotta is Head of Innovation Chemistry at Tozaro, where he leads the strategy and delivery of advanced synthetic materials for bioprocessing and analytical applications. He is also responsible for driving innovation and developing new intellectual property related to polymer design, manufacturing, and application. With over 15 years' experience in polymer chemistry, nanotechnology, and affinity technologies, he focuses on developing scalable synthetic ligand platforms for challenging biological targets. He holds an MBA from the University of Cambridge, complementing his technical expertise with commercial and strategic acumen.

Smart PolymersTM Enabling Detection, Capture and Release of AAV

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Abstract:

Adeno-associated virus (AAV) vectors are central to the growing gene therapy market, thanks also to the possibility of novel gene therapies targeting specific organs. However, their high manufacturing costs remain a significant barrier to broader clinical adoption. Downstream purification represents a major cost driver and thus a key target for process innovation. Here, we present the development of Smart PolymerTM-based affinity materials as a cost-effective and scalable alternative to traditional purification approaches.

Polymer design was developed using computational techniques, including in silico screening and machine learning combined with in-vitro experiments, such as AAV serotype microplate screens and FIDA peptide screening. Smart PolymersTM were further characterised via HPLC, biolayer interferometry (BLI), and bind/elute experiments. The resulting Smart PolymersTM have been shown to selectively target multiple AAV serotypes, with the potential for engineered capsid detection.

A wide range of solid supports, including membranes and resins, can be used with Smart PolymersTM due to the polymeric nature and ease of functionalization, enabling the capability to fit within any workstream and the potential for purification at scale. Our Smart PolymersTM have shown highly selective binding to AAV serotypes, against Spiking MVP, with great recoveries, and significant host cell protein (HCP) and DNA removal.

Biography:

A senior scientist at Tozaro that has been with the company since it spun out from the University of Leicester. Working on creating polymers that bind selectively to a wide variety of targets (small molecules to proteins and viruses). Currently focused on developing polymers that bind and elute multiple serotypes of AAV to create a column-based purification product.

Advanced Antibacterial Nanocomposites Fibers for Biomedical Applications

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[8]Center for Advancing agri-Food System Transformation, Santiago, Chile.

Abstract:

Wound infections pose major clinical challenges due to antibiotic resistance and recurrence, particularly involving Pseudomonas and Staphylococcus species. Electrospun nanofibrous dressings mimic the

extracellular matrix and enable localized antibacterial delivery. Silver nanoparticles (AgNPs) offer broad-spectrum activity, while surface functionalization reduces cytotoxicity and enhances stability. Therefore, this study aimed to evaluate the antibacterial activity of polycaprolactone (PCL)/poly(ethylene oxide) (PEO)-electrospun fibers containing capped AgNPs for their potential use in biomedical applications.

AgNPs were synthesized by chemical reduction using cysteine, citrate, diclofenac, or ketorolac as capping agents and assessed for in vitro antimicrobial activity. PCL/PEO-electrospun fibers incorporating capped AgNPs were fabricated, physicochemically characterized, and assessed for antimicrobial performance using standardized dynamic and contact-based microbiological assays.

Among the nanoparticle formulations tested, diclofenac-capped AgNPs demonstrated the lowest minimal inhibitory concentration (MIC) (18.8 mg/L) against Staphylococcus aureus and Pseudomonas aeruginosa. Electrospun nanofibers exhibited uniform morphology (PCL fiber thickness = 2.224 ± 0.707 µm, morphology index = 0.80; PEO fibers with diclofenac-capped AgNPs = 0.359 ± 0.080 µm, morphology index = 0.95) and preserved thermal stability (Tm = 62.09 °C; Td = 421.83 °C). FTIR spectroscopy confirmed molecular interactions between AgNPs and polymer matrices. Contact-killing assays demonstrated a significant reduction in viable bacterial counts for fibers containing diclofenac-capped AgNPs, from 5.13×10^{6} to 1.90×10^{6} CFU/mL for P. aeruginosa and from 8.60×10^{5} to 4.33×10^{5} CFU/mL for S. aureus, indicating a surface-mediated antibacterial mechanism.

Overall, these PCL/PEO-electrospun fibers incorporating diclofenac-capped AgNPs emerged as promising candidates for biomedical wound-healing applications, particularly in the management of infected and antibiotic-resistant wounds.

Biography:

Dr. Francisca Acevedo, is associated academic at the Basic Sciences Department, Faculty of Medicine at Universidad de La Frontera, Temuco, Chile. She earned her Ph.D. in Sciences of Natural Resources at the Universidad de La Frontera. Her main research areas are related to the development of bioproducts for cosmetic and pharmaceutical applications. She has been involved in several R&D projects as director, principal and co-researcher, particularly in topics focusing on biomaterials and micro and nanoencapsulation of bioactive compounds.

Antibacterial CMC Foam Dressings via Citric Acid Crosslinking and Silver Incorporation

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[a]Korea Institute of Industrial Technology, Ansan, South Korea

[b]Dankook University, Yongin, South Korea

Abstract:

This study reports the development and characterization of carboxymethyl cellulose (CMC) foams crosslinked with citric acid (CA) and loaded with silver nitrate (AgNO3) for wound-dressing applications. Increasing CA concentration increased crosslinking density, improving structural integrity while reducing liquid-handling capacity. AgNO3 incorporation conferred antibacterial activity without compromising liquid-handling performance, and wet compressive strength slightly increased with higher AgNO3 content, likely due to a nanofiller effect from in situ-formed silver nanoparticles (AgNPs). Silver release was sustained over 72 h, reaching a maximum of 10.56 mg/L for the highest-silver-content foam — a tenfold increase over the lowest. Antibacterial assays revealed concentration-dependent activity: 1.0 wt% AgNO3 foams showed contact inhibition, whereas 2.0 wt% foams produced clear inhibition zones. This one-step, CA-crosslinked CMC foam with in situ silver incorporation represents a green strategy for producing wound dressings with superior absorption, mechanical stability, and antibacterial performance, highlighting strong potential for safe and effective wound-care applications.

Biography:

Gyu Dong Lee is a Researcher at the Korea Institute of Industrial Technology (KITECH). He earned his B.S. and M.S. degrees in Polymer Science and Engineering from Sungkyunkwan University. His recent research centers on sustainable materials and energy technologies, including PFAS-free composite membranes, green hydrogen production, and advanced electrolyzer systems. Additionally, he has extensive experience developing high-performance air filtration media and medical wound dressings. With a strong background in polymer science, Lee has published widely on functional nanomaterials for environmental, biomedical, and energy applications.

Release Characteristic and Antioxidant Activity of Gac Seeds (Momordica cochinchinesis) from Collagen- and Chitosan-Based Hydrogel Composite

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Abstract:

Chitosan- and collagen-based hydrogel composites were successfully prepared with 5–20 wt % gac loading, and this study explores their development and characterization, focusing on structural, thermal, swelling, antioxidant, and degradation properties for potential biomedical applications Scanning electron microscopy (SEM) confirmed a well-integrated hydrogel network at lower gac concentrations, while higher loading led to particle agglomeration All characteristic peaks investigated by Fourier transform infrared spectrometer are typically present in the similar features, suggesting that no change of structure properties is observed The hydrogel is thermally stable within 200 °C The glass transition temperature and melting temperature are to be 50 and 90–110 °C With the presence of gac, no change of thermal and morphological properties is observed Swelling behavior indicated that higher gac concentrations reduced water absorption, likely due to hydrophobic interactions In addition, water solubility and water vapor transmission rates are reduced when gac is loaded The optimal data are 54 05% and 888 19 g m2 h, respectively The hydrogel composite exhibits a burst release at the initial 300 min The degradation is also very fast Also, it illustrates the antioxidant activity as observed by the DPPH and ABTS assays It is remarkably noted that antioxidant biomaterials have applications in wound dressing

Biography:

Dr. Piyachat Chuysinuan is a Research Scientist at the Laboratory of Organic Synthesis, Chulabhorn Research Institute, Thailand. She received her Ph.D. in Polymer Science from The Petroleum and Petrochemical College, Chulalongkorn University, under the Development and Promotion of Science and Technology Talents (DPST) Scholarship. Her research focuses on natural polymer-based biomaterials, including hydrogels, electrospun nanofibers, wound dressings, and tissue engineering scaffolds. Her work integrates polymer science with bioactive natural products to develop sustainable biomaterials for wound healing, controlled drug delivery, regenerative medicine, and other biomedical applications.

Electro-Mechanical Behavior of PVC Gels in the Sol–Gel Transition Region

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Abstract:

Poly (vinyl chloride) (PVC) gels, comprising PVC with various plasticizers, are known to exhibit electromechanical responses. Under an applied field, plasticizer molecules migrate toward the anode-side gel surface, driving a characteristic creep deformation of the PVC gel. This electrically induced mechanical behavior depends strongly on the internal gel structure, which is in turn governed by the compatibility between PVC and the plasticizer. In a previous study, PVC gels prepared with four plasticizers of varying compatibility were compared. Among them, the gel containing dibutyl adipate (DBA) exhibited the largest electric field-induced deformation, making it the most promising candidate for soft actuator applications. Based on this, the present study focuses on the PVC/DBA system in the sol–gel transition region, where gel structure and mechanical properties change markedly with plasticizer concentration and where enhanced electromechanical responses are consequently expected. The electromechanical behavior of PVC gels at DBA concentrations ranging from 90 wt% to 96 wt%, within the sol–gel transition region was systematically characterized. A plasticizer concentration dependence was confirmed in the electromechanical behavior. For each PVC gel, electro-rheological measurements were performed across voltages ranging from 0 V/mm to 1.5 kV/mm to assess the gel network structure. An electric field dependence of the storage modulus (G′) of PVC gel was observed, which was found to depend on the plasticizer concentration. These results clarify the correlation between network formation and electromechanical properties and demonstrate the importance of structural control in the design of high-performance PVC gel actuators.

Biography:

Ryota Miyazaki is a graduate student at the Graduate School of Life Sciences, Ritsumeikan University, Japan. His research primarily focuses on the development and electromechanical characterization of PVC gel actuators. Currently, he is dedicated to his Master's degree research, aiming to establish design guidelines for actuators with superior response characteristics. By enhancing the performance and investigating the practical applications of PVC gels, he seeks to provide fundamental insights for the next generation of soft actuation technology.

Development of Coated Metallized BOPET Films for Offset Printing in Luxury Paperboard Packaging and Evaluation of Metal Transfer Performance

Hasret KARAKURT MUMCU[a*] Gülgün KAYIN ÇETİN[a], Gizem Şahin[a], Eda Nur DİNÇ[a]

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Abstract:

This study presents the development of a coated metallized BOPET film designed to enhance metal transfer performance in offset printing systems, with a particular focus on luxury paperboard packaging applications. The study focuses on the fundamental interfacial mechanisms governing adhesion between the metallized layer and the transfer lacquer, as well as the controlled release and transfer behavior onto substrate surfaces. Within this framework, coating formulations with targeted chemical compositions were systematically designed, and the effects of coating weight, surface energy, and curing conditions on transfer efficiency were investigated.

The results demonstrate that surface energy compatibility and interfacial adhesion are critical parameters

determining transfer performance. The optimized coating structure enables controlled and consistent release of the metallized layer, resulting in uniform and high-integrity transfer onto the substrate surface. This leads to enhanced surface gloss and a pronounced metallic effect. Furthermore, the system maintains high transfer efficiency even at reduced coating weights, indicating an optimized balance between interfacial forces and coating design. The developed structure also exhibits stable and reproducible performance under process conditions.

In conclusion, the developed coated metallized BOPET film provides an effective and scalable solution for controlling metal transfer mechanisms in offset printing systems. The study contributes to the advancement of metallized transfer technologies by combining functional performance with high visual quality through a surface engineering-based approach.

Biography:

Super Film is a well-established company founded in 1993, standing out in the packaging industry with its innovative production approach. Its R&D Center, launched in 2017, has strengthened its technological capabilities. With high quality standards, a sustainability-focused vision, and innovative solutions, it continues to enhance its competitiveness in both national and international markets.

BOPET-Based Thermal Transfer Coating Films for Polystyrene Surfaces

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Abstract:

In this study, the biaxially oriented polyester (BOPET) film structure with a coating transfer system working with thermal activation, used in polystyrene (PS) based under-parquet insulation materials, was examined. The porous structure and low surface energy of polystyrene surfaces limit direct laminate applications. On such surfaces, glue reduces product quality due to limited surface adhesion in lamination and printing processes. Therefore, printing and coating processes are first carried out on the film surface, and then the coating layer is transferred to the polystyrene surface thanks to the heat-activated coating system.

The system under review stands out with three basic features. Firstly, the transfer coating approach eliminates the need for direct printing on polystyrene surfaces, allowing for a more controlled finish. Secondly, thanks to its low seal feature, the carrier film is easily separated after the process and the coating layer remains on the surface. Thirdly, the material's structural integrity is preserved because the process is carried out below the polystyrene's thermal deformation limits. In addition, the printing patterns created on the film make a practical contribution to the parquet flooring process by facilitating cutting and alignment processes during application.

As a result, this approach is considered a practical method that both increases surface functionality and supports the application process in polystyrene-based insulation materials.

Biography:

Super Film is a well-established company founded in 1993, standing out in the packaging industry with its innovative production approach. Its R&D Center, launched in 2017, has strengthened its technological capabilities. With high quality standards, a sustainability-focused vision, and innovative solutions, it continues to enhance its competitiveness in both national and international markets.

Performance Evaluation of Recycled PP Granules Derived from Post-Consumer FIBC Waste for Industrial Tape Production

Betül Gülgeç[a*], Nahide Elif Aşcı Kıymaz[a], Murat Halıcıoğlu[a]

[a]İşbir Sentetik Dokuma Sanayi A.Ş., Balıkesir, Türkiye

Abstract:

This study investigates the feasibility of utilizing recycled polypropylene (rPP) granules derived from post-consumer Flexible Intermediate Bulk Container (FIBC) waste as a partial substitute for virgin polypropylene in industrial PP tape production. The aim was to develop high-performance rPP formulations with properties comparable to virgin materials and validate their applicability at an industrial scale.

Post-consumer FIBC waste was processed through optimized recycling operations and converted into granule form. To enhance material performance, antioxidant, compatibilizer, and strength-promoting additive systems were incorporated during recycling. The resulting rPP granules were characterized by ash content, melt flow index (MFI), and moisture analyses, while chemical structure and oxidation levels were evaluated using Fourier Transform Infrared Spectroscopy (FTIR).

Tape formulations containing 30–50% recycled PP were developed and processed under industrial production conditions. Mechanical performance was assessed through tensile strength and elongation tests. The findings demonstrated that optimized rPP formulations achieved process stability and mechanical properties comparable to virgin-based formulations, meeting industrial quality standards.

These results confirm that post-consumer FIBC-derived rPP can be successfully utilized in high-performance PP tape production through appropriate formulation and process optimization. The study contributes to sustainable material development by enabling higher recycled content in technical textile applications while supporting circular economy practices.

Keywords: Recycling; Polypropylene (PP); Polyethylene (PE); Flexible Intermediate Bulk Container (FIBC); Tape production; Sustainable material design

Biography:

I am a chemist working in product development and R&D within the polymer and packaging industry. My expertise focuses on polypropylene-based materials, reactive extrusion, recycling technologies, and performance optimization for industrial applications such as FIBCs, liners, and technical textiles. I am actively involved in developing sustainable material solutions, including post-consumer recycling and innovative composite formulations. My research interests include polymer modification, additive technologies, and circular economy approaches in plastics processing. Through my work, I aim to bridge industrial practice with scientific advancement in polymer engineering and sustainable materials development.

Enhancing Recycled Polystyrene Properties through Lignin Incorporation and Optimized Melt Processing

Fabio Faragun[a*], Petra Pongrac, Ante Jukić

University of Zagreb Faculty of Chemical Engineering and Technology, Zagreb, Croatia

Abstract:

This study investigates the modification of recycled polystyrene through the incorporation of lignin as a sustainable, bio-based filler to mitigate the property degradation typically observed in recycled plastics. Composites with varying lignin contents (1, 5, and 10 wt.%) were prepared via melt mixing. Particular attention was paid to the effects of processing intensity and duration –specifically screw speed and mixing time – on the material's final performance. The structural, thermal, and mechanical properties of the resulting materials were systematically evaluated. The results revealed that higher screw speeds and extended mixing times significantly improved lignin dispersion within the recycled polystyrene matrix. This enhanced dispersion directly influenced both the thermal stability and microhardness of the composites.

While the glass transition temperature of the polymer remained largely unaffected by the lignin content and processing conditions, extended mixing durations led to a more pronounced shortening of the polystyrene chains, indicating processing-induced degradation. Ultimately, these findings demonstrate that lignin is a viable bio-filler for upgrading recycled polystyrene systems. Furthermore, the study highlights the critical importance of optimizing processing parameters to balance filler dispersion against polymer matrix degradation in sustainable composite manufacturing.

Biography:

Assoc. Prof. Fabio Faraguna research focuses on functional polymers, polymer additives, nanocomposites, polymer characterization, and advanced materials for energy and industrial applications. He has conducted research at the Chinese Academy of Sciences, the Leibniz Institute of Polymer Research Dresden, and the University of Warwick. He collaborates extensively with industry on material analysis, product innovation, and process optimization. His scientific achievements have been recognized with prestigious awards, including the Vera Johanides Prize for Young Scientists.

Composition–property Relationships in PBS/PHBV Blends for Sustainable Food Packaging

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Abstract:

The growing demand for sustainable packaging materials has stimulated research into biodegradable polymer blends with balanced processing and mechanical performance. Poly(butylene succinate) (PBS) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) are promising bio-based polyesters whose complementary properties enable the development of materials with tailored characteristics. This study investigated the influence of blend composition on the rheological, dynamic mechanical, and processing behavior of PBS/PHBV blends prepared at different mass ratios. Oscillatory rheology, dynamic mechanical analysis (DMA), and melt flow index (MFI) measurements were performed to evaluate the viscoelastic properties of the blends in both the molten and solid states.

The results showed that increasing the PHBV content progressively reduced the complex viscosity, storage modulus, and loss modulus, indicating lower melt resistance to deformation while maintaining the characteristic shear-thinning behavior. Dynamic mechanical analysis revealed that PHBV increased blend stiffness, whereas PBS contributed to a more pronounced viscous response. Intermediate blend compositions exhibited two glass transition temperatures, suggesting limited miscibility and the coexistence of PBS-rich and PHBV-rich phases. MFI measurements confirmed improved melt flow with increasing PHBV content, in agreement with the rheological findings. Overall, the PBS/PHBV blend ratio was identified as a key factor governing rheological, dynamic mechanical, and processing properties. By optimizing the blend composition, biodegradable materials with balanced performance can be developed, making PBS/PHBV blends promising candidates for sustainable food-packaging applications.

This work was supported by project NPOO.C3.2.R3-II .04.0059 under the National Recovery and Resilience Plan, funded by the European Union, NextGenerationEU.

Biography:

Vesna Ocelić Bulatović, is an Associate Professor at the University of Zagreb Faculty of Chemical Engineering and Technology. She has authored or co-authored more than 80 scientific and conference publications, with over 1,200 citations and an h-index of 19. Her research focuses on biodegradable and sustainable polymer materials, polymer composites, advanced polymer characterization, and structure–property relationships. She has participated in numerous national and international research projects and has received four innovation awards. Prof. Ocelić Bulatović has extensive experience in international scientific collaboration, conference organization, and the supervision of undergraduate, master's, and doctoral research.

PIGMENTS: Development of an international Master's programme in sustainable paints and coatings

Nevena Milčić [a*], Zvjezdana Findrik Blažević [a*], Ante Jukić [a], Ernest Meštrović [a], Sanja Lučić Blagojevića, Marko Rogošić [a], Jerome Marcilloux[b], Julie Pontvianne[b], Jean-Pascal Philibert[b], Sophie Nazarian[b], Mathilde Lagarde[b], Manuel Freitasc, Ana Paula Duartec, Natalia Espirito Santoc, Susana Rodriguesc, Jerome Claverie[d], Vincent St-Onge[d], Pascale Lafrance[d]

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[d]*Université de Sherbrooke, Sherbrooke, Canada*

Abstract:

PaInts and coatinGs: Material Engineering, desigN and innovative Technologies for Sustainability – PIGMENTS is an Erasmus Mundus Design Measures project dedicated to developing a new international master's programme in sustainable paints and coatings, a strategic field that remains underrepresented in current higher education offerings. The initiative responds to the growing need for specialists who can design and implement low impact coating systems across the full value chain, from raw materials and formulation to application, durability and end of life management. The two year, 120 ECTS programme is structured around a mobility scheme spanning four partner institutions in Europe and Canada, with semester long specializations in foundations of paints and coatings, advanced formulation and sustainable technologies, innovations in fields such as nanotechnology and biobased materials, and an individual master's thesis in collaboration with academia and industry. The curriculum integrates state-of-the-art polymer science, surface and interface engineering, nanostructured materials, biopolymers and sustainable process design, complemented by digital tools, AI driven modelling and Industry 4.0 concepts for coatings development. Developed with strong input from industrial stakeholders and professional associations, PIGMENTS aligns academic training with current and emerging needs of the coatings sector, including eco-design, life-cycle assessment and regulatory and sustainability drivers. The poster will present the programme concept, consortium, thematic areas, and planned summer school in advanced characterization, and will highlight opportunities for industrial partners to contribute to curriculum co-creation, student projects and joint research in sustainable polymers, recycling and environmental applications.

Biography:

Assist. Prof. Nevena Milčić, PhD, is Head of the Department of Reaction Engineering and Catalysis at the University of Zagreb Faculty of Chemical Engineering and Technology. Since 2019, she has co-authored 19 WoS-indexed papers and has presented 37 conference contributions, including 3 invited lectures. She has grant-management experience, currently coordinating the Erasmus Mundus PIGMENTS project and participating in several Horizon Europe projects. Her research interests include biocatalysis and reaction engineering.

Influence of Extrusion and Biaxial Stretching Parameters on ePTFE Membrane Characteristics

Gyu Dong Lee[*], Hyuk Jun Kwon, Jung Nam Im, and Song Jun Doh

Korea Institute of Industrial Technology, Ansan, South Korea

Abstract:

Expanded polytetrafluoroethylene (ePTFE) is a critical material for high-performance membranes, requiring precise control over multi-step manufacturing processes to achieve targeted properties. This study investigates the impact of sequential fabrication parameters on the structural and mechanical characteristics

of porous ePTFE supports. The experimental procedure encompasses two major phases: pre-forming/extrusion and calendering/stretching. Initially, we evaluate different PTFE powder types and lubricant concentrations (21–25 wt%), alongside variations in aging and ram extrusion temperatures. Subsequently, the extruded precursors are processed under specific calendering gaps (300–500 µm) utilizing lubricants with varying volatilities. Finally, the films undergo biaxial stretching, where heating time, stretching temperature, stretching speed, and machine/transverse direction (MD/TD) stretch ratios are rigorously controlled. By evaluating the resulting films, we identify how these interconnected variables govern key responses such as final thickness, porosity, and tensile strength, establishing robust manufacturing guidelines for tailoring ePTFE microstructures for advanced applications.

Biography:

Gyu Dong Lee is a Researcher at the Korea Institute of Industrial Technology (KITECH). He earned his B.S. and M.S. degrees in Polymer Science and Engineering from Sungkyunkwan University. His recent research centers on sustainable materials and energy technologies, including PFAS-free composite membranes, green hydrogen production, and advanced electrolyzer systems. Additionally, he has extensive experience developing high-performance air filtration media and medical wound dressings. With a strong background in polymer science, Lee has published widely on functional nanomaterials for environmental, biomedical, and energy applications.

Development of Polymeric Gutters for Industrial Applications

Joel Priora , Jorge Priora , Anderson Chavesa, Ângelo Marquesb, Rui Oliveirab, Catarina Rebelob, Lourenço Bastosb, André Gomesb, Filipa Carneirob, Ricardo Freitasc, Pedro Peixotoc and Carlos Nevesc

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[b]*PIEP - Centre for Innovation in Polymer Engineering, Guimarães, Braga, Portugal*

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Abstract:

Industrial roof rainwater gutter systems are traditionally manufactured from galvanized steel due to their structural performance. However, these systems are susceptible to corrosion, require frequent maintenance, and involve complex manufacturing and installation. Replacing them with thermoplastic alternatives offers significant advantages, including corrosion resistance, reduced weight, improved thermal insulation and greater design flexibility.

This work presents the engineering development of a double-wall thermoplastic gutter for industrial buildings. Combining material selection, product design and structural, thermal and fluid analysis, the development began with defining functional and mechanical requirements based on the assessment of existing metallic systems. Multiple design concepts were generated using CAD tools, focusing on hydraulic efficiency, structural stiffness and compatibility with extrusion and co-extrusion processes.

A systematic material selection methodology identified polyvinyl chloride (PVC) as the most suitable thermoplastic candidate to meet the defined requirements.

To support the engineering design, the proposed concepts were iteratively evaluated using Finite Element Method (FEM) and Computational Fluid Dynamics (CFD) simulations. Starting from a structural assessment of the conventional metallic gutter, the numerical analyses established the critical loading scenarios and performance targets for the new solution. Successive simulations enabled the refinement of the geometry and the assessment of its mechanical response under representative service conditions, supporting the feasibility of the polymer-based design before physical prototyping.

The proposed methodology demonstrates the potential of integrating material selection, product engineering and numerical simulation to accelerate the development of polymer-based construction components, providing a robust framework for the optimization and validation of innovative extruded

thermoplastic systems for industrial applications.

Biography:

Joel Santos Prior is a Commercial and Marketing Manager with a multidisciplinary background in agribusiness, industrial management and business development. He holds a degree in Agricultural Engineering, a Master's in Agricultural Business Management and a postgraduate qualification in Industrial Economics and Management. Since 2016, he works at J.Prior in areas including commercial management, cost analysis, budgeting, digital marketing, project coordination, event management and information systems. He has also completed specialised training in innovation standards, Industry 4.0, circular economy, international trade, quality management and automotive-sector standards. Joel combines strong teamwork, creativity and problem-solving skills with practical experience in sustainable product development and innovation.

Functionalization-Driven Interfacial Polarization and Dielectric-Magnetic Synergy in Vitrimer f-MWNT/ZnO Composites

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Abstract:

Increasing electromagnetic radiation has created an urgent need for the development of sheer absorbing composites with configurable dielectric-magnetic response. Interfacial engineering in carbonaceous composites offers a promising route to achieve high-performance absorption with reduced thickness in X-band. In this study, acid-functionalized f-MWNT/ZnO composites were synthesized to analyze the influence of surface functionalization on electromagnetic (EM) properties. The f-MWNT/ZnO composite demonstrates a stronger frequency-dependent dielectric response, which is attributed to enhanced polarization losses arising from the oxygen-functional groups introduced during acid-treatment. Dielectric loss and Cole-Cole plots further revealed the co-existence of multiple Debye relaxation processes along with Maxwell-Wagner-Sillars polarization. Permeability plots show distinct peaks for f-MWNT/ZnO composite associated with natural and exchange resonance mechanisms, whereas the pristine MWNT/ZnO composite demonstrated a weaker response. The synergy of dielectric-magnetic interactions and improved impedance matching resulted in superior EM absorption, with f-MWNT/ZnO composite achieving an RL of -12.7 dB at a thickness of 1.9mm, corresponding to ~94% absorption efficiency at 12.3 GHz. In addition to its EM performance, the composite demonstrates autonomous self-healing by rejoining the two halves after heating at 70 oC for 40 minutes. Moreover, the healed f-MWNT/ZnO composite demonstrates ~88% recovery of its properties, validating the dynamic vitrimeric network's ability to restore the mechanical efficiency. The results obtained underscore the importance of surface functionalization in optimizing interfacial interactions and improving the microwave absorption performance of carbon nanotube-based composites.

Biography:

I am Nehal, a CSIR-SRF Fellow at University of Petroleum and Energy Studies (UPES), Dehradun, India, pursuing research in Stealth Technology with a focus on advanced multifunctional composites as radar absorbing materials. My work involves the development of self-healable vitrimeric composites for stealth applications. I am passionate about translating scientific research into practical technological solutions and continuously seek opportunities to broaden my expertise through collaborative research and international scientific platforms. I aspire to contribute effectively toward innovation and advancements in the field of advanced materials and defense technologies.

Direct Comparison of Dextran, Ficoll, and Albumin Compressibility by High-Resolution Ultrasound Spectroscopy

Jana Fojtíková [a *] and Eliška Bartheldyová [a]

[a] *Faculty of Chemistry, Brno University of Technology, Brno, Czech Republic*

Abstract:

Dextran and Ficoll have long been used as molecular probes in studies of glomerular permselectivity, serving as substitutes for globular proteins that are reabsorbed by proximal tubules and therefore cannot be detected in urine. Ficoll was traditionally regarded as an inert hard sphere and, consequently, an ideal model of globular proteins. However, Venturoli and Rippe (2005) questioned this assumption, showing that Ficoll is more deformable than previously thought. Its higher deformability may lead to greater permeability across the glomerular barrier compared with globular proteins of similar molecular weight.

Although these findings have been supported by crowding experiments, intrinsic viscosity measurements, gel filtration, and small-angle neutron scattering, we aimed to directly investigate the compressibility of these molecules using high-resolution ultrasound spectroscopy (HR-US). We compare the adiabatic compressibility (βS) and specific apparent compressibility (φKS) of dextran-70, Ficoll-70, and bovine serum albumin (BSA), together with their hydrodynamic radii determined by dynamic light scattering (DLS). Intrinsic viscosity values are also included to ensure consistency with previous studies.

Our results are consistent with previous reports, as no significant difference was observed between the compressibility of Ficoll and dextran of similar molecular weight and size.

Biography:

Jana Fojtíková is a second-year PhD student in Biophysical Chemistry. Her research focuses on the mechanical and transport properties of biopolymer-based hydrogels. As part of her PhD project, she is developing a simple hydrogel model of the extracellular matrix for diffusion studies. She also contributes to the development of magnetically responsive hydrogels for 4D printing and participates in the MEBioSys project. She sees the conference as an opportunity to present her work, gain new inspiration, and connect with experts and fellow students from related fields.

Spectral Analysis of Heat Diffusion in Polymeric Materials Using Eigen function Expansion

Ehtisham Ali[a*] and Asad Zaigham[b]

[a,b] *Department of Mathematics, Riphah International University, Islamabad, Pakistan*

Abstract:

Efficient thermal management is a critical aspect of polymer processing, influencing product quality, dimensional stability, and mechanical performance. This study presents a spectral analytical framework for investigating transient heat diffusion in polymeric materials using the eigen function expansion method. The one-dimensional heat conduction equation is formulated as a Sturm–Liouville eigenvalue problem and solved analytically by separation of variables, yielding a series solution in terms of orthogonal eigen functions. A high-density polyethylene (HDPE) slab of thickness 20 mm is considered, with an initial temperature of 100°C and boundary temperatures maintained at 25°C. The material properties used in the analysis are thermal conductivity 0.45 W m^{-1} K^{-1}, density 950 kg m^{-3}, specific heat capacity 2300 J kg^{-1} K^{-1} and thermal diffusivity 2.06 × 10^{-7} m^2 s^{-1}. Numerical evaluation demonstrates rapid convergence of the spectral solution, with the first five eigen functions accurately representing the transient temperature field. The centerline temperature decreases from 100°C to approximately 35°C after 1200 s, while higher-order modes decay rapidly, confirming the dominance of the fundamental eigen mode during long-term heat transfer. The proposed approach offers an efficient analytical alternative to conventional numerical methods by reducing computational effort while maintaining high solution accuracy. The developed mathematical model provides valuable insight into heat transport during polymer cooling and processing and can be extended to polymer composites, multilayer polymer systems, and additive manufacturing applications.

The findings demonstrate that eigenvalue-based spectral methods are effective tools for thermal analysis and process optimization in advanced polymer engineering.

Biography:

Ehtisham Ali has completed an MSc in Mathematics and an MS in Applied Mathematics, with academic expertise in mathematical modelling, differential equations, eigenvalues, and eigen functions. His research interests focus on applying mathematical methods to real-world scientific and engineering problems, particularly in heat transfer, system stability, and renewable energy technologies. At the 7th International Conference on Advanced Polymer Science and Engineering – Polymer Connect 2026, taking place October 26–28, 2026, in Madrid, Spain, he will present his work on Spectral Analysis of Heat Diffusion in Polymeric Materials Using Eigen function Expansion. His work highlights how applied mathematics can support a better understanding, improved efficiency and sustainable design of polymers.

Thermal Evaluation and Optimization of Polymeric Enclosures for Electric Vehicle Applications

Agnieszka Żmijewska Rocha[a*], Ângelo Marques[a], Lourenço Bastos[a], Luciano Rietter[a], David Serrão[a], Rui Oliveira[a] and Filipa Carneiroa

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Abstract:

The rapid and ongoing electrification of the automotive sector is accelerating the demand for lightweight, compact battery packs and advanced power electronics systems. This technological shift introduces significant engineering challenges, particularly regarding the design and thermal protection of sensitive components. Replacing conventional metallic components with high-performance polymeric materials offers exceptional opportunities for structural weight reduction and functional integration but demands a precise assessment of thermal performance under demanding operating conditions. This study presents a simulation-based methodology dedicated exclusively to the design and thermal evaluation of polymeric enclosures for battery packs and power electronics intended for refrigerated commercial vehicles. Computational fluid dynamics (CFD) and thermal simulations were executed to analyze heat dissipation, internal fluid flow, and global temperature distributions within the system. Diverse cooling strategies were systematically investigated, including both air- and water-based active cooling methods, alongside critical variations in cooling-channel geometry, cross-sectional area, and dimensional parameters. Adopting a polymeric enclosure highlights a delicate balance between thermal conductivity, heat extraction efficiency, weight minimization, and geometric design constraints. The numerical results confirm the high potential of advanced CFD tools to guide the thermal optimization of lightweight polymeric housings. Ultimately, the developed approach establishes a reliable framework for predicting thermal behavior, verifying cooling performance, and ensuring the suitability of polymers for demanding automotive electrification and power electronics applications.

Biography:

MSc in Robotics and Automation Engineering, Warsaw University of Technology, Faculty of Power and Aeronautical Engineering. Project manager and researcher in product development, with particular emphasis on composites products. With over 15 years of advanced experience in structural numerical simulation and optimization methods, has specialized on evaluating the mechanical performance of composite materials, using commercial software, as well as python scripting. She has also experience in thermal and thermomechanical analysis, using numerical models.

Post-Consumer Textile Recycling: From Fibre Recovery to Recycled Materials and Further Possibilities for Functional Valorisation

Saikat Ghosh [a*], Parikshit Goswami [a]

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Abstract:

The exponential growth of post-consumer textile waste necessitates sustainable end-of-life management strategies based on closed-loop circular economy principles. This work presents an integrated framework for recovery, recycling, and plausible high-value functional valorisation of complex post-consumer textile streams.

The initial phase addresses non-destructive waste characterisation by developing an automated sorting technique designed to classify complex post-consumer blends based on fundamental polymer types, including cotton and polyethylene terephthalate (PET). To overcome the technical challenge of intimate fibre blends, the second phase employs selective enzymatic hydrolysis; this bioprocess selectively degrades and dissolves the cellulosic component (cotton), enabling the effective physical recovery and separation of intact PET fractions.

The core focus of this study investigates the chemical transformation and upcycling of both recovered streams into functional materials. The recovered cellulosic fractions are subjected to chemical derivatisation via an acetylation process to yield high-purity cellulose acetate. This intermediate is then functionalised with active-agent additives during electrospinning to produce functional nanofibrous mats. In parallel, the recovered PET fractions are reprocessed via melt spinning to engineer recycled filament yarns, with ongoing studies exploring direct polymer dissolution techniques for filament formation and the integration of functional chemical additives within PET matrices.

By integrating automated sorting, selective enzymatic fractionation, chemical conversion, and electrospinning, this multi-stage pathway demonstrates a viable strategy for converting low-grade post-consumer textile waste into advanced functional material systems, thereby extending the boundaries of technical textile valorisation.

Biography:

Dr. Saikat Ghosh is a Research Fellow in Textile Recycling at the University of Huddersfield, where he also earned his Ph.D., following a master's degree from Indian Institute of Technology Delhi. His scholarly work focuses on material science, functional textile engineering, and circular economy methodologies for post-consumer waste valorisation. Dr. Ghosh specialises in nanoparticle-based surface modifications, nanofinishing, and the electrospinning of cellulosic materials from recycled substrates. His research focused on enhancing the durability, performance, and characterisation of natural and synthetic fibers to advance sustainable textile recycling applications, directly supporting global initiatives in climate action and responsible material stewardship.

Acknowledgement:

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From Molecular Design to Functional Nanohybrids: Applications in Sensing and Water Purification

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Abstract:

The rational design of catechol-containing polymers provides a versatile strategy for developing functional organic–inorganic nanohybrids for environmental applications. In this work, different polymer architectures incorporating catechol groups were designed for two complementary purposes: sensing and removal of contaminants from water.

For sensing applications, well-defined catechol-containing polymers were synthesized by reversible addition–fragmentation chain-transfer (RAFT) polymerization and polymerization-induced self-assembly (RAFT-PISA). The presence of catechol groups provides specific interaction sites while polymer architecture controls self-assembly and the resulting nanostructure. These systems were explored as functional platforms for the stabilization of fluorescent copper nanoclusters (CuNCs), whose optical response can be modulated by interactions with metal ions and other inorganic contaminants.

For water purification, catechol-containing random copolymers were combined with magnetic iron oxide nanoparticles. Catechol groups promote interactions with the inorganic surface and provide functional sites for contaminant binding, while the magnetic component enables straightforward recovery of the nanohybrids from aqueous media using an external magnetic field.

Overall, these results demonstrate how catechol functionality, combined with controlled polymer architecture, can be exploited to tailor polymer–nanoparticle interactions and develop complementary nanohybrid platforms for water monitoring and remediation.

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Biography:

Isabel Quijada-Garrido is a Research Scientist at the Institute of Polymer Science and Technology (ICTP), Spanish National Research Council (CSIC), in Madrid, Spain. Her research focuses on the design and synthesis of functional polymeric materials, with particular emphasis on controlled radical polymerization, thermoresponsive polymers, polymer self-assembly, and organic–inorganic nanohybrids. Her current research explores RAFT and RAFT-PISA strategies to develop functional nanostructures incorporating metallic nanoclusters and magnetic nanoparticles for applications in chemical sensing, water purification, and other environmentally relevant technologies.

Thermal Polymerization from Amino-Nitrile Monomers: A New Route for Construction of Nitrogen-Rich Materials with Functional Properties

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Abstract:

Polymerizations based on triple-bond building blocks, most prominently alkynes, isocyanides, and nitriles, have attracted extensive interest from polymers researchers; and these compounds have emerged as a uniquely powerful class of monomers for the construction of functional polymers. The unique electronic character and geometric rigidity of these bonds not only confer remarkable reactivity, but also enable polymerizations that yield architectures inaccessible through conventional vinyl one. Remarkable progress has been made in those processes where alkynes are used, however nitrile monomers have been less studied; though the polymerizations based on carbon-nitrogen bonds generate materials with unique properties. In this context, the thermally induced polymerization of amino-nitrile monomers, like diaminomaleonitrile (DAMN), is becoming a valuable alternative to conventional polymerizations, free of solvents, catalysts, or initiators. Substantial advancements have been conducted by our group, starting with DAMN, which has been successfully polymerized, both in solution and in bulk, yielding materials with interesting optoelectronic properties and applications.1 In this same line, we have also focused on the bulk liquid thermal polymerization of aminomalononitrile.2 The easy, quick, and highly efficient polymerization of these dinitrile compounds motivated the exploration of new multinitrile monomers, such as the malononitrile dimer, 2-amino-1,1,3-tricyanopropene (ATCP). Thus, a recent work revealed ATCP as a promising precursor for the synthesis of C=N conjugated organic materials featuring triazine linkages.3 Kinetic studies by DSC demonstrated the autocatalytic character of these polymerizations, and this technique made it possible to explore the thermochemistry of these singular monomers.

Biography:

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2 Hortelano, C.; Ruiz-Bermejo, M.; de la Fuente, J. L. Polymers 2022, 14, 3460.

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Novel 3-Ethylcarbazole-Derived Hosts for High-Efficiency OLED Applications

Daiva Tavgenienė[1*], Dovydas Blazevicius[1], Raminta Beresneviciute[1], Mantas Kirstukas[1], Saulius Grigalevicius[1], Chih-Hung Ko[2], Cai-Fan Lo[2] and Chih-Hao Chang[2]

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Abstract:

In recent years, organic light-emitting diodes (OLEDs) have attracted considerable attention in both academia and industry due to their high efficiency, sustainability, and potential for innovative device design. This growing interest has created a strong demand for advanced functional materials. In response, we developed four novel donor–acceptor–donor (D–A–D) type host materials: CzeCzS, eCz2S, CzeCzM, and eCz2M. These compounds incorporate carbazole-based electron donors with either diphenylmethanone or diphenyl sulfone acceptor units, along with one or two ethyl substituents to enhance film-forming properties.

Thermal characterization using differential scanning calorimetry (DSC) confirmed that all materials form stable amorphous films with relatively high glass-transition temperatures. Photophysical studies revealed that the compounds possess high triplet energy levels, making them suitable as host materials for green phosphorescent and yellow thermally activated delayed fluorescence (TADF) emitters. Device performance evaluation demonstrated that host materials containing methanone acceptor units consistently outperform their diphenyl sulfone analogues, exhibiting higher current density, luminance, and overall efficiency. The best-performing device, based on CzeCzM as a host for green phosphorescent OLEDs, achieved a maximum external quantum efficiency (EQE) of 16.5%. Furthermore, the use of mixed co-host systems significantly enhanced device performance, leading to improved efficiency and reduced efficiency roll-off. Notably, a co-host device employing the methanone-based host eCz2M reached a peak EQE of 20.3%. Overall, these results demonstrate the superior performance of methanone-based host materials and highlight the effectiveness of co-host strategies in optimizing OLED device efficiency.

Biography:

Dr. Daiva Tavgenienė has been working at the Department of Polymer Chemistry and Technology at Kaunas University of Technology for about 15 years, focusing on electroactive derivatives. She has published 63 articles in high-impact journals indexed in Web of Science, with over 560 citations and an H-index of 12. She has also carried out project activities in 14 international and national projects over the past 10 years. In 2022, she also received a scholarship from the World Federation of Scientists for scientific work, and in 2023 and 2024, she was recognized as the most active young scientist at KTU.

Efficient Red Phosphorescent OLEDs Enabled by Benzophenone–(Benzo)carbazole Host Systems through Co-Host Design

Gintare Krucaite[1] and Dovydas Blazevicius[1], Raminta Beresneviciute[1], Saulius Grigalevicius[1], Yi-Qi Chao[2], Zih-Ru He[2], Kuan-Yu Su[2], Chih-Hao Chang[2]

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Abstract:

Organic light-emitting diodes (OLEDs) have rapidly gained widespread commercial adoption; however, efficiency losses and stability issues remain persistent challenges, particularly for long-wavelength emitters. We designed and synthesized four new benzophenone-(benzo)carbazole-based host materials, namely BP-Cz2 (4,4′-bis(9H-carbazol-9-yl)phenylmethanone), BP-BCz2 (bis(4-(11H-benzo[a]carbazol-11-yl)phenyl)methanone), BP-BCz ((4-(11H-benzo[a]carbazol-11-yl)phenyl)(phenyl)methanone), and BP-CzBCz ((4-(11H-benzo[a]carbazol-11-yl)phenyl)(4-(9H-carbazol-9-yl)phenyl)methanone), incorporating carbazole and extended π-conjugated benzo[a]carbazole electron-donating units, either individually or in combination. All synthesized compounds exhibited excellent thermal stability and a strong tendency to form stable amorphous thin films, with glass transition temperatures exceeding 100 °C for most materials. Photophysical characterization revealed singlet energy levels ranging from 2.90 to 3.61 eV and triplet energy levels between 2.50 and 3.10 eV, corresponding to singlet–triplet energy gaps of 0.35–0.51 eV. These energy characteristics confirm that the benzophenone derivatives provide sufficient exciton confinement for red phosphorescent emitters. Furthermore, charge-transport measurements indicated hole and electron mobilities spanning from 10^{-3} to 10^{-12} cm^2/Vs, highlighting the tunability of charge-transport properties through molecular design. The donor-acceptor compounds were evaluated as host materials in red OLED devices. Notably, devices employing a co-host configuration consistently outperformed their single-host counterparts. In particular, the BP-BCz-based co-host system utilizing OLED achieved a maximum external quantum efficiency of 17.9% with a reduced efficiency roll-off at high luminance. These results demonstrate that benzophenone-(benzo)carbazole-based host materials, when implemented within a co-host architecture, facilitate balanced charge transport, suppress exciton quenching, and enable high-performance red OLEDs.

Biography:

Senior researcher Dr. Gintarė Kručaitė has worked in the field of synthesis and characterization of electroactive derivatives in Department of Polymer Chemistry and Technology of Kaunas University of Technology for about 15 years. She has already published 71 papers in journals from the Web of Science data base, also prepared 3 review articles for journal "Synthetic Metals", "Materials" and "Coatings". Most of the articles belong to Q1-Q2 quartile publications. She is also the author of two US patents and one Taiwan patent. She has participated and still participates in international, institutional and national projects. She has received award L´Oréal-UNESCO For Women in Science Young Talent in 2022.

Glass Fiber-Reinforced Polymer Inclusion Membranes: Mechanical Enhancement without Compromising Transport Performance

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[b]Department of Chemical Engineering, The University of Melbourne, Parkville, VIC 3010, Australia

[c]Faculty of Chemistry and Technology, University of Split, Rudjera Boskovica 35, 21000 Split, Croatia

Abstract:

Polymer inclusion membranes (PIMs) are promising materials for the separation and extraction of ionic species from aqueous solutions due to their versatility, relatively simple preparation, and low reagent consumption. However, their mechanical properties can limit their practical application. This study investigates the incorporation of glass fibers (GFs) into PIMs as a reinforcement strategy to improve their mechanical properties while preserving ion transport performance.

PIMs composed of poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) and Aliquat 336 were prepared with different GF concentrations of up to 5 wt.%. The membranes were characterized using scanning electron microscopy (SEM), thermal analysis (TG/DTA), and tensile testing. Their transport performance was evaluated by using thiocyanate ions as a model system.

SEM observations revealed good adhesion between the polymer matrix and glass fibers and a relatively uniform fiber distribution. Increasing the GF concentration resulted in an increase in the elastic modulus from approximately 25 MPa for the unreinforced membrane to 40 MPa for the membrane containing 5 wt.% GF, accompanied by a moderate decrease in plasticity. Importantly, incorporation of GFs did not significantly hinder thiocyanate ion transport.

These results demonstrate that glass-fiber reinforcement can improve the mechanical properties of PIMs without compromising their transport performance, with 3 wt.% GF providing a favorable balance between strength and plasticity.

The results demonstrate the potential of glass fiber reinforcement for improving the mechanical and thermal stability of PIMs while maintaining their ion transport performance.

Biography:

Kalina Velikova is a PhD researcher at Sofia University "St. Kliment Ohridski", Bulgaria, in the Department of Applied Inorganic Chemistry, Faculty of Chemistry and Pharmacy. Her research focuses on functional polymer inclusion membranes for the extraction and separation of metal ions and toxic anions from environmental and industrial wastewater. Her research interests include polymeric membrane materials, membrane-based separation, ion transport, and the development and characterization of functional materials for environmental applications.

Development of a Cast Polypropylene (CPP) Film Heat-Sealable at 90 °C

Gülgün KAYIN ÇETİN, Gizem Şahin[a*], Hasret KARAKURT MUMCU[a], Eda Nur DİNÇ [a]

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Abstract:

This study aimed to develop a new Cast Polypropylene (CPP) film structure capable of heat sealing at lower temperatures as an alternative to conventional CPP films used in food and flexible packaging applications. Lower heat-sealing temperatures may contribute to improved packaging process efficiency and reduced energy consumption. Accordingly, the study focused on developing a film capable of initiating heat sealing at approximately 90 °C while maintaining its mechanical, optical, and processing properties.

Within the project, literature and market research were conducted, alternative raw materials were evaluated, and different formulations were developed. Following pilot-scale Cast CPP production trials, the films were evaluated in terms of heat sealing, Hot Tack, mechanical and optical properties, coefficient of friction, and blocking performance. The developed film showed heat-sealing initiation at 90 °C, with a significant increase in sealing strength between 100 and 110°C. Mechanical and optical properties were maintained, while acceptable blocking performance was achieved.

Based on the technical results and customer trials, the product was found suitable for commercial production and added to the company's product portfolio. The developed film offers potential for improving process efficiency and energy utilization in packaging applications requiring lower-temperature heat sealing.

Keywords: Cast polypropylene (CPP), low-temperature heat sealing, Heat Seal, Hot Tack, flexible packaging.

Biography:

Super Film is a well-established company founded in 1993, standing out in the packaging industry with its innovative production approach. Its R&D Center, launched in 2017, has strengthened its technological capabilities. With high quality standards, a sustainability-focused vision, and innovative solutions, it continues to enhance its competitiveness in both national and international markets.

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