POLYMERS 2026, COMPOSITES 2026 AND 3BS MATERIALS TECH 2026

INTERNATIONAL JOINT CONFERENCE

08 - 10 APRIL 2026 | LISBON - PORTUGAL

Book of Abstracts

Organizer

SETCOR
Conferences & Exhibitions

Polymers / Composites / 3Bs Materials Tech 2026
Joint International Conferences Preliminary Program
08 - 10 April 2026, Lisbon - Portugal

Wed. 08 April 2026		
08:00 - 12:00	**Conference Registration / Welcome Coffee Break / Posters Installation - Mezzanine Area**	
Conference Room Roma II		
Polymers / Composites / 3Bs Materials 2026 Plenary Session I. A		
Session's Chairs: **Prof. Geoffrey Mitchell, Polytechnic Institute of Leiria, Portugal** **Prof. Maria Laura Di Lorenzo, CNR- Institute for Polymers, Composites and Biomaterials, Italy**		
10:00 - 10:30	Dependence of the Reinforcement of Polymer-Based Nanocomposites upon the Nanofiller Geometry Z. Li, M. Liu and **R.J Young**	**Prof. Robert J Young**, Univ. of Manchester, **UK**
10:30 - 11:00	The Future of Composites Manufacturing **N. Warrior**	**Prof. Nick Warrior**, The Univ. of Nottingham, **UK**
11:00 - 11:30	Bioinspired polyphenol-based functional biointerfaces S. Suárez-Garcia, J. Bolaños-Cadet, B. Pepio and **D. Ruiz-Molina**	**Prof. Daniel Ruiz-Molina,** ICN2-CSIC, **Spain**
11:30 - 12:00	Active fibrous materials based on PLA/Magnetic nanoparticles prepared by Solution Blow Spinning N. Nikolić, M. Žabčić, S. Kralj, S. Gyergyek, M. Vukomanović and **J. González-Benito**	**Prof. Javier Gonzalez-Benito**, Univ. Carlos III de Madrid, **Spain**
12:00 - 14:00	**Lunch Break - Restaurante Rio de Janeiro**	
Polymers 2026 Session I. B: Synthesis, Processing and Characterization		
Session's Chairs: **Prof. Robert J Young, Univ. of Manchester, UK** **Prof. Javier Gonzalez-Benito, Univ. Carlos III de Madrid, Spain**		
14:00 - 14:30	Manipulation of crystallization kinetics of poly(L-lactic acid) as a tool to develop novel applications **M.L. Di Lorenzo**	**Prof. Maria Laura Di Lorenzo**, CNR- Institute for Polymers, Composites and Biomaterials, **Italy**
14:30 - 14:45	Advancements in Multifunctional Composite Nanofibrillar PVA-Fe3O4 Materials: Exploring Preparation of PVA-Based Materials by Solution Blow Spinning Technique **F. Ashraf**, D. Olmos and González-Benito	**Mrs. Fazila Ashraf**, Univ. Carlos III de Madrid, **Spain**
14:45 - 15:00	Quercetin-loaded PLA nanofibers for active food packaging applications prepared by Solution Blow Spinning **N. Nikolic**, E. Olewnik-Kruszkowska, A. Richert and J. González-Benito	**Ms. Natasa Nikolic**, Univ. Carlos III de Madrid, **Spain**
15:00 - 15:15	Electrospun Nanofibrous Scaffolds for Biomedical and Soft Packaging Applications **M. Waqas**, D. Sun and R; Salehiyan	**Dr. Muhamamd Waqas**, Edinburgh Napier Univ;, **UK**
15:15 - 15:30	Processing-Driven Structure–Property Relationships in 3D-Printed PBSA Membranes and Their Impact on Permeation Performance **L. Tazrout**, L. Hespel, G. Gbabode, A. Guinault, C. Sollogoub and N. Follain	**Mrs. Lisa Tazrout**, Univ Rouen, **France**
15:30 - 15:45	PET synthesis based on various amounts of terephthalic acid from chemical recycling of PET / cotton textiles **G. André**, S. Giraud, P. Zinck, R. Benkirane, C. Campagne and A. Cayla	**Mr. Gabriel André**, Univ. Lille, **France**
15:45 - 16:00	Sustainable functionalisation of poly(3-hydroxybutyrate): solvent and catalyst-free aminolysis and enzymatic transesterification approaches **J. Jayaprakash**, G. Garnier and V.S. Haritos	**Mrs. Jayalakshmi Jayaprakash**, Monash Univ. Clayton, **Australia**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session - Mezzanine Area**	

Session's Chairs: Prof. Robert J Young, Univ. of Manchester, UK Prof. Maria Laura Di Lorenzo, CNR- Institute for Polymers, Composites and Biomaterials, Italy		
16:30 - 17:00	The study of lattice structure implementation and integration in a bicycle helmet produced in AM G.L. Valinho, A. Rodrigues and **A. J. Pontes**	**Prof. António José Vilela Pontes**, University of Minho, **Portugal**
17:00 - 17:15	Degradation-to-Reconstruction Upcycling of P(Styrene-co-DOT) Copolymers into Epoxy Thermosets **U.U. Ozkose**, Y. Guillaneuf, E. Gastaldi, V. Lapinte, S. Caillol and J. Pinaud	**Dr. Umut Ugur Ozkose**, ICGM, Univ. Montpellier, **France**
17:15 - 17:30	Bio-based polyurethane with a photolabile o-nitrobenzyl molecule for degradation on demand **A. Limouzin** and B. Voit	**Ms. Apolline Limouzin**, Leibniz Institute of Polymer Research Dresden, **Germany**
17:30 - 17:45	Dynamic behavior of functionalized alginates revealed by electron paramagnetic resonance spectroscopy **G. Ionita**, M. L. Ciutu, A. G. Bucur, E. E. Antonia, A. V. F. Neculae, C. Pacuretu, L. Aricov and S. R. A. Marque	**Dr. Gabriela Ionita**, Institute of Physical Chemistry – Ilie Murgulescu, **Romania**
17:45 - 18:00	Synthesis of Bio-Based Polyesters for Next-Generation Sustainable Packaging Materials **M. V. Loureiro**, A. Pereira, R. G. Santos, J. C. Bordado, S. Lourenço, L. Gonçalves, P. Allen, L. Aparicio, A. L. Maulvault, D. Bolotas, R. V.C. Gomes, J. Ramos, T. Chainho, T. Valério and A. C. Marques	**Dr. Mónica Loureiro**, Sovena Portugal Consumer Goods, S.A, **Portugal**

Wed. 08 April 2026		
Conference Room Milão I		
Composites Session I. C: Synthesis, Processing and Characterization		
Session's Chairs: **Prof. Nick Warrior, The Univ. of Nottingham, UK** **Dr. Pietro Russo, Institute for Polymers, Composites and Biomat- Napoli, Italy**		
14:00 - 14:30	Epoxy nanocomposites as Joule adhesives for a more sustainable manufacturing in the composites sector. **C. Valles**, Y. Huang and I.A. Kinloch	**Dr. Cristina Vallés**, Univ. of Manchester, **United Kingdom**
14:30 - 15:00	On fracture response and traction separation relations in DCB specimens loaded under pure moments or end opening forces **J. Botsis**	**Prof. John Botsis**, EPFL, **Switzerland**
15:00 - 15:30	Edible, Flexible and Smart: Redefining Electronics with Natural Biopolymer-based Nanocomposites. M. Dong and **D. Papageorgiou**	**Dr. Dimitrios G. Papageorgiou,** Queen Mary University of London, **UK**
15:30 - 15:45	PBAT Composites Reinforced with Latxa sheep wool and Tannins for Sustainable Fishing and Agricultural Applications **A. Larruscain,** C. Peña-Rodriguez and A. Arbelaiz	**Mr. Ander Larruscain Garate**, Univ. of the Basque Country, **Spain**
15:45 - 16:00	Tailoring Magnetic Properties of Fe/Fe-oxide Composite Architectures **I. Lasa**, C. Redondo, D. Salazar and R. Morales	**Ms. Irati Lasa Uriarte**, Univ. of the Basque Country, **Spain**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session - Mezzanine Area**	
Session's Chairs: **Dr. Cristina Vallés, Univ. of Manchester, United Kingdom** **Dr. Dimitrios G. Papageorgiou, Queen Mary Univ. of London, UK**		
16:30 - 16:45	Development of Quality Assessment Methods for Filament-Wound Composite Overwrapped Pressure Vessel Surfaces **V. Grün**, A. Dyagilev, C. Greb and T. Gries.	**Mr. Vinzent Grün**, RWTH Aachen University, **Germany**
16:45 - 17:00	Photoinduced Frontal Polymerization of Acrylic Resins Reinforced by Biofillers **M. Dizman**, A. Vitale and R. Bongiovanni	**Mr. Mirac Dizman**, Politecnico di Torino, **Italy**
17:00 - 17:15	Lignocellulosic biomass revalorization inside a circular-economy frame to produce competitive polyhydroxyalkanoate composites for packaging applications. **S. Roig-Sanchez**, D. Martin, C. Prieto, L. Cabedo and J.M. Lagaron	**Dr. Soledad Roig-Sanchez**, IATA-CSIC, **Spain**

Wed. 08 April 2026		
Conference Room Milão II		
3Bs Materials Session I. D: Synthesis, Processing and Characterization		
Session's Chairs: **Prof. Maria Beatrice Coltelli, Univ. of Pisa, Italy** **Prof. Luisa Neves, NOVA School of Science and Technology, Portugal** **Prof. Branka Pilić, Univ. of Novi Sad, Serbia**		
14:00 - 14:30	Unlocking the Potential of Residual Streams for Biopolymer Production: Bridging Lab-scale Innovation and Scale up. **M. Reis**	**Prof. Maria Reis**, NOVA Lisbon, **Portugal**
14:30 - 15:00	Sea urchin inspired bioadhesives for biomedical and biotechnological applications **R. L. A. dos Santos**	**Prof. Romana Lopes Almeida dos Santos**, Univ. of Lisbon, **Portugal**
15:00 - 15:30	Using Algal and Fungal Multi-omics to Enable Sustainable Biomaterials **I. V. Grigoriev**	**Dr. Igor Grigoriev**, University of California Berkeley, **USA**
15:30 - 15:45	Virus-like particles as modular interfaces for biomaterial functionalization **R. Hedna**, H. Maayouf, A. Boché, T. Dos Santos, K. Tārs, I. Brigaud, T. Petithory, F. Carreiras, C. Arnold, A. Lambert, and L. Pieuchot	**Dr. Rayane Hedna**, CNRS-IS2M, Mulhouse Materials Science Institute, **France**
15:45 - 16:00	3D-Printed PCL/Chitosan Hybrid Scaffolds with Dual Porosity for Periodontal Regeneration and Antimicrobial Functionality A. Zanfardino, A. Gloria, G. Castagliuolo, S. Scialla, R. De Santis, M. Varcamonti and **T. Russo**	**Dr. Teresa Russo**, Institute of Polymers, Composites & Biomaterials - Naples, **Italy**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session - Mezzanine Area**	
Session's Chairs: **Prof. Maria Reis, NOVA Lisbon, Portugal** **Prof. Romana Lopes Almeida dos Santos, Univ. of Lisbon, Portugal**		
16:30 - 17:00	Microbial Polymers as Biomaterials for Topical Drug Delivery Applications **F. Freitas**	**Dr. Filomena Freitas**, NOVA Lisbon, **Portugal**
17:00 - 17:15	Mixed species biofilms on non-woven fiber pads -Characterizing a self-organizing, catalytic, living material **J. Lambrecht** and K. Bühler	**Dr. Johannes Lambrecht**, Helmholtz Centre for Environmental Research, **Germany**
17:15 - 17:30	Polyphenolic surface functionalization of fluorinated contact lenses for peptoid grafting and enhanced properties **R. Refaei**, P. Demian, M. Lamrani and N. Allali	**Dr. Roeya Refaei**, Faculty of Sciences and Techniques, Tangier, **Morocco**
17:30 - 17:45	Tailored Bio-Based Plasticizers from Vegetable Oils: Design Toward Sustainable PVC Applications P. Maroulas, E. Gkartzou, **M. Karamitrou** and C. A. Charitidis	**Dr. Melpo Karamitrou**, National Technical Univ. of Athens, **Greece**

Thu. 09 April 2026		
Conference Room Milão I + II		
Polymers / Composites / 3Bs Materials 2026 Plenary Session II. A		
Session's Chairs: **Prof. Robert J Young, Univ. of Manchester, UK** **Prof. Nick Warrior, The Univ. of Nottingham, UK** **Dr. Pietro Russo, Institute for Polymers, Composites and Biomat- Napoli, Italy**		
08:30 - 09:00	Enhancing dynamic feedback during polymer processing **G. Mitchell**	**Prof. Geoffrey Mitchell**, Polytechnic Institute of Leiria, **Portugal**
09:00 - 09:30	Recycling and valorisation of textile waste through vitrimer chemistry **J. Rumeau**	**Prof. Jannick Rumeau,** Univ. of Lyon, **France**
09:30 - 10:00	Design and Processing of Sustainable Polymers: A POLYMERS-5B Perspective **B. Pilić**	**Prof. Branka Pilić**, Univ. of Novi Sad, **Serbia**
10:00 - 10:30	From Agri-Food Residues to Sustainable Polymers based on the Polymers-5B Pathway Toward Circular Bioplastics **L. J. P. Fonseca**	**Prof. Luís J.P. da Fonseca,** University of Lisbon, **Portugal**
10:30 - 11:00	**Morning Coffee Break / Posters Session - Mezzanine**	
11:00 - 11:30	Novel Fully Bio-based Copolymers for Food Packaging Applications M. Pacheco-Romeralo, Y. Flores, A. Martínez de Ilarduya 2, C. Sammon and **S. Torres-Giner**	**Prof. Sergio Torres-Giner**, Polytechnic Univ. Valencia, **Spain**
11:30 - 12:00	Biopolymer-based materials for packaging valorizing agricultural waste of the Mediterranean area V. Gigante, F. Cartoni, V. Berrugi, M. Chadni, A. Aboudia, A. Lazzeri, L. Aliotta, A. Castagna and **M. B. Coltelli**	**Prof. Maria Beatrice Coltelli,** University of Pisa, **Italy**
12:00 - 14:00	**Lunch Break - Restaurante Rio de Janeiro**	
Group Photo at 13:45		
Polymers / Composites / 3Bs Materials Session II. B: **Biomaterials and Drug delivery applications**		
Session's Chairs: **Prof. Daniel Ruiz-Molina, ICN2-CSIC, Spain** **Dr. Filomena Freitas, NOVA Lisbon, Portugal** **Prof. Luís J.P. da Fonseca, Univ. of Lisbon, Portugal**		
14:00 - 14:30	Ensuring Medical Device Success with Nano Composites: 40,000 Patients and Counting **T. J. Webster**	**Prof. Thomas J. Webster**, Hebei University of Technology, **China**
14:30 - 15:00	Eco-Friendly Glycerol-Derived Polyesters: Advancing the Sustainability of Polymers in Liquid Formulations and Medical Applications **V. Taresco**	**Dr. Vincenzo Taresco**, University of Nottingham, **UK**
15:00 - 15:15	Formation of a scaffold based on silica-gelatin-polymer by supercritical technology for its use in biomedicine **A. Montes Herrera**, D. Valor, D. M. de los Santos, I. García-Casas and C. Pereyra	**Dr. Antonio Montes Herrera**, University of Cádiz, **Spain**
15:15 - 15:30	Light-Responsive Self-Immolative Polymers Based on o-Nitrobenzyl Groups **B. Hajjchehade**, J. Potier, P. Woisel and K. Belkhir	**Mr. Bilal Hajjchehade**, Centrale Lille, **France**
15:30 - 15:45	Bio-Reinforced Hydrogels: Development and Characterization of Poly(sodium 2-acrylamido-2-methylpropane sulfonate)/Hemp Fiber Composites for Wound Dressings W. Sukmongkolwongs, S. Sudrungruang, P. Wongruang, A. Rungrod, A.K. Aldred and **R. Somsunan**	**Dr. Runglawan Somsunan**, Chiang Mai University, **Thailand**
15:45 - 16:00	Synthesis and Properties Testing of P(Na-AMPS)/CMC/Glycerin Amorphous Hydrogels for Wound Dressing Applications	**Ms. Waewploy Sukmongkolwongs**,

	W. Sukmongkolwongs, P. Aewprasert, P. Yodkum, A. Roungrod and R. Somsunan	Chiang Mai University, **Thailand**
16:00 - 16:15	Formulation and Evaluation of a Neem-Loaded Dual-Responsive Pluronic F127/N-Succinyl Chitosan Sprayable Hydrogel for Wound Dressing Applications **A. Rungrod**, A. Makarasen, S. Patnin, S. Techasakul and R. Somsunan	**Dr. Amlika Rungrod**, Chulabhorn Research Institute, **Thailand**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session - Mezzanine Area**	

Thu. 09 April 2026		
Conference Room Roma II		
Workshop on Safe and Sustainable BioBased Polymers: from design to end of life in Circular Value Chains		
Workshop Chairs: **Dr. Carmen Fernández Ayuso, CETEC, Spain** **Mrs. Erica Moresco, ICONS foundation, Italy**		
09:00 - 09:10	Opening & General introduction to the workshop	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
BLOCK 1. European Innovation Landscape, Safe and Sustainable by Design Polymers		
09:10 - 09:15	BIO4PACK CLUSTER introduction	**Dr. Milad Mosallaei,** VTT, **Finland**
09:15 - 09:25	ViSS project	**Dr. Carmen Fernández Ayuso**, CETEC, **Spain**
09:25 - 09:35	REBIOLUTION project	**Dr. Yannick Matt**, BASF, **Germany,**
09:35 - 09:45	MAGNO project	**Dr. Alejandra Pita Milleiro**, IDENER, **Spain**
09:45 - 09:55	STOPP project	**Dr. Milad Mosallaei**, VTT, **Finland**
09:55 - 10:05	Interactive session. Q&A	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
10:05 - 10:10	PHAntastic, ViNNY & BIOVIVE CLUSTER introduction	**Dr. Carmen Fernández Ayuso**, CETEC, **Spain**
10:10 - 10:20	PHAntastic Project	**Dr. Carmen Fernández Ayuso**, CETEC, **Spain**
10:20 - 10:30	ViNNY Project	**Dr. Margarida M. Fernandes**, Univ. Minho, **Portugal**
10:30 - 11:00	**Morning Coffee Break / Posters Session - Mezzanine Area**	
11:00 - 11:10	BioVIVE Project	**Dr. Asier Fernandez de Añastro,** Centro Tech Miranda del Ebro, **Spain**
11:10 - 11:25	Interactive session. Q&A	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
11:25 - 11:30	ANIPH & MAGICBIOMAT CLUSTER introduction	**Mrs. Cristina Blaya, CETEC, Spain**
11:30 - 11:40	ANIPH project	**Mrs. Cristina Blaya**, CETEC, **Spain**
11:40 - 11:50	MAGICBIOMAT project	**Dr. Yuanyuan Chen**, TUS, **Ireland**
11:50 - 12:00	Interactive session. Q&A	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
12:00 - 14:00	**Lunch Break - Restaurante Rio de Janeiro**	
Group Photo at 13:45		
Session 1: From Research Data to Sustainable Exploitation: Policy and IP Frameworks		
14:00 - 14:05	Introduction and opening	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
14:05 - 14:20	Managing research data for sustainable exploitation: accessibility, sustainability, and IP protection	**Mrs. Roberta Mallia**, ICONS, **Italy**
14:20 - 14:35	Policy and standards	**Mrs. Suzan Naz Uzel**, REVOLVE Media, **Belgium**
14:35 - 14:50	Maximising EU Projects' Synergies and Policy Impacts	**Salima Abu Jeriban (Research Executive Agency, European Commission)**
14:50 - 15:00	Interactive session. Q&A	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
BLOCK 2: Safe and Sustainable-by-Design (SSbD): From Frameworks to Digital Tools		

15:00 -15:05	Introduction and opening	**Mrs. Alba Matamoros**, KVC, **Belgium**
15:05- 15:20	Safe and sustainable by Design framework	**Mrs. Alba Matamoros**, KVC, **Belgium**
15:20- 15:35	LCA supporting sustainable design development	**Mrs. Inka-Mari Sarvola**, VTT, **Finland**
15:35- 15:50	LCC and S-LCA in practice: the ViSS case study	**Mrs. Alba Matamoros**, KVC, **Belgium**
15:50 - 16:05	Interactive session. Q&A	**Mrs. Alba Matamoros**, KVC, **Belgium**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session - Mezzanine Area**	
Session 2.1: Advance Bio-Based Polymers: Processing, Scale-Up and Digitalisation		
16:30 - 16:35	Introduction and opening	**Mrs. Ana Crespo Cortés**, CETEC, **Spain**
16:35 - 16:45	Stimuli-responsive PLLA nanovesicles for controlled delivery of grape cane extracts in sustainable viticulture.	**Mrs. Beatriz Cardoso**, Univ Minho, **Portugal**
16:45 - 16:55	Biobased plastics compounding: from lab to pilot scale	**Dr. Luis Minguez**, CETEC, **Spain**
16:55 - 17:05	Ecosystem Digital Twin for Circular Packaging Solutions: From Manufacturing to End of Life (MAGNO EU Project)	**Dr. Alejandra Pita Milleiro**, IDENER, **Spain**
17:05 - 17:15	Bio-based and biodegradable solutions for agriculture	**Dr. Yannick Matt**, BASF, **Germany**
17:15 - 17:25	Interactive session. Q&A	**Mrs. Erica Moresco**, ICONS foundation, **Italy**
Session 2.2. Biodegradation in Open Environments: Methods, Applications and Assessment		
17:25 - 17:30	Introduction and opening	**Dr. Christian Lott**, HYDRA Marine Sciences GmbH, **Germany**
17:30 - 17:40	Biodegradation in the open environment: methodologies and gaps in standardisation	**Dr. Miriam Weber**, HYDRA Marine Sciences GmbH, **Germany**
17:40 - 17:50	Biodegradation of PLA	**Dr. Yuanyuan Chen**, TUS, **Ireland**
17:50 - 18:00	AI-Enabled Multi-Property Prediction of Biodegradability, Toxicological, and Physicochemical Characteristics in PHA-Based Biopolymers	**Dr. Marianna Kotzabasaki**, AUA, **Greece**
18:00 – 18:10	Interactive session. Q&A	**Dr. Christian Lott**, HYDRA Marine Sciences GmbH, **Germany**
Closing and Final Remarks		
18:10 – 18:20	Final remarks, closing and networking time by **Mrs. Erica Moresco**, ICONS foundation, **Italy**	

Fri. 10 April 2026		
Conference Room Milão I		
Polymers / Composites / 3Bs Materials Session III: Biomaterials and Drug delivery / Food and Agriculture applications		
Session's Chairs: Prof. Javier Gonzalez-Benito, Univ. Carlos III de Madrid, Spain		
08:00 - 08:30	Innovative Approaches to Bio-Based Membrane Design and Development D. Gazcón, R. Nascimento, N. Gorvo, A. Almeida, A. Paiva, F. Freitas and **L.Neves**	**Prof. Luisa Neves**, NOVA School of Science and Technology, **Portugal**
08:30 - 08:45	Innovation in Circular Packaging: Establishing a Recycling Chain for Yogurt Cups **I. Costa**, D. Ribeiro, B. Silva, C. Basto-Silva, A. M. Silva, J. Fernandes, R. Pinto, N. Lima and C. Faria	**Ms Catarina Faria**, PIEP – Centre for Innovation in Polymer Engineering**, Portugal**
3Bs Materials Tech 2026: AGRO4AGRI Project Workshop Pathways to Impact in Sustainable Agrochemistry: A 360° Innovation Approach from Lab to Market		
Workshop Chairs: Dr. Kristie Tanner, Packaging technologies- AINIA, Spain		
08:45 - 09:00	Introduction of the AGRO4AGRI Project Workshop	
09:00 - 09:20	Nanocellulose-Based Advanced Fertilizer Systems for Controlled Nutrient Release in Sustainable Agriculture **E. Usala**, R. Morcillo, A. Salas, F. Vargas and C. Bosch	**Ms. Elena Usala**, Packaging technologies- AINIA, **Spain**
09:20 - 09:40	Engineering Forest-derived Biochar as a Nanoplatform for Sustainable Nutrient Delivery in Plants **I. Ortiz-Gómez**, M. M. Peña-Perez, S. Rodriguez-Varilla, A. Sánchez-Corrionero, I; Grondona, C. Manteca-Martínez and Á. Yedra-Martínez	**Dr. Inmaculada Ortiz Gomez**, CTC – Fundación Centro Tecnológico de Componentes, **Spain**
09:40 - 10:00	From Lab to Pilot: Process Design and Scale-Up of Wheat Straw Nanocellulose Production for Fertilizer Delivery Systems **A. Somoza**, E. Usala and F. Vargas	**Dr. Alba Somoza Cerviño**, SYSPRO Automation S.L., **Spain**
10:00 - 10:30	**Morning Coffee Break - Mezzanine Area**	
10:30 - 10:50	Stakeholder-aligned pathways to impact and exploitation in sustainable agrochemistry **J. Beinarovič̌a**	**Dr. Jolanta Beinarovič̌a**, OPTIMAT, **UK**
10:50 - 12:20	**Expert Panel Discussions with Audience Participation** **Panel 1:** From Frameworks to Field Decisions: Making Sustainability Actionable in Agriculture **Panel 2**: Biobased Innovation in Practice: Stakeholder Expectations, Barriers, and Enablers Panellists so far include: - **Mr. Francisco Jose Antequera Calvo**, *Head of the AgriTech Center at Misión Andalucía | President Founder ATG SynBio,* ***Spain*** - **Dr. Margarida Fernandes,** *Project Coordinator VINNY, CMEMS, University of Minho,* ***Portugal*** - **Prof. Sergio Torres-Giner,** *Polytechnic University of Valencia,* ***Spain*** - **Dr. Jolanta Beinarovič̌a**, *Senior Business Strategy Consultant at OPTIMAT,* ***UK***	

Fri. 10 April 2026		
Conference Room Milão II		
Polymers / Composites 2026 Session III. A: Energy and Environmental Applications		
Session's Chairs: Prof. Robert J Young, Univ. of Manchester, UK Prof. John Botsis, EPFL, Switzerland		
09:00 - 09:30	Smart Systems for Energy Conversion and Decarbonization **J.C.M. Bordado**	**Prof. João Carlos Moura Bordado**, University of Lisbon, **Portugal**
09:30 - 10:00	The application of polymers and polymer nanocomposites in electrical engineering **M. Liu**, R. J. Young and L. Chen	**Dr. Mufeng Liu,** University of Manchester, **UK**
10:00 - 10:30	**Morning Coffee Break (Mezzanine Area)**	
10:30 - 10:45	Environmental and human hazard characterisation of biobased materials and products: the Biouptake case study **I. Lopes**, C. Venâncio, S. Costa, C. Chatard, S. Malburet, R. Geerinck, R. De Bisschop, H. Knudsen, S.K. Lang, A. Marqués, J. Vidal, A. Genua and L. Hernandez	**Dr. Isabel Lopes**, University of Aveiro, **Portugal**
11:45 - 11:00	Integration of printed electronics into composites: advances towards smart and sustainable composites **R. Herrero**, M. Lasheras, J. Alias, A. Ameztoi, J. Peña, J. Mota and J. Artola	**Dr. Rakel Herrero**, NAITEC, **Spain**
11:00 - 11:15	Longlife of organic sensors dedicated to ammonia monitoring for environmental applications: a two years study E. A. Da Silva, A. Gregori, N. Redon and **C.Duc**	**Dr. Caroline Duc**, IMT Nord Europe, **France**
11:15 - 11:30	Surface modification of Carbon Nanofibers (CNFs) and their incorporation in polyester coating matrix for enhanced corrosion resistance of galvanized steel **R. Arora Kumar** and N. Kabir Chaubey	**Mr. Rohit Kumar**, R&D Tata Steel Limited, **India**
11:30 - 11:45	Effect of Surface Treatment on the Water Resistance of Cardboard **B. Basto**, F. Leite, J. Bessa, R. Costa and R. Fangueiro	**Dr. Bruna Basto**, Fibrenamics, **Portugal**
11:45 - 12:00	Enhanced Wastewater Treatment Using MOF-Modified Polysulfone Membranes **M.A. Jamil**, J. Hashemibeni and G. Janusas	**Dr. Muhammad Asif Jamil**, Kaunas University of Technology, **Lithuania**

Polymers / Composites / 3Bs Materials Tech 2026 Posters Sessions

Mezzanine Area

08 and 09 April 2026 (No posters sessions on 10 April 2026)

N.	Poster Title	Author, Affiliation, Country
1.	Polymeric Nanostructures from Biowaste: Formulation of Polymer Nanocomposites of Chitosan-Opuntia Ficus Nanoparticles and Investigating their Antioxidant and Antibacterial Activities **E. Elhawary** and W. Mamdouh	**Dr. Enas Elhawary**, The American University in Cairo, **Egypt**
2.	Enhancing the Hydrophilicity of Electrospun Polylactide Scaffolds via Polymaleate–N-acetyl-L-cysteine Conjugates **M. Chrószcz-Porębska**, T. Gołofit, D. Polak, M. Szwast and A. Gadomska-Gajadhur	**Dr. Marta Chrószcz-Porębska**, Warsaw University of Technology, **Poland**
3.	Effects of Calcination and Acid Treatments for Fillers on Rheological and Mechanical Properties of PLA-based Blends J-H. Park and **K-S. Jang**	**Prof. Keon-Soo Jang,** The University of Suwon, **Rep. of Korea**
4.	X-Ray Computed Tomography for Microplastic Analysis in Textile sector **R. Mossotti**, A. Patrucco and A. Anceschi	**Dr. Raffaella Mossotti**, CNR-STIIMA, **Italy**
5.	Ultrasensitive Optical Bio-nanosensors for detection of standard and low-concentration Biomarkers in body fluids. A. Necas, **M. Crha**, A. Pashchenko, L. Varvarovska, S. Cruciani, B. Sopko, T. Jarosikova, M. Maioli and E. Amler	**Prof. Michal Crha**, Univ. of Veterinary Science Brno, **Czech Rep.**
6.	Evaluation of multilayer PE film with addition of wood particles obtained by developed blow molding process **M. Bilewicz**, T. Tański and T. Gliński	**Dr. Marcin Bilewicz**, Silesian University of Technology, **Poland**
7.	Advancing bio-based polymers from sustainable feedstocks: a clustered European approach to high-performance circular materials **A. Marrocchi**, K. Bernaerts and L. Fonseca	**Prof. Assunta Marrocchi**, Univ. of Perugia, Perugia, **Italy**
8.	Molecular Dynamics Simulations to Predict the Thermo-Mechanical Properties of Bio-based Polyesters T. Vieira, **T. Branco,** C. Andrade and L. P. Fonseca	**Mrs. Tamara Branco**, CENTIMFE, **Portugal**
9.	Safe-and-Sustainable-by-Design (SSbD) from packaging decoration perspective E.Vare, M. Mulakkal, I. Rytöluoto, **M. Mosallaei**, A. Bruno and F. Javanshour	**Dr. Milad Mosallaei**, VTT, **Finland**
10.	Mycelium-Based Composites from Invasive Biomass: Low-Carbon Materials for Circular Manufacturing C. Longo, F. Stainsby, R. Salehiyan and **D. Sun**	**Dr. Dongyang Sun**, Edinburgh Napier Univ., **UK**
11.	Can nature support the recovery of High-performance polymers from composite wastes? **G. Forte** and M. Chokai	**Dr. Guiseppe Forte**, Teijin Holdings Europe B.V., **The Netherlands**
12.	From Waste to Technological Products: Bioplastics Production from Proteins Extracted from the Black Soldier Fly A. Di Pasquale, **M. Zoccola**, A. Mohod, G. Dalla Fontana, A. Anceschi and S. Dalle Vacche	**Dr. Marina Zoccola**, CNR STIIMA, **Italy**
13.	Efficient Microwave Processing for the Preparation of Acrylated Soybean Oil Thermosetting Foams **A. Vignali**, S. Iannace and F. Bertini	**Dr. Adriano Vignali**, CNR-SCITEC, **Italy**
14.	Valorization of Green Seaweed Biomass through a Multi-Step Biorefinery Approach A. Vignali, J. Paini, G. Ottolina, F. Zaccheria and **F. Bertini**	**Dr. Fabio Bertini**, SCITEC - CNR, **Italy**
15.	Safe and Sustainable by Design PHBV from waste streams **A. Crespo Cortes** et al	**Mrs. Ana Crespo Cortés, CETEC, Spain**
16.	Dynamic Characterization of Fiber-Reinforced Thermoplastic and Steel Hybrid Materials for Automotive Applications **D. Minon**, J. García-Barruetabeña and B. Achiaga	**Mr. David Minon Alonso**, University of Deusto- Bilbao, **Spain**
17.	Advancing Timber–Composite Systems for Sustainable and Green Building **P.G. Kossakowski**	**Prof. Paweł Kossakowski,** Kielce University of Technology, **Poland**
18.	Environmentally Friendly Sustainable Thermoset Vitrimer-Containing Polyrotaxane **S. Ando**, M. Hirano and K. Ito	**Dr. Shota Ando**, University of Tokyo, **Japan.**

19.	Sustainable Hybrid Composites from Recycled PETG, TPU, and Tennis Strings Reinforced with Carbon, Glass, and Tenron Mineral Fibers via Hot Compaction **W. Chebli**, G. Ç. Kabakcı, M. Moinet, C. Ben Brahim, C. Puyenchet1, S. Toumi, O. Klinkova, E. Bayraktar*	**Mr. Wathek Chebli**, ISAE-SUPMECA- Paris, **France**
20.	Rheological behavior and Dynamic-Mechanical properties of Polyamide 11 composites filled with Bamboo Flour **P. Russo** and J. Passaro	**Dr. Pietro Russo**, Institute for Polymers, Composites and Biomat - Napoli, **Italy**
21.	Tribocatalytic Degradation of Paracetamol Using Sol–Gel and Hydro-thermally Synthesized ZnO and Ho-Modified ZnO **N. Kaneva**, S. Petrova and A. Bachvarova-Nedelcheva	**Dr. Nina Kaneva**, University of Sofia, **Bulgaria**
22.	Comparative Study of Albumin Nanoparticles Loaded with Resveratrol or Curcumin K. Yoncheva, **L. Radeva**, A. Belchev, M. Demireva and P. Karimi	**Dr. Lyubomira Radeva,** Medical University of Sofia, **Bulgaria**
23.	Incorporation of Curcumin-Albumin Nanoparticles in PVA Patch for Dermal Application **A. Belchev**, L. Radeva, P. Karimi, I. Spassova , D. Kovacheva and K. Yoncheva	**Mr. Aleksandar Belchev,** Medical University of Sofia, **Bulgaria**
24.	Synthesis, Characterization, and Fabrication of a Poly(L-lactide-co-Ɛ-caprolactone) Block Copolymer for Absorbable Nerve Conduits **M. Sriyai**, C. Saeheng, A. Fuongfuchat, R. Molloy and W. Punyodom	**Dr. Montira Sriyai**, Chiang Mai Univ., **Thailand**
25.	Integration of anthocyanins into bacterial cellulose films for food safety enhancement in fish **C-M. Kuo**, Y-R. Chang, S-Q. Huang, J-J. Shen and C-H. Liu	**Dr. Chiu-Mei Kuo**, Chung Yuan Christian Univ., **Taiwan**
26.	Enhanced cell adhesion on poly-e-caprolactone for heart valve tissue engineering by H2-N2 plasma treatment **J.A. Seiler**, J. Schütrumpf, M. Saeid Nia, L. Jesaitis, B. Book, V. Schneider, H. Kersten and G. Lutter	**Dr. Jette Anika Seiler,** Univ. Hospital Schleswig-Holstein Kiel, **Germany**
27.	Novel Dental Implants via Hybrid Ceramic Reinforcements and Dual Manufacturing Routes H. Gamoudi, A. Taboun, A. Stajcic, M, Petrovic, D. Stojanovic, R. Jancic Heinemannl. Stajcic and **V. Radojevic**	**Prof. Vesna Radojevic**, University of Belgrade, **Serbia**
28.	Porous inorganic nanoparticles for Improved Nutrient Delivery and Environmental Sustainability **I. Ortiz-Gomez**, P. Ruiz-Losada, F. B. Aguirre-Yagüe, A. Sánchez-Corrionero, I. Grondona and A. Yedra-Martínez	**Dr. Inmaculada Ortiz Gomez,** CTC – Fundación Centro Tecnológico de Componentes, **Spain**
29.	Synergistic effect of Hypoxic Conditioning and Cell-Tethering Colloidal Gels enhanced Productivity of MSC Paracrine Factors and Accelerated Vessel Regeneration **J.S. Lee**, E. Choi, S.R. Shin and I.K. Kwon	**Dr. Jae Seo Lee**, Kyung Hee University, **Rep. of Korea**
30.	Novel fluorinated polynorbornene dicarboximide for gas separation **L. Rubio-Rangel**, A. A. Santiago, M. López-González and J. Vargas	**Ms. Lisandra Rubio-Rangel**, National Autonomous University of Mexico, **Mexico**
31.	The influence of process parameters on the microstructural evolution of a resorbable magnesium alloy in SLM technology **T.Tanski**, A. Woźniak, P. Snopiński and K. Cesarz-Adraczke	**Prof Tomasz Tanski**, Silesian University of Technology, **Poland**
32.	Zirconium-Alloyed β-Type Ti-14Cr Alloys for Biomedical Applications **W. Borek**	**Dr. Wojciech Borek,** Silesian University of Technology, **Poland**
33.	Development of Self-Cleaning and Antimicrobial Coatings for Medical Assistive Devices **J. Sousa,** D. Leal, G. Oliveira, J. Bessa, M. Barbosa and R. Fangueiro	**Mr. Jose Duarte Sousa**, Fibrenamics, **Portugal**
34.	NEWPACK: Active Packaging with Controlled Antioxidant Release **S. Lourenço**, L. Gonçalves, A. S. Pereira, M. V. Loureiro, R. Galhano, C. Marques, J. C. Bordado, A. L. Maulvault, D. Bolotas, R. V. C. Gomes, J. Ramos, T. Chainho, T. Valerio, L. Aparicio and P. Allen	**Dr. Sofia Lourenço**, Sovena Portugal Consumer Goods, S.A., **Portugal**

Polymers / Composites / 3Bs Materials Tech 2026 Plenary Session I. A

Dependence of the Reinforcement of Polymer-Based Nanocomposites upon the Nanofiller Geometry

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Abstract:
The role of the geometry of nanofillers on the mechanical properties of polymer nanocomposites, such as Young's modulus and toughness, will be reviewed based on the published data in the literature. The fillers considered include carbon black (CB), carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs), reinforcing either elastomers or epoxy resins that act respectively as examples of flexible and rigid polymers. The Young's modulus of nanocomposites reinforced by CB is revealed to follow the classical theories on particulate reinforcement. The Young's modulus of nanocomposites reinforced by GNPs and CNTs are analysed using composite micromechanics theories, i.e. a combination of the shear lag theory and rule of mixtures. A surprising finding is that if the Young's modulus of the nanofillers is considerably higher than that of the matrix, the Young's modulus of the nanocomposite is only dependent on the aspect ratio, volume fraction and orientation of the nanofillers (Figure 1), and is independent of their mechanical properties. The failure of the nanocomposites by crack propagation has also been analysed regarding the fracture toughness of the epoxy nanocomposites and tear strength of elastomer nanocomposites. The additional nanoparticles are found to improve the crack resistance through crack pinning whereby the crack front length increases by pinning at individual particles. It is revealed that the tear strength of the elastomer nanocomposites and the fracture toughness of the epoxy nanocomposites filled with either GNPs or CNTs is dominated by the pull-out of nanoparticles, while for elastomers other toughening mechanisms, such as cavitation, may also occur.

Keywords: carbon nanomaterials; elastomers; epoxy resins; Young's modulus; fracture toughness; rule of mixtures; shear lag theory.

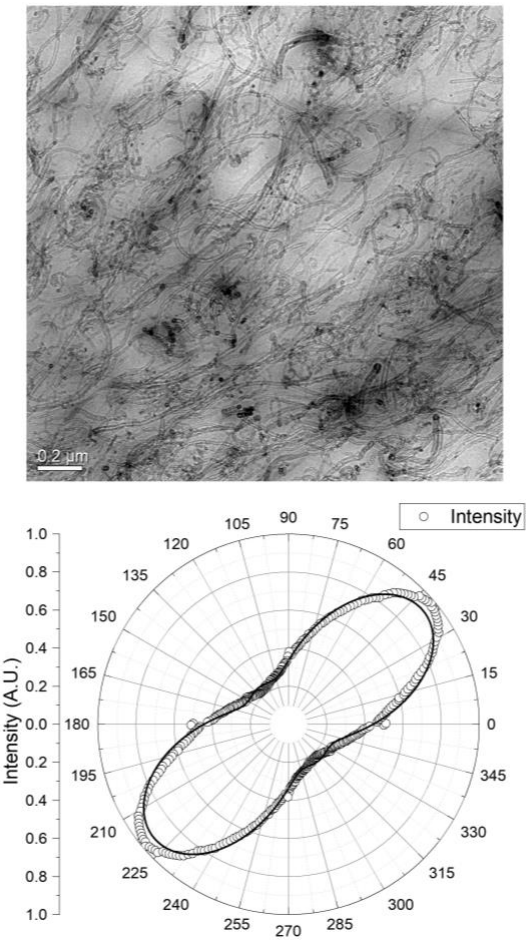

Figure 1: Determination of the orientation of CNTs in a nanocomposite with a volume fraction of 0.0546 showing a TEM section of a specimen with randomly-oriented CNTs and a polar plot of the orientation of the individual nanotubes.

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The Future of Composites Manufacturing

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Abstract:
The UK Research and Innovation EPSRC Future Manufacturing Research Hub was a £10.3m programme from 2017-2024. The Hub developed fundamental process science and technology in composites manufacturing by funding 48 projects across 16 UK universities and leveraging 105 PhD and EngD studies via matching industrial and institutional support. This keynote presents highlights from the 8 workstreams (WS1-8) of the Hub.
From WS1 Automated Fibre Deposition Technologies, novel manufacturing processes and process advancements for fibre steering and automated tape laying including Digital Twin control will be described.
From WS2 Optimisation of Fabric Architectures, a computational framework for multi-objective optimisation of 3D architectures using multi-scale modelling will be presented.
A novel manufacturing process and simulation tool from WS3 Multifunctional Structural Composites, to create complex 3D structural power devices from carbon aerogel composites will be outlined.
Layer-by-Layer manufacturing technology and a simulation methodology, incorporating a coupled thermo-chemo-mechanical solution for multi-ply laminates will be depicted from WS4 Online Consolidation.
In WS5 Liquid Moulding Technologies, simulation tools and extensive experimental permeability studies (including synchrotron) were delivered. A novel Bayesian inversion algorithm to capture material non-uniformity and edge effects using in-process data with a linked purpose-built neural surrogate model [1] interpreting an extensive library of finite element simulations enables on-line process control. For dual-scale porous media flow problems an efficient Fast Fourier Transform numerical solver [2] has been developed. A Fourier Neural Operator (FNO) model has been created as a surrogate to the FFT solver for predicting permeability in bi-porous media from 3D images. These findings will be summarised in the presentation.
In WS6 Composite Forming Technologies were advanced for textiles and moulding compounds to deliver experimentally validated simulation tools. Models including multi-scale explicit finite element representations of global to local regions to identify critical defects during forming will be described.
Activities in WS7 Microwave Processing Technologies offering increased control and reduction in curing time via rapid and localised heating will be outlined.
Finally, WS8 Thermoplastic Processing Technologies, created methodologies for in-situ polymerisation of polyamide in double diaphragm forming (DDF) and in injection overmoulding of fibre reinforced composites. Thermoforming and injection moulding simulation tools have been combined to create a process simulation numerical tool.
The keynote aims to initiate lively debate and encourage future research collaborations!

Keywords: composites manufacturing, process simulation, textile permeability, automated tape laying, multi-scale finite element analysis, in-situ polymerization, multifunctional structural composites.

Figure 1: Manual transfer of infusion frame into press tool during in-situ polymerisation of polyamide in Double Diaphragm Forming (DDF) process.

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Bioinspired polyphenol-based functional biointerfaces

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Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and BIST, Campus UAB, Bellaterra, 08193 Spain. Email address: dani.ruiz@icn2.cat)

Abstract:
Polyphenol-based interfaces have been subject to intense research, aimed at mimicking natural protein-segregation adhesive properties of mussels and barnacles. To achieve these objectives, our group has been very active on different synthetic approaches, ranging from the polymerization of catechols in the presence of amines (ammonia or bisamines) to the oxidative condensation of readily available pyrocatechol and thiol-capped functional moieties. So far, we have developed functional coatings and thin-films with a broad range of architectures, functionalities and characteristics relevant in biomedicine, among them:
Nanoparticle-coatings for diagnosis and therapy.
Fiber-coatings to modulate hydrophilicty, biocompatibility and antimicrobial properties.
Thin films for the regeneration of human cells/tissues.
In this talk I will give a brief overview of these research topics using representative examples.

Keywords: Polyphenol, biointerfaces, biomaterial, bioinspired, bioapplication, thin-film., coating.

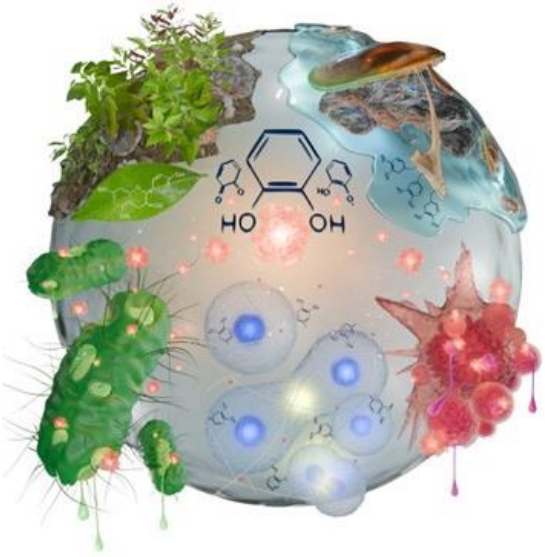

Figure 1:Schematic representation of the different bioapplications of polyphenol interfaces.

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11.

Active fibrous materials based on PLA/Magnetic nanoparticles prepared by Solution Blow Spinning

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[4] Instituto Tecnológico de Química y Materiales "Álvaro Alonso Barba", Universidad Carlos III de Madrid, Avda. Universidad 30, Leganés, 28911, Spain

Abstract:
Fibrous materials derived from biodegradable polymers, such as polylactic acid (PLA), show great potential for a wide range of applications, including actuators, biosensors, and bioengineering, particularly when functionalized with active nanoparticles. Among the various techniques available for producing fibrous materials, solution blow spinning (SBS) stands out due to its high production rate, operation simplicity, and capability for *in situ* fiber deposition. For biomedical applications, this ability to directly deposit fibers onto a surface or tissue represents one of the most valuable and versatile features of the method. In this work, we present PLA-based nanofibers modified with Fe_3O_4 magnetic nanoparticles and investigate their response to an external alternating magnetic field. The interaction between the magnetic nanoparticles and the applied field can generate localized effects, such as heating, which may influence nearby cells and contribute to the development of magnetically responsive biomaterials. Cytotoxicity assays confirmed that the materials are non-toxic and support cell proliferation over time, indicating their biocompatibility and suitability for further biological studies. PLA fibers containing Fe_3O_4 nanoparticles were characterized in terms of morphology, structure, magnetic behavior, and thermal response under magnetic excitation. Overall, this study highlights the potential of magnetically active fibrous materials for biomedical and bioengineering applications and provides a strong basis for understanding how magnetic fields can interact with living cells.

Keywords: Polylactic acid, Fe_3O_4 nanoparticles, Solution Blow Spinning, Magnetic nanofibers, Hyperthermia therapy.

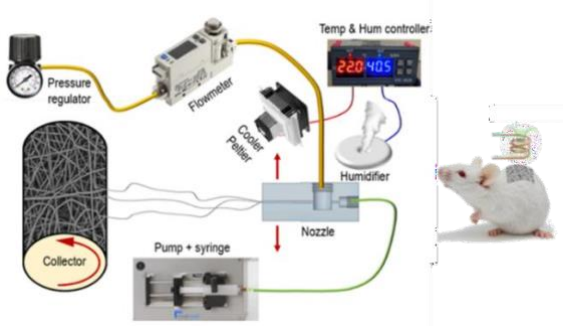

Figure 1: Solution blow spinning (SBS) process and the use of an alternating magnetic field in hyperthermia therapy for cancer treatment.

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Acknowledgments:

2025 UC3M Mobility Grants for Predoc Research stays. Álvaro Alonso Barba Institute - 2025 mobility grants for UC3M PhD stu- dents. The authors acknowledge the projects PID2023-147765OB-C21 and PID2020-112713RB-C22, financially supported by MICIU/AEI/10.13039/501100011033/, and the projects UC3M / 2012-00130-004 and 2011-00287-003 supported by the Univer- sidad Carlos III de Madrid.

Polymers 2026 Session I. B: Synthesis, Processing and Characterization

Manipulation of crystallization kinetics of poly(L-lactic acid) as a tool to develop novel applications

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Abstract:
Poly(L-lactic acid) (PLLA) is the most widely used biobased, biodegradable/compostable and biocompatible synthetic polymer [1-2], being the ideal environmentally-friendly substitute for petrochemical-based plastics. To date, PLLA is used for a variety of applications that range from food packaging and agriculture to biomedicine [3].

PLLA is a nature-inspired polymer with excellent properties, with the only weak point that it crystallizes very slowly. The slow crystallization kinetics hinders production of high crystallinity material upon conventional industrial processing, especially when high cooling rates and fast processing times are mandatory, like in injection molding [1,3]. This implies poor mechanical performance of molded PLLA, which have poor modulus and no resistance to high temperatures.

These few words summarize the importance and need to improve crystallization kinetics of PLLA. However, its manipulation can also be exploited as an engineering tool to develop novel applications, based on a deep knowledge of the processes, attained during about 25 years of research on crystallization kinetics of PLLA.

Thorough understanding of crystallization kinetics of PLLA allows to tailor it by varying molecular features, like molar mass, stereoregularity, chain branching, or formulation, favoring new processes and applications.

The latter include development of a novel technology to produce multilayered foams using a single polymer, via tailoring crystallization kinetics and the interplay with foaming agent [4].

Development of a novel crystal nucleating agent constitutes the core of BORN Project, GA 101223095, financed by European Innovation Council (EIC) and SMEs Executive Agency (EISMEA). Inclusion of the novel nucleating agent in biobased polymers formulations will allow crystallization upon industrial processing of polymers that are otherwise amorphous. This will lead to improved resistance to high temperatures (100 °C), allowing to foresee a portfolio of applications, which, for food packaging, may include compostable microwavable containers for ready-to-eat meals, as well as low-cost cups for hot beverages.

Keywords: poly(L-lactic acid), polymer crystallization, kinetics, polymer properties.

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Acknowledgements:

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Advancements in Multifunctional Composite Nanofibrillar PVA-Fe_3O_4 Materials: Exploring Preparation of PVA-Based Materials by Solution Blow Spinning Technique

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[1] Materials Science and Engineering and Chemical Engineering Department, Carlos III University of Madrid, Madrid, Spain

Abstract:
This study presents a prospective investigation on the current uses and applications of composite polyvinyl alcohol (PVA) nanofibrillar materials. Polyvinyl alcohol is a synthetic polymer that has gained attention for its biocompatibility and sustainable qualities, making it a material of choice in fields ranging from innovative food packaging, advanced hydrogen fuel cells and sophisticated biomedical platforms (e.g., wound dressings and tissue engineering scaffolds).

Firstly, the detailed theoretical background necessary to understand the structure-property relationships of PVA performance is discussed, with a specific focus on intrinsic features such as crystallinity, viscosity, and molecular weight. Following this, the main processing parameters of solution blow spinning (SBS), which define nanofibrillar morphology and nanofiber performance, are systematically studied and established. We systematically explore the primary processing parameters of solution blow spinning (SBS), which are pivotal in defining nanofibrillar morphology and performance.

Next, to validate the practical feasibility of the process, multifunctional PVA nanofibers with superparamagnetic iron oxide nanoparticles (Fe_3O_4) were fabricated under the optimized and established protocols. These magnetic particles can facilitate targeted drug delivery and their potential use in magnetic hyperthermia therapy because of their superparamagnetic behavior, large surface area, biocompatibility, and surface functionalization. Morphological, structural, and thermal characterization of the resulting materials was carried out to elucidate the differences between different concentrations of Fe_3O_4 nanoparticles. This work concludes with a discussion of future research directions aimed at addressing current challenges and exploring innovative approaches for the fabrication of PVA-Fe_3O_4 composite nanofibrous materials, targeting their application in next-generation biomedical technologies.

Keywords: polyvinyl alcohol (PVA); nanofibers; solution-blow spinning (SBS); magnetite nanoparticles; biodegradability; biomedical applications; food packaging.

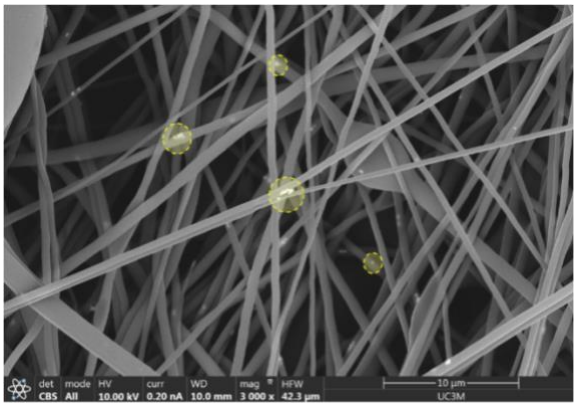

Figure 1: SEM micrograph of solution-blow spun PVA nanofibers filled with 0.5% magnetite nanoparticles.

Acknowledgment: This research has been supported by the project **I+D+i / PID2023-147765OB-C21**, funded by the Spanish Ministry of Science, Innovation and Universities (MICIU) and the State Research Agency (AEI).

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Quercetin-loaded PLA nanofibers for active food packaging applications prepared by Solution Blow Spinning

Nataša Nikolić [1*], Ewa Olewnik-Kruszkowska [2], Agnieszka Richert [3] and Javier González-Benito [1,4]
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Abstract:
The development of food packaging materials that can protect food from external environmental factors is currently generating significant interest. To be suitable for this application, these materials should meet certain properties, such as biocompatibility and biodegradability. However, most of these materials do not exhibit the antioxidative and antibacterial properties, which are crucial for their intended use. In accordance with this, it is necessary to incorporate specific additives to the bio-polymers, to improve material - food interaction, food protection, and extend shelf life. Among the biodegradable and biocompatible materials, Polylactic acid (PLA) is commonly used for this purpose. Materials with multifunctional properties can be produced by combining a polymer with specific additives to improve the final and targeted properties. Besides, if they are produced with a fibrous morphology, properties can be enhanced because of an increase in surface/volume ratio. Quercetin is a naturally occurring polyphenol found in plants; it has antioxidative characteristics due to its structural configuration and redox potential. Based on this, the combination of PLA nanofibers modified with quercetin stands as a promising material for food packaging applications. In this work, PLA nanofibers were modified with different concentrations of quercetin powder, and the mixture was processed with the use of the Solution Blow Spinning method. In order to investigate the influence of quercetin, different concentrations of powder were added. Structural, morphological, antioxidant, antibacterial, and water vapor transmission characterizations were conducted to estimate the effect of quercetin on the final material properties. The findings of these characterizations were studied to quantify the performance of PLA/quercetin nanofibers and their prospects in smart food packaging materials.

Keywords: Polylactic acid, Quercetin, Solution Blow Spinning, Food packaging.

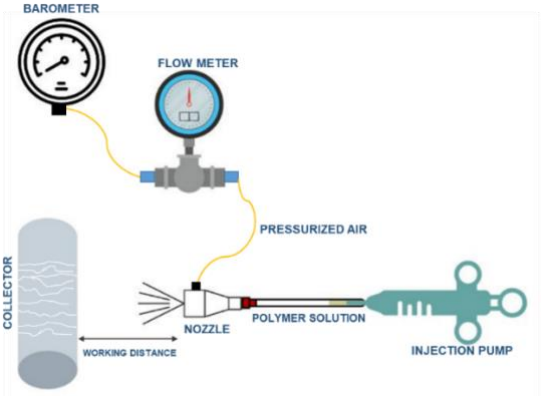

Figure 1: Schematic representation of the nanofibers processing containing the main elements of the SBS device

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Electrospun Nanofibrous Scaffolds for Biomedical and Soft Packaging Applications

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Abstract:
This study investigates electrospun scaffolds made from polycaprolactone (PCL), polyhydroxybutyrate (PHB), and their blends using both green and halogenated solvents. The aim is to evaluate their potential for biomedical and soft packaging applications due to their biodegradable nature. The electrospun scaffolds were produced using green solvent system based on acetone, dimethyl carbonate (DMC), 2-Methyltetrahydrofuran (2-MTHF), and halogenated solvents such as Cholorform, hexafluoro-2-propanol (HFIP). We set out to investigate the influence of different process parameters on the fibre morphology (diameter and size distribution) and polymer concentration in the electrospinning solution [1]. The solvents systems were optimized for solubility, viscosity, volatility, and electrospinnability to produce bead-free, uniform nanofibers mats with morphological tunability. Physicochemical and thermal properties, including mechanical properties, thermogravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) analysis, were used to characterise the electrospun nanofibers. Ultraviolet (UV) degradation tests were also carried out. The findings provide insight into how solvent choice influences the electrospinning behaviour and final properties of nanofibres, offering practical guidance for developing biodegradable materials for biomedical and packaging applications.

Keywords: Electrospinning, Nanofibres, Biodegradation, Green solvent systems, Soft packaging, Biomedical applications.

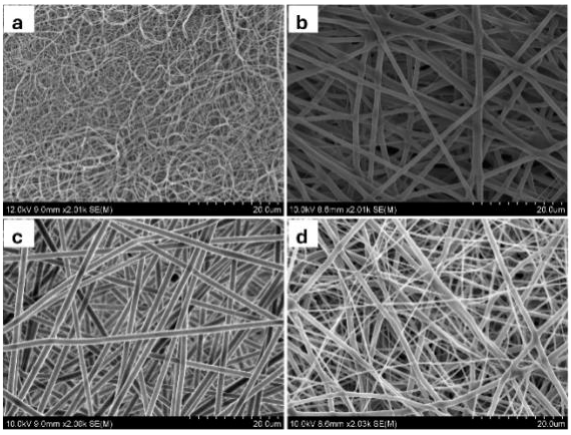

Figure 1: Electrospun nanofibers prepared from (a) polycaprolactone (PCL), (b) polyhydroxybutyrate (PHB), (c) PCL:PHB blend at 70:30, and (d) PCL:PHB blend at 30:70. All solutions were prepared in hexafluoro-2-propanol (HFP), and the PCL used had a molecular weight of 80 kDa.

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Processing-Driven Structure–Property Relationships in 3D-Printed PBSA Membranes and Their Impact on Permeation Performance

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Abstract:

Traditionally, polymer membranes are produced by film extrusion, which provides precise control over their structural and functional properties. Additive manufacturing, in particular fused filament fabrication (FFF), is emerging as a promising alternative due to its flexibility, low cost, and ease of use[1]. Additive manufacturing also offers new opportunities to adapt the microstructure and performance of polymer membranes for use in sustainable separation processes. In this study, poly(butylene succinate-co-adipate) (PBSA), a biodegradable biopolymer, was processed using FFF to produce dense membranes. PBSA has already been utilized for 3D printing functional components and mechanical parts[2], but its potential for membrane manufacturing has not yet been investigated. Here, a systematic investigation was conducted into the effects of printing parameters on morphology, crystallinity, and mechanical properties, including nozzle temperature, build plate temperature, and printing speed. Thorough characterization combining scanning electron microscopy (SEM), differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA) highlighted the role of structural heterogeneities induced by the process on the functional behavior of the membranes. The optical properties of the printed PBSA membranes were also evaluated. Nitrogen gas permeation tests revealed barrier properties comparable to those of membranes obtained by conventional extrusion. These results demonstrate the potential of 3D printing as a versatile tool for designing and understanding the structure–properties relationships of biobased polymeric membranes. This paves the way for the development of durable and high-performance materials for gas separation and other related applications.

Keywords: Additive manufacturing; 3D printing; fused filament fabrication (FFF); poly(butylene succinate co adipate) (PBSA); bio-based polymers; membranes processing; structure-property relationships; morphology; gas permeation; sustainable materials.

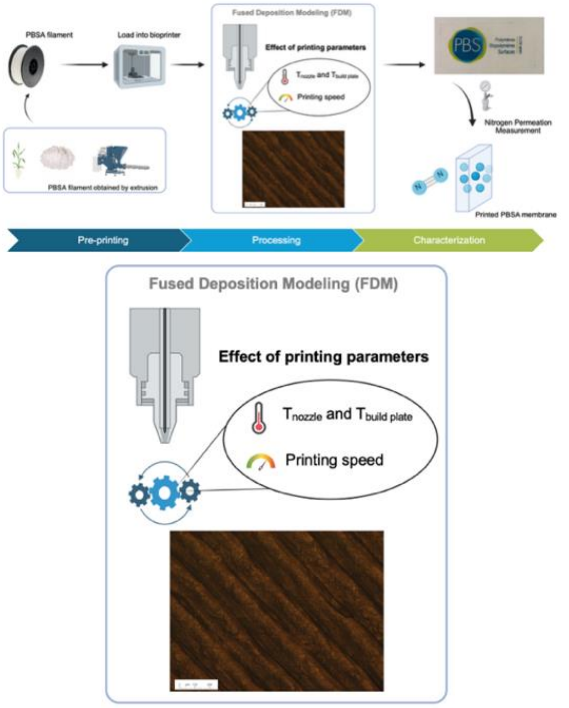

Figure 1: The Figure illustrates the core research question of this study: how does controlling 3D printing parameters affect the structure, morphology, and gas permeation performance of bio-based PBSA membranes? The schematic summarizes the relationships between processing conditions, resulting microstructure, and functional properties, offering an insight into how membrane performance can be tuned through FFF 3D printing.

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PET synthesis based on various amounts of terephthalic acid from chemical recycling of PET / cotton textiles

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Abstract:
Polyethylene terephthalate (PET) is, by far, the most produced polymer for textile applications, representing 59 wt.% of the market. Less than 1% of the produced fibres are nowadays made from recycling of pre- and post-consumer textiles. Yet, recycling, together with rethinking the way of producing and consuming, is one of the major challenges to reduce the impact of the textile industry. These low recycling rates are due to complex compositions and addition of several chemicals during formation of products made from fibres [1].
Chemical recycling is one of the solutions to reach closed-loop recycling of PET from textiles. Preliminary work showed that alkaline hydrolysis, with several treatment steps, notably controlled precipitation in an aqueous medium, enables the obtention of terephthalic acid from chemical recycling (CrTPA) with the properties needed for further processing, as presented on Figure 1 [2]. The produced CrTPA can then be used for PET synthesis, the most used industrial pathway being the polycondensation of TPA and ethylene glycol (EG). Two main steps are needed: oligomerization of TPA and EG, forming bis-hydroxyethyl terephthalate and oligomers, and polycondensation of these species into PET.
In this study, PET samples are synthesized by the reaction of various amounts of CrTPA on a lab-scale process. The as-formed polymers are compared to each other and to a reference PET, that is produced with 100% commercial TPA. The chemical structure is confirmed by ^{1}H Nuclear Magnetic Resonance. It also enables quantification of diethylene glycol segments, which is an important factor for PET quality. Thermal characterization is also carried out: crystallization degree and structure properties relationships are assessed by Differential Scanning Calorimetry, while degradation behaviors are studied by Thermogravimetric Analysis. Moreover, the impact of the initial proportion of CrTPA on rheology and macromolecular chain length will be carefully evaluated notably thanks to intrinsic viscosity measurements. The environmental impact of the process is evaluated by Life Cycle Assessment, enabling the comparison between commercial TPA and CrTPA for synthesis of PET on various impact categories. To this extent, the EcoInvent 3.6 database and/or the EF 3.1 database will be used and the evaluation will be performed with the EF 3.1 method and ReCiPe 2016 method.

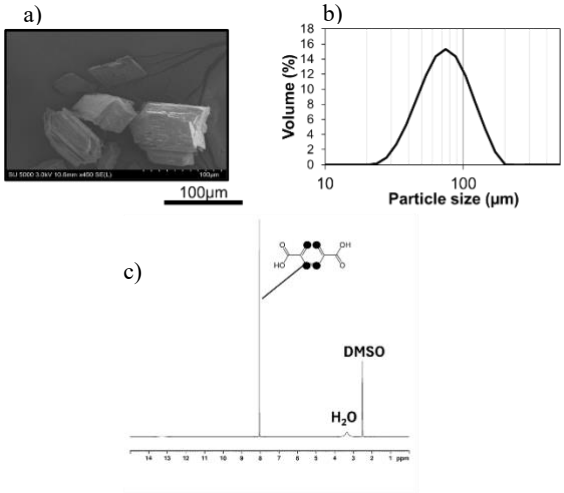

Figure 1: Presentation of the properties of CrTPA, matching the industrial specifications in terms of a) morphology, evaluated by Scanning Electron Microscopy, b) granulometry, quantified by Laser Diffraction Analysis (in H_2O) and c) purity, assessed by ^{1}H NMR (in DMSO-d6, 300MHz, 256 scans).

Keywords: chemical recycling, textile recycling, polyethylene terephthalate, alkaline hydrolysis, polycondensation, thermal properties, structural properties.

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Sustainable functionalisation of poly(3-hydroxybutyrate): solvent and catalyst-free aminolysis and enzymatic transesterification approaches

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Abstract:
Non-biodegradable plastics pose a major environmental challenge due to the large volumes of waste they generate. To address this, bioplastics are emerging as a sustainable alternative. Among these, polyhydroxyalkanoates (PHAs) are microbially synthesised polyesters which are both biodegradable and renewable, offering properties similar to conventional plastics. However, poly(3-hydroxybutyrate) (PHB), the most widely produced PHA, has high crystallinity, which results in brittleness and a narrow thermal processing window. Furthermore, it is soluble only in chlorinated or non-green solvents, and its chemical modification has only been achieved using toxic catalysts[1], while the lack of reactive functional groups in the polymer backbone restricts post-synthetic copolymerisation. To overcome these issues, we present two novel and sustainable strategies for PHB functionalisation by reacting with amines and diols, respectively, whose products have enhanced reactivity, processability, and copolymerisation potential (Figure 1).

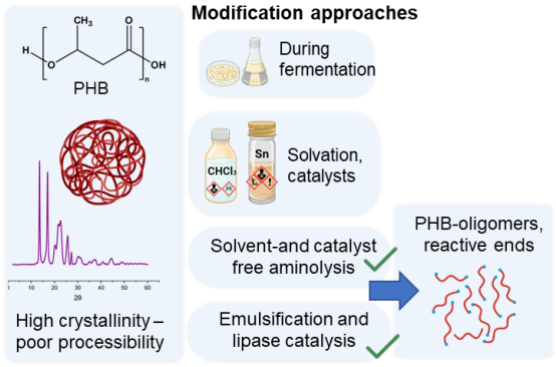

Figure 1: Challeges, existing and proposed PHB modification approaches.

First, we demonstrate direct amidation of high-molecular-weight PHB via aminolysis with nucleophilic amines under solvent- and catalyst-free conditions. Reactions with ethylenediamine (EDA), ethanolamine (EA), diethanolamine (DEA), methylbenzylamine (MBA), and branched polyethyleneimine (PEI) produced amide functionalised oligomers, with outcomes dependent on amine nucleophilicity, reaction temperature, and time. Covalent incorporation of amine groups was confirmed by FTIR and ^{1}H NMR, while GPC analysis showed EDA yielding the lowest molecular weight oligomers (<1700 g/mol), EA causing ~400-fold M_w reduction, and PEI producing both chain scission (Mw = 19,000 g/mol) and extension (Mw = 2 × 10^6 g/mol). DSC and TGA analyses revealed reduced melting and degradation temperatures and decreased crystallinity at melting point, consistent with chain shortening. These modifications improved solubility and reactivity of PHB, producing pre-polymers suitable for block copolymer synthesis.

The second approach explores the biocatalytic esterification of PHB. To overcome the limited access for the enzyme imposed by biopolymer's high crystallinity, an amorphous form of PHB was first prepared via emulsification in an aqueous surfactant solution, as described in previous studies[2]. In this amorphous form, lipase enzyme can readily catalyse the hydrolysis of PHB, which is otherwise not possible with untreated polymer. Building on that, we explore lipase-catalysed transesterification reactions, offering a mild, sustainable route for PHB modification, which has previously only been achieved via a toxic tin catalyst[1]. The emulsified PHB suspension also shows potential for coating and encapsulation applications. Together, these approaches enable new, environmentally benign strategies to broaden the use of PHB across diverse applications.

Keywords: PHB-amides, oligomers, depolymerisation, Solvent-free reactions, Biodegradable polymers, lipase-catalysed esterification

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The study of lattice structure implementation and integration in a bicycle helmet produced in AM

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Abstract
This work investigates the integration of lattice structures produced by Additive Manufacturing (AM) into bicycle helmet to enhance impact performance, design flexibility, and sustainability. Conventional helmets rely on expanded polystyrene (EPS) foam liners, which limit customization, recyclability, and multi-impact protection. Additive Manufacturing (AM), particularly Selective Laser Sintering (SLS), enables the production of complex geometries, such as lattice structures, that can be tailored for improved energy absorption and structural efficiency.

The mechanical behavior of three lattice unit cells: Body-Centered Cubic (BCC), Face-Centered Cubic (FCC), and Octet, implemented within a redesigned liner, was studied. To accommodate the helmet's organic geometry, a custom cube-to-sphere projected cell map was developed, achieving uniform lattice distribution while avoiding topological convergence. A fully encapsulating shell was also introduced to contain fractured elements and improve load dispersion during impact. Prototypes were fabricated in PA12 and tested at -20°C, identified as the most demanding condition from preliminary EPS benchmark tests. Results indicate that the Octet lattice offers superior energy absorption and structural stiffness compared to BCC and FCC.

One achievement of this study is to contribute to the advancement of AM in protective equipment, demonstrating both the promise and current limitations of lattice-integrated helmet designs. By harnessing AM's design freedom, the study lays the foundation for future high-performance, customizable, and more sustainable bicycle helmets.

Keywords: lattice structures, additive manufacturing, selective laser sintering, bicycle helmet design, sport safety equipment.

Degradation-to-Reconstruction Upcycling of P(Styrene-*co*-DOT) Copolymers into Epoxy Thermosets

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Abstract:
The incorporation of degradable comonomers into traditionally non-degradable vinyl polymers offers a powerful route toward circular material design. Here, we report the synthesis of Poly(Styrene-*co*-DOT) copolymers containing thioester linkages derived from the radical ring-opening of Dibenzo[*c,e*]oxepine-5(7*H*)-thione (DOT) [1]. Selective backbone cleavage is achieved using the strong organocatalyst 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD), which efficiently degrades the thioester units and generates α-thiol-ω-carboxylic acid terminated oligomers with well-defined chemical structures [2]. Unlike previous studies focusing solely on depolymerization of DOT-containing materials, we demonstrate here that these degradation fragments can serve as reactive intermediates for further materials construction. The di-functional oligomers are subsequently reacted with trimethylolpropane triglycidyl ether (TMPTGE) *via* concomitant thiol-epoxy and acid-epoxy reactions as curing process, producing crosslinked thermosets [3]. The resulting networks exhibit characteristic signatures of thiol-epoxy and acid-epoxy curing and confirm the reactivity of degradation-derived oligomers. This two-step "degradation-to-reconstruction" strategy represents a novel upcycling pathway in which a degradable styrenic copolymer is transformed into a new functional material rather than simply reduced to low-value waste. Overall, these findings highlight the broader potential of DOT-based comonomers not only to enable selective polymer backbone scission but also to generate chemically valuable building blocks, demonstrating a promising platform for next-generation circular polymer technologies.

Keywords: radical ring-opening polymerization (RROP), P(Styrene-*co*-DOT) copolymers, TBD organocatalytic degradation, epoxy thermosets, polymer upcycling, degradation-to-reconstruction.

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Bio-based polyurethane with a photolabile o-nitrobenzyl molecule for degradation on demand

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Abstract:
Smart bio-based and UV-degradable polymers have been prepared. Indeed, polyurethanes (PUs) were synthesized from the bio-based diol 2,5-bis(hydroxymethyl)furan (BHMF), and the bio-based diisocyanates L-lysin diisocyanate (LDI) or pentamethylene diisocyanate (PDI). A photo-labile molecule (PLM), containing the sensitive o-nitrobenzyl group, was successfully incorporated into bio-based polyurethanes (PU), and suitable reaction conditions were found for achieving high molar masses PUs up to M_n=83 kg/mol. Incorporating PLMs into linear chains renders them degradable under UV light irradiation, yielding to oligomers.[1,2,3]

To better analyze and understand the degradation process, ultraviolet-visible (UV−vis) spectroscopy was used for kinetic studies of PLM degradation; nuclear magnetic resonance (NMR) spectroscopy was used to measure the proportion of degraded PLM; and size-exclusion chromatography (SEC) was employed to monitor chain cleavage. One PU-PLM system demonstrated promising behavior, enabling the formation of oligomers up to 20 times smaller than the initial polymers. Additionally, various effects influencing the degradation have been studied, such as the irradiation solvent, the amount of PLM, and the initial polymer molar mass. Furthermore, UV degradation of the PLM does not necessarily correlate with effective polymer backbone degradation, but a suitable PLM structure and optimized parameters can achieve oligomers. Finally, fluorescence characterization enabled the qualification and quantification of the end groups, verifying the suggested degradation mechanism of the used PLM containing o-nitrobenzyl groups. These new insights into PU UV-degradation and their resulting oligomers are crucial for potential medical applications, but will also be important regarding the recycling-on-demand option and repolymerization.

Keywords: photo-degradation, polyurethane, degradation on demand, bio-based, o-nitrobenzyl group

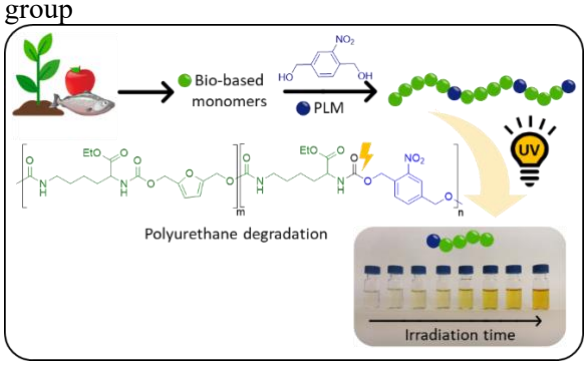

Figure 1: Figure illustrating the degradation of bio-based polyurethane with photolabile molecules with UV light.

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Dynamic behavior of functionalized alginates revealed by electron paramagnetic resonance spectroscopy

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Abstract:

Electron paramagnetic resonance (EPR) spectroscopy represents a sensitive tool that can provide meaningful structural and dynamic insight in various molecular systems with applications in various fields of chemistry, materials science, and the biomedical sciences. In order to use this method, it is necessary for the analyzed systems to contain a paramagnetic species. Since most molecular systems do not have paramagnetic groups, in order to use this method, it is necessary to introduce them either by covalent attachment or as spin probes. The ionotropic alginate-based hydrogels have been explored by different physico-chemical methods in relations with their applications. In this study, the formation of alginate gel from low molecular weight alginate functionalized with β-cyclodextrine (Alg-1,3-β-CD) and adamantane units (Alg-Ad-AT) in the presence of divalent cations (Ca^{2+}, Sr^{2+}, Ba^{2+}, Zn^{2+}) was investigated using EPR spectroscopy (Figure 1). In addition paramagnetic spin labels (TEMPO units) were covalently attached to the polysaccharide chain. The transition from sol to gel in the presence of divalent cations was monitored by the changes in the dynamics of spin-labelled alginate. The immobilisation of the spin label in the alginate gel reflects the strength of interaction between the cation and alginate chain.

The local information provided by EPR parameters of the spin label were correlated with the global information obtained by IR spectroscopy and rheological measurements. Altogether these investigations demonstrated that, although host–guest interactions are not the driving force for the generation of alginate gels, their presence influences and can modulate the gel properties. The results shown that type of the cations influences the strength of the gels, thus Ba^{2+} forms the strongest gels, while Zn^{2+} the weaker gel. Further work will be dedicate on studying enzymatic processes on peptide attached to spin-labels in alginate gels.

Keywords: alginate gel, spin-labeling, cyclodextrine, adamantane, host-guest complexes, cations, EPR spectroscopy, rheology, IR-spectroscopy.

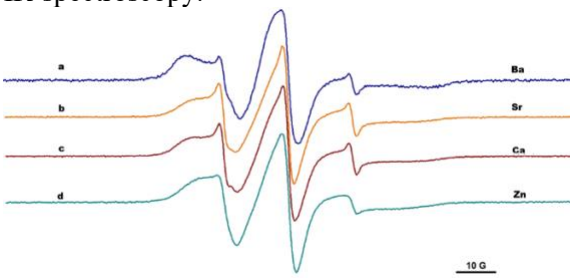

Figure 1: The EPR spectra of gels formed by complexation of Alg-Ad-AT and Alg-1,3-bCD in the presence of a) Ba^{2+}, b) Sr^{2+}, c) Ca^{2+} and d) Zn^{2+}

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Acknowledgements:

This work was supported by Project PNRR-III-C9-2023-I8 "Chemical host-guest molecular systems for health applications (OMRI for identification of inflammatory pathologies)" contract no. 760283/27.03.2024 funded by European Union – NextGenerationEU

Composites Session I. C: Synthesis, Processing and Characterization

Epoxy nanocomposites as Joule adhesives for a more sustainable manufacturing in the composites sector

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University of Manchester, Manchester, UK

Abstract:
Carbon fibre reinforced plastics (CFRPs) are increasingly used due to their strength, low weight, and design flexibility, but their growing use creates environmental challenges, particularly in waste management. Novel out-of-autoclave (OoA) strategies for repairing and bonding CFRPs that enable facile manufacture and maintenance of CFRPs based components while reducing unnecessary scrappage and avoiding the use of an autoclave are, thus, currently on high demand.
This paper will show our recent research on the development of novel OoA methods for repairing and bonding CFRPs using Joule heat curing of electrically conductive epoxy nanocomposites filled with carbon nanoparticles used as structural adhesives (Figure 1). How the Joule adhesive's formulation affects the heating rate and distribution of the Joule heat generated within the adhesive during the repair/bonding process is investigated as key to optimize the process. The mechanical performance of Joule cured versus oven cured CFRPs are compared, and the joints failure mechanisms investigated to gain insight on new directions to improve this OoA bonding method and the mechanical performance of the bonded joints[1,2].
The potential for reversible bonding (i.e., selective Joule debonding) to enable recycling and reuse of CFRP parts, supporting a more sustainable composite manufacturing[3], will be also discussed.

Keywords: carbon nanomaterials, epoxy nanocomposites, Joule heating, bonding, debonding, mechanical properties, electrical properties.

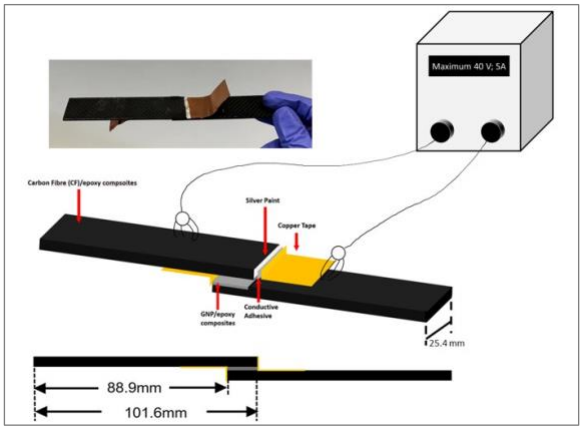

Figure 1: Figure illustrating the set-up for CFRPs OoA repair/bonding and debonding using electrically conductive nanocomposites as Joule adhesives.

References:

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On fracture response and traction separation relations in DCB specimens loaded under pure moments or end opening forces

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Abstract:
The double cantilever beam specimen (DCB) is commonly employed in testing of layered composite materials and adhesive joints under mode I-Fracture. The resulting resistance to fracture is dependent not only on constituent materials and microstructure, but also on loading conditions and specimen stiffness, rendering its experimental characterization and modeling a challenging task. Discussed in this presentation are experimental results and fracture modeling of: (i) adhesive joints with 7022-T651 rolled-aluminum arms, bonded with two plies of Gurit SA-80 pre-preg adhesive with ~0.4 mm cured ply thickness [1], (ii) intralaminar fracture of carbon/epoxy specimens of SE-70 from Gurit SP™. In both cases, the DCB specimens are loaded by two end-opening forces (EOF) or two moments (PM) using a specially designed apparatus [1]. Energy release rates (ERR) are calculated using standard beam theory or the contour *J*-integral. Experimental results show that the R-curves of the adhesive joints are independent of the loading type, i.e., EOF or PM (Fig 1a), while the R-curves of the composite specimens depend on loading type (Fig. 1b). These results are explained by the fact that the adhesive ligaments bridging the crack, in the wake of the crack tip, do not support bending contrary to the fiber bundles in the bridging zone of the composite specimens. Thus, the behavior of the adhesive joints is controlled only by the crack opening displacement and that of the composite by crack opening and stiffness of the specimen's arm. Modeling involves an interactive scheme to calculate bridging tractions using experimental strain measurements, parametric finite element modeling and optimization. Further analysis shows that for the adhesive joint a single traction separation relation (TSR) predicts the response of both loading types (i.e., EOF and PM). However, in the case of the composite the TSR depends on the loading type and specimen thickness [2]. When the latter TSR is enriched with the local crack opening angle, a specimen thickness independent single traction separation and angle relation is obtained. The resulting relations are employed in cohesive zone simulations to predict very well load-displacement history and fracture resistance [1,2].

Keywords: adhesive joint, composite, delamination, R-curve, traction-separation relation.

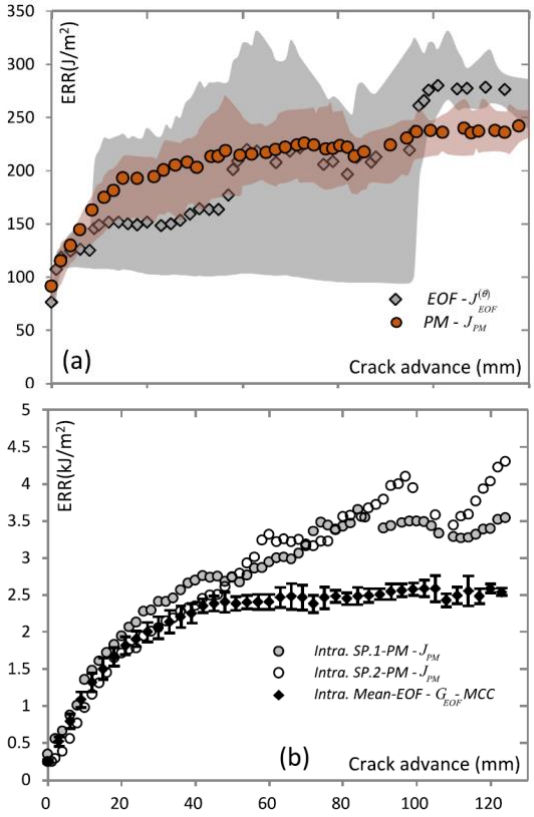

Figure 1: R-curves in DCB specimens plotted against total maximum ERR under EOF and PM: (a) adhesive joints specimen [1], (b) layered composite [1].

References:

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Edible, Flexible and Smart: Redefining Electronics with Natural Biopolymer-based Nanocomposites

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Abstract:
The rapid proliferation of electronic devices has led to an alarming rise in electronic waste (e-waste), underlining the urgent need for sustainable, degradable alternatives to conventional materials. This talk will present recent advances in the development of bio-based nanocomposites for electronics and sensing applications, with a focus on starch- and gelatin-derived materials reinforced with functional fillers. These systems have been engineered not only for electrical conductivity and mechanical integrity but also for environmental and physiological compatibility.

Starch, one of the most abundant natural polymers, has been successfully integrated with MXene nanoplatelets through scalable techniques, yielding mechanically robust and electrically conductive films with high sensitivity to humidity and strain. These materials demonstrate low percolation thresholds and excellent mechanical properties, outperforming many existing degradable alternatives. Their sensing capabilities span from skin hydration and respiration to handwriting and speech analysis. Importantly, these devices degrade completely in soil, offering a viable path towards transient and environmentally responsible electronics.

Complementing this, edible gelatin composites have been developed for ingestible and fully recyclable diagnostic and environmental monitoring tools. These films exhibit high-precision, multimodal sensing (strain, temperature, and humidity) with rapid response times and long-term durability, all while maintaining safety for human ingestion and zero electronic waste footprint.

Our innovations demonstrate that biodegradable and even edible electronics are not just plausible. They are performant and fully scalable. By leveraging abundant biopolymers and smart nanocomposite design, our work lays foundational steps towards a circular economy in flexible electronics and sustainable diagnostics.

Keywords: sustainable electronics, biopolymers, strain sensors, starch, gelatin

PBAT Composites Reinforced with Latxa sheep wool and Tannins for Sustainable Fishing and Agricultural Applications

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Abstract:
Poly(butylene adipate-co-terephthalate) (PBAT) is a biodegradable copolyester that can be processed using conventional technologies (extrusion film blowing, injection moulding) and is compostable under controlled conditions, which makes it an interesting candidate to replace conventional plastics in fishing and agriculture [1]. However, the very high plastic consumption in both sectors and the evidence of fragmentation into microplastics, even for compostable materials, highlight the need to desing matrices and composites that maintain performance in the service while being able to biodegrade without leaving persistent residues [2]. In this context, industrial composting and marine environments are considered as two key and complementary end-of-life scenarios, where disintegration, mineralization and ecotoxicological safety must be evaluated in a consistent way.
In this work, it is proposed the development of a composites with PBAT matrix reinforced with Latxa sheep wool, a local waste stream with good mechanical properties and an itrinsec flame-retardant behaviour. As an additional functional additive, tannins extracted for the pine bark, a by-product of the basque forestry sector, are incorporated, taking advantage of their antimicrobial and antioxidant properties and their potential effect on reducing flammability [3]. The aim is to obtain a biodegradable material specially designed for use in fishing gear and in agricultural mulching or tying systems, and to evaluate its processability, mechanical response and degradation behaviour in both industrial composting and simulated marine conditions.

Keywords: PBAT, Latxa sheep wool, tannins, fishing and agriculture, biodegradation, microplastics.

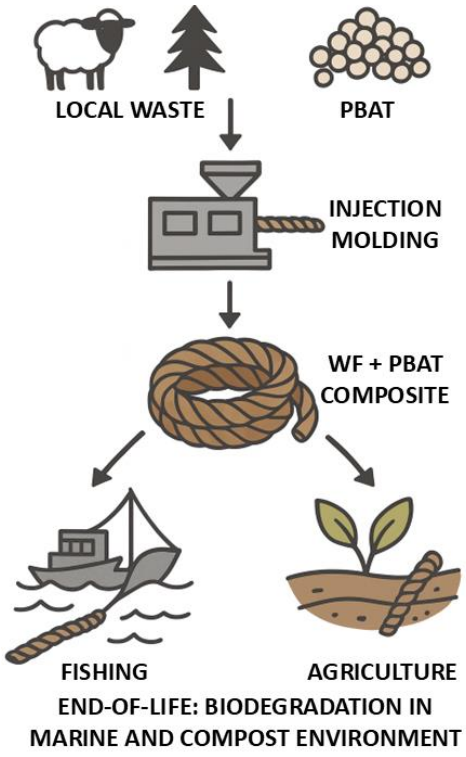

Figure 1: Processing route and life cycle of Latxa wool/ tannin reinforced PBAT composite rope for fishing and agricultural applications, including end-of-life biodegradation in marine and compost environments.

References:

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Tailoring Magnetic Properties of Fe/Fe-oxide Composite Architectures

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Abstract:
The development of composite microstructures with controlled magnetic behavior is essential for a wide range of advanced technologies, such as functional composites, biomechanical applications, information storage, and spintronics.[1] In this work, we investigate the fabrication, phase transformation, and magnetic performance of iron-oxide–based thin films and microdiscs engineered to achieve low magnetic remanence, a key requirement for biomedical composite platforms.[2] Thin films of Fe were thermally deposited on silicon wafers and subsequently oxidized under controlled thermal treatments, resulting in tunable phase conversion from Fe to γ-Fe_2O_3 and Fe_3O_4 depending on thickness and atmosphere. Microdiscs of 4 µm diameter were fabricated via direct-laser-writing lithography and lift-off, enabling the study of geometric confinement on magnetic response.
Structural analyses (XRD) revealed that oxidation at 400 °C for 2 h promotes full transformation to maghemite in layers thinner than 50 nm, while thicker films retain a fraction of metallic Fe, providing pathways to tailor composite magnetic performance through thickness-dependent diffusion kinetics (Figure 1). Magnetometry measurement showed a pronounced drop in saturation magnetization after full oxidation, alongside a significant reduction in remanence, consistent with the formation of ferrimagnetic phases, which is desirable for biomedical applications. In the case of microdiscs, the coercive field increased after thermal treatment; however, the remanence did not decrease accordingly, likely due to the enhanced coercivity.
These findings highlight how geometry, thickness, and thermal processing parameters can be combined to engineer iron-oxide systems with tunable magnetic properties.

Keywords: iron-oxide thin films, magnetic microstructures, iron/iron-oxide composites.

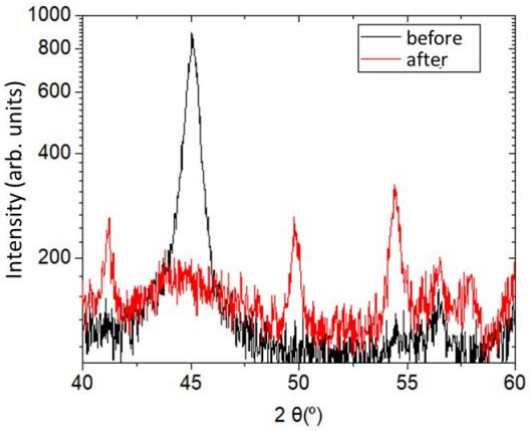

Figure 1: XRD spectra of a 100 nm Fe thin film before (as-deposited) and after thermal treatment at 400 ºC, showing the emergence of diffraction peaks associated with the γ-Fe_2O_3 phase.

References:

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Development of Quality Assessment Methods for Filament-Wound Composite Overwrapped Pressure Vessel Surfaces

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Abstract:
Surface analysis is used to quantify the filament winding quality of composite overwrapped pressure vessels (COPVs) during manufacture. The focus is on high-resolution surface scans and image-based evaluation of fibre orientations, enabling early detection of winding defects and geometric inconsistencies.

Continuous surface imaging using photogrammetric line scanning captures the texture and fibre pattern of the composite overwrap along the full vessel contour. High resolution surface capture is used to reveal small-scale misalignments, overlaps, gaps, or band width variations. On a global level, an evaluation of the surface pattern is applied to identify dominant winding directions and systematic deviations from the nominal angle distribution across vessels or defined regions.

The combined local and global image analysis allows direct comparison of measured fibre angles with design specifications, supporting the identification of process drift, such as changes in winding tension, fibre guidance, or path accuracy. Characteristic surface patterns, including periodic fiber overlaps, clustering of fibre bundles, or irregular angle distributions, can be linked to specific process anomalies and are used as indicators for structural inhomogeneity and potential stress concentrations. This information provides a basis for performance-oriented accept–reject criteria and enables targeted process adjustments during production rather than after final inspection.

By filtering out noise and emphasizing statistically significant deviations, the monitoring framework supports robust, quantitative quality control of filament-wound COPVs. This reduces scrap and rework, improves material utilization, and increases consistency of winding quality, which is critical for meeting safety margins and certification requirements for hydrogen storage applications. Ultimately, the approach contributes to safer and more efficient deployment of COPVs in hydrogen energy systems by tightly coupling manufacturing, inspection, and structural performance considerations.

Keywords: hydrogen storage; composite overwrapped pressure vessel; filament winding; inline quality control; winding angle measurement

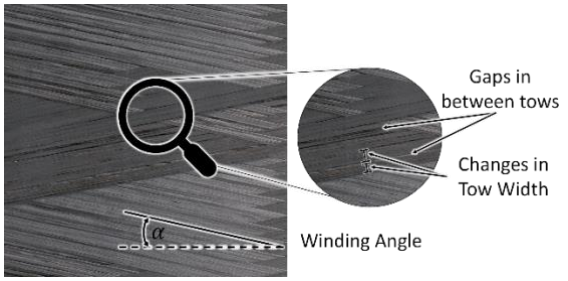

Figure 1: Figure illustrating part of the full surface scan of a filament wound pressure vessel

References:

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Photoinduced Frontal Polymerization of Acrylic Resins Reinforced by Biofillers

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[2]INSTM – Politecnico di Torino Research Unit, Italy

Abstract:
Frontal polymerization (FP) is a self-propagating reaction in which a localized "polymerization front" is created after an initial stimulus (such as heat or light) activates the system. The heat released by the exothermic reaction raises the temperature at the front, enabling the polymerization to continue forward into the unreacted monomer, typically producing a steadily moving planar front. Photoinduced frontal polymerization (PIFP) is a hybrid approach that employs both a photo and thermal initiator, enabling light-triggered initiation followed by thermally sustained propagation. Compared with traditional polymerization techniques, PIFP provides several key benefits: (a) the reaction proceeds quickly, reducing processing time; (b) it is energy efficient and environmentally friendly, since it does not rely on continuous external heating or irradiation; (c) it achieves high monomer conversion; and (d) it eliminates the need for solvents [1,2].

This study demonstrates that biobased acrylic monomers can be rapidly cured into bulk samples within seconds via PIFP, with the reaction capable of sustaining itself even after the light source is removed. Successful autonomous propagation was found to depend on the system's average functionality, as well as effective thermal management such as the choice of mold and the balance between photoinitiators and thermal initiator concentrations. The work further examined curing behavior in thick and light hindered regions, along with the influence of natural fillers. Characterization methods included FT-IR, viscometry, thermal imaging, and FESEM, while process optimization focused on thermal effects, front propagation velocity, monomer conversion, formulation design, and environmental conditions. The optimized PIFP formulations showed promising performance as biobased adhesives for wood bonding and repair applications [3].

Keywords: photoinduced frontal polymerisation, composite, biofiller, biobased acrylate, wood adhesive

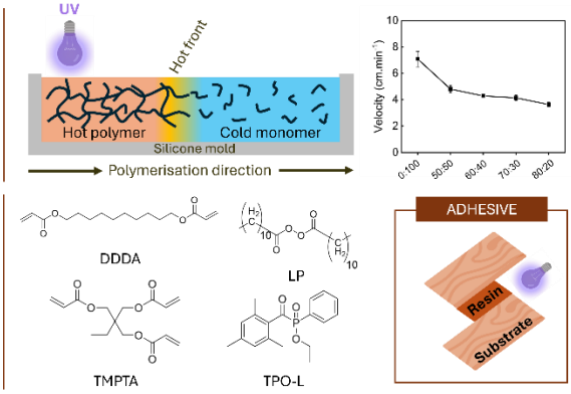

Figure 1: Schematic overview of the PIFP system. Top left: Illustration of the PIFP process, showing the transition from cold monomer to hot polymer as the reaction front moves within a silicone mold. Top right: Effect of monomer ratios on frontal velocity. Bottom left: Chemical structures of the monomers and initiators used in the formulation. Bottom right: Adhesive application, where the resin bonds to the substrate.

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Acknowledgment
This project received funding from the #horizoneurope20212027 programme under the Marie Skłodowska-Curie Doctoral Networks (MSCA-DN) grant agreement No 101073432

Lignocellulosic biomass revalorization inside a circular-economy frame to produce competitive polyhydroxyalkanoate composites for packaging applications

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[2] EQS Group (Sustainable Energy and Chemistry Group), Institute of Catalysis and Petrochemistry (ICP), Spanish Council for Scientific Research (CSIC), Madrid, Spain
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Abstract:
Biopolymers offer a sustainable alternative to conventional petroleum-based plastics. However, their practical application is often limited by low mechanical strength, suboptimal barrier performance and a narrow processing window.[1,2] To address these challenges, a novel biodegradable film that combines two biodegradable biopolymers is presented. Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) is combined with cellulose nanocrystals (CNC) derived from high-purity cellulose obtained from lignocellulosic residues through a circular extraction with γ-valerolactone.[3] The films are produced through electrospinning, which enables the homogeneous integration of both components and allows their processability at room temperature, and are subjected to a controlled thermal treatment that coalesces the fibers into a continuous film.
The study reveals how the barrier performance of the final material is strongly influenced by the production method of the nanocellulose. Those films containing CNCs derived from revalorized residues, which were not neutralized by salt addition, exhibited superior oxygen barrier properties compared to pristine PHBV or the films incorporating commercial nanocellulose. An improvement from medium–low barrier levels (>10 cc/m²·day) to high-barrier values (<1 cc/m²·day) was observed. Those results are comparable to petroleum-based polymers such as ethylene vinyl alcohol. This remarkable reduction was achieved under relatively demanding conditions (60% relative humidity), without the need for multilayer structures or additional protective coatings. The resulting materials were transparent, showed no evidence of incompatibility between components, and exhibited a slight enhancement in moisture resistance. However, the mechanical performance declined, as the films exhibited increased stiffness accompanied by reduced flexibility. Overall, these results demonstrate that the morphology and surface characteristics of residue-derived CNCs play a decisive role in determining the interfacial compatibility and tuning the barrier performance of PHBV-based films to produce materials with barrier properties approaching those of conventional plastics, paving the way toward competitive biopolymers with applicability as packaging substrates or as coatings in diverse packaging scenarios.

Keywords: cellulose nanocrystals, poly(3-hydroxybutyrate-co-3-hydroxyvalerate), PHBV, electrospinning, barrier properties, packaging, biopolymer composite.

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3Bs Materials Session I. D: Synthesis, Processing and Characterization

Unlocking the Potential of Residual Streams for Biopolymer Production: Bridging Lab-scale Innovation and Scale up.

Maria A. Reis
NOVA School of Science and Technology (FCT-NOVA), Portugal

Abstract

Polyhydroxyalkanoates (PHAs) are biodegradable and biocompatible polyesters with versatile thermal and mechanical properties, making them promising sustainable alternatives to conventional petroleum-based plastics. However, their widespread commercialization remains constrained by high production costs, largely associated with the use of expensive carbon sources. Agro-industrial residues represent an abundant and inexpensive source of carbon and bioactive compounds, offering an attractive platform for the microbial production of value-added products such as organic acids, fine chemicals, and PHAs. Their valorization not only addresses waste management challenges but also creates economic value through the generation of sustainable bioproducts, contributing to the transition towards a circular bioeconomy.

This keynote will present recent advances and proof-of-concept processes for PHA production from agro-waste using both mixed microbial cultures and selected bacterial strains. Different strategies for the conversion of diverse feedstocks into biopolymers will be discussed, highlighting their potential for scalable and sustainable PHA production. Particular attention will be given to innovative reactor operation modes and advanced monitoring approaches designed to optimize microbial performance, polymer accumulation, and downstream recovery at both laboratory and pilot scales.

The results demonstrate the feasibility of transforming agro-industrial residues into high-value biopolymers and provide practical insights into scalable strategies for cost-effective PHA production. Overall, this work highlights the potential of agro-waste valorization as a key pathway for the development of environmentally friendly bioplastics and the advancement of a circular bio-based economy.

Sea urchin bioadhesive for biomedical and biotechnological applications

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[2] MARE – Marine and Environmental Sciences Centre
[3] ARNET – Aquatic Research Network

Abstract: The bioadhesives market holds significant commercial potential, driven by a growing emphasis on sustainable and eco-friendly solutions, pushed by a higher environmental consciousness, regulatory pressures towards greener alternatives, and a shift in consumer preferences towards nature-based products.

The development of new bioadhesives is of utmost importance because many existing and emerging areas (eg. nanotechnology, 3D printing, nanomedicine, robotics, regenerative medicine, microelectronics, nanosensors) require adhesives with properties that synthetic adhesives cannot reach.

Given their strong underwater adhesion (0.5 MPa) and having evolved in the presence of seawater (a hostile medium with high dielectric and ionic strength like physiological fluids), makes sea urchins a unique model organism to discover new molecules for the development of novel protein-based bioadhesives. In addition, adhesives produced by marine invertebrates are generally non-toxic, biodegradable, and do not elicit an immunological response, making them ideal for biomedical applications such as tissue repair, wound sealants, and drug delivery.

Sea urchin bioadhesives are made up of proteins and glycans, and through a combination of 'omic approaches and lectin-based assays, progress has been made towards the identification of the key molecular components that are worth mimicking. It has been shown that these adhesive proteins contain recurrent functional domains that seem to be more important to their adhesive function than to copy their exact amino acid sequence.

Based on +20y of experience on marine bioadhesion, a multidisciplinary team is engaged in designing sea-urchin inspired recombinant adhesive proteins that combine high adhesiveness and production yields, adequate shelf-life/stability, and biocompatibility for biomedical/biotech applications.

Keywords: sea urchin, temporary adhesion, biomietic adhesive, biomedical and biotechnological applications.

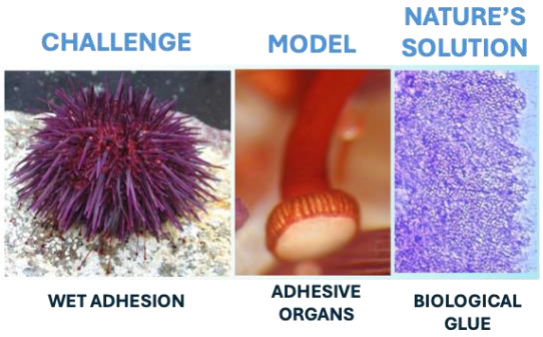

Figure 1: Figure illustrating the fundamental question that we are tempting to solve experimentally: what is Nature's strategy for strong adhesion in wet environments.

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Using Algal and Fungal Multi-omics to Enable Sustainable Bimaterals

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U.S. Department of Energy Lawrence Berkeley National Laboratory and Department of Plant and Mcrobial Biology, University of California Berkeley, Berkeley, CA, USA

Abstract:
Biological materials produced by algae and fungi represent a largely untapped resource for the development of sustainable and renewable biomaterials. These organisms synthesize a wide range of structural polymers, metabolites, and enzymes that determine biomass composition, material properties, and the capacity to transform natural and synthetic substrates. However, the biological basis underlying these properties remains poorly understood for most species of interest, limiting their use in materials applications.

Here, we describe how large-scale genome sequencing combined with transcriptomics, metabolomics, and comparative genomics provides a systems-level view of algal and fungal biology relevant to biomaterials. By expanding genomic coverage across diverse photosynthetic algae and fungi, we identify conserved and lineage-specific pathways involved in carbon allocation, polymer biosynthesis, and cell wall architecture. Integrating functional data reveals regulatory mechanisms that shape biomass accumulation, stress responses, and material-relevant traits.

Examples from algal and fungal systems illustrate how multi-omics approaches enable the discovery of carbohydrate-active and other enzymes involved in lignocellulose modification and polymer turnover, as well as targets for improving growth and material yield. These datasets are integrated into open community resources (Figure 1), MycoCosm [1] for fungi and PhycoCosm [2] for algae supporting comparative analysis and accelerating translation from genome-scale insight to practical materials innovation. Together, this work highlights the value of combining genomics with materials science to develop scalable biological platforms for sustainable biomaterials.

Keywords: biomaterials; multi-omics; algal genomics; fungal enzymes; sustainable materials; bio-based polymers

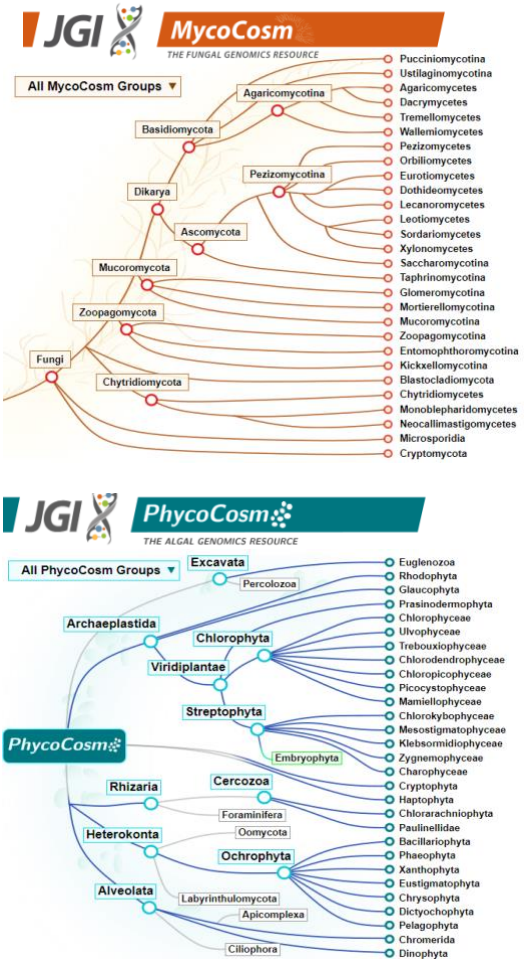

Figure 1: JGI genomics resources MycoCosm (mycocosm.jgi.doe.gov [1]) and PhycoCosm (phycocosm.jgi.doe.gov [2]) with 4000+ fungal and 300+ algal genomes, respectively.

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Virus-like particles as modular interfaces for biomaterial functionalization

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Abstract:

Precise control over cell-material interactions requires reliable presentation of bioactive motifs at the material surface. However, current functionalization strategies based on extracellular matrix (ECM) proteins or synthetic peptides suffer from batch variability, high cost, poor surface adsorption, and limited control over peptide presentation. To address these limitations, we developed a novel VLP-based approach that displays biomimetic ECM-derived peptides on highly ordered, multivalent, self-assembling protein scaffolds.

We engineered AP205 and Mi3 VLPs to present adhesive and instructive peptides, including RGD, YIGSR, and a BMP-2-derived motif, using either direct genetic fusion or the SpyTag–SpyCatcher ligation system. These bioactive VLPs converted otherwise cell-repellent surfaces into biologically active interfaces. RGD- and YIGSR-functionalized VLPs markedly enhanced cell adhesion, spreading, migration, and proliferation, and robustly supported myogenic differentiation. Incorporation of the SpyTag–SpyCatcher system further increased modularity and improved peptide presentation, enabling performance comparable to or surpassing that of native ECM proteins and synthetic RGD peptides. In addition, the platform demonstrated the capacity to co-present multiple bioactive motifs in a controlled manner, expanding opportunities for engineering multifunctional, cell-instructive biomaterial coatings.

Overall, this work establishes VLPs as a versatile and cost-effective alternative to conventional coating strategies, offering stable, multivalent, and molecularly organized presentation of bioactive cues (Figure1). Current efforts focus on developing covalent immobilization strategies to anchor VLPs onto material surfaces and on expanding the library of displayed functionalities, enabling broader control over cell behavior and further enhancing the versatility of this platform for regenerative medicine applications.

Keywords: virus-like particles (VLPs), cell-material interactions, extracellular matrix mimetics, surface functionalization, tissue engineering.

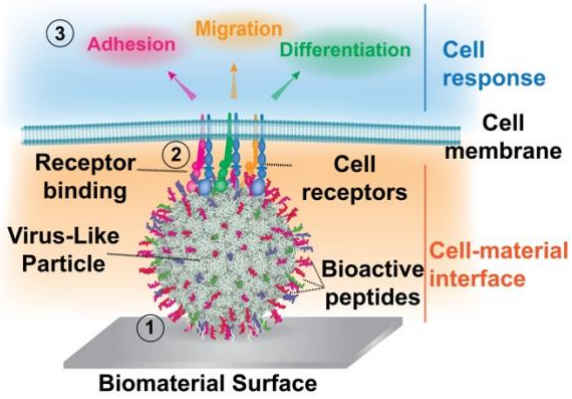

Figure 1: Graphical abstract illustrating how engineered virus-like particles (VLPs) provide a versatile and effective platform for biomaterial biofunctionalization and control of cell behavior (Adapted from [1]) . (1) VLPs readily adsorb onto clinically relevant biomaterials such as titanium. (2) Displayed peptides are presented in an orientation- and multivalency-optimized manner, enabling efficient engagement of cell-surface receptors. (3) VLP-functionalized surfaces elicit enhanced and desirable cellular responses..

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3D-Printed PCL/Chitosan Hybrid Scaffolds with Dual Porosity for Periodontal Regeneration and Antimicrobial Functionality

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Abstract: The regeneration of periodontal tissues requires biomimetic scaffolds capable of reproducing the complex mechanical and biological gradients of the tooth–periodontal ligament–bone system. Recent studies highlighted the wide range of elastic moduli characterizing periodontal components, spanning from the kPa–MPa range of the periodontal ligament to the GPa range of mineralized tissues. This mechanical heterogeneity represents a major challenge for scaffold design in periodontal tissue engineering.

In this work, we present a first step toward the development of customized 3D-Printed hybrid scaffolds with interconnected dual porosity, integrating poly-ε-caprolactone (PCL) and chitosan (CS) to achieve balanced mechanical performance and enhanced biological functionality. The scaffolds were fabricated by additive manufacturing, combining a rigid PCL framework with an internal porous CS network, improving long-term dimensional stability and providing intrinsic cues for cell retention and differentiation.

Morphological and physicochemical characterization was performed using scanning electron microscopy (SEM), micro-computed tomography (μ-CT), swelling, degradation, and compressive testing. The optimized architecture, characterized by 50–60% porosity and an average pore size of approximately 300 μm, exhibited compressive moduli of 412.8 ± 20.2 MPa and 436.5 ± 35.6 MPa for PCL and hybrid scaffolds, respectively. These values are compatible with the mechanical requirements of periodontal and adjacent mineralized tissues and can be further tuned according to specific implantation sites.

In vitro biological evaluation demonstrated good cytocompatibility and favorable cellular responses, while the intrinsic antimicrobial properties of the CS network contributed to bacterial growth inhibition. Moreover, the hierarchical structure offers opportunities for the development of CS-based reservoirs for the controlled and localized delivery of bioactive molecules, including drugs, proteins, genes, and antimicrobial peptides, with potential immunomodulatory and anti-inflammatory effects. Overall, this study establishes the foundation for a multifunctional and customizable scaffold platform for periodontal repair, integrating mechanical stability, hierarchical porosity, antimicrobial activity, and drug delivery capability. Although the present work is limited to in vitro validation, the results support further development toward graded and compartmentalized architectures and preclinical evaluation.

PRIN 2020WREYF2 - 3D Customized HYbrid MedicAl Devices for Alzheimer's disease-related Periodontitis Treatment - 3D CHYM ADAPT financial supported the proposed research.

Keywords: additive manufacturing; 3D hybrid scaffold; poly-ε-caprolactone (PCL); chitosan (CS); dual porosity; periodontal tissue regeneration; antimicrobial activity; cell viability

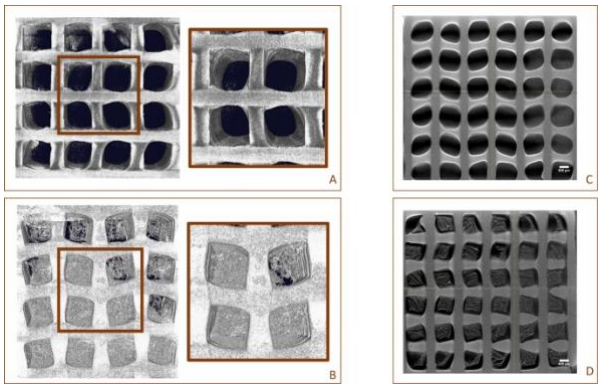

Figure 1: Figure XCT analyses: 3D rendering of PCL (A) and hybrid (B) scaffolds. 2D slicing of PCL (C) and hybrid (D) scaffolds. Scale bar 500 μm.

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Microbial Polymers as Biomaterials for Topical Drug Delivery Applications

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Abstract:
Microorganisms can synthesize different classes of biopolymers, particularly polysaccharides and polyhydroxyalkanoates (PHAs). Microbial polysaccharides, such as xanthan gum, bacterial cellulose, hyaluronic acid, and pullulan, are typically hydrophilic and may be either water-soluble or insoluble[1]. These properties enable their application as rheology modifiers, biosurfactants, gels, films, and bioactive materials[1]. In contrast, PHAs are intracellularly accumulated bacterial polyesters with hydrophobic characteristics, making them particularly suitable as biodegradable plastics and structural biomaterials[2].

The combination of these microbial polymers enables the design of diverse functional biomaterial structures, including films, membranes, scaffolds, hydrogels, emulsions, microparticles, nanoparticles, and microneedles. These platforms can be loaded with bioactive compounds and engineered for targeted biomedical functions such as controlled drug delivery and wound healing. For example, PHA-based films exhibit bioadhesive properties and conform well to the skin without causing irritation, highlighting their potential for topical therapeutic applications[3].

Advanced biomaterial platforms derived from microbial polymers include electrospun scaffolds for tissue engineering[4], microneedle arrays for minimally invasive drug administration, and hydrogels for skin regeneration and cosmetic formulations. Microneedles fabricated from PHAs provide high mechanical strength, enabling efficient skin penetration[5], while polysaccharide-based microneedles can dissolve after insertion, allowing controlled release of encapsulated compounds. Hydrogels produced from microbial polymers such as chitin-glucan complexes[6,7], FucoPol[8,9], and bacterial cellulose[10] also demonstrate high water retention, structural stability, and favorable interactions with skin cells.

Overall, microbial polymer-based biomaterials represent a versatile and sustainable platform for developing next-generation biomedical products, supporting innovations in drug delivery, tissue engineering, and skin health while contributing to circular bioeconomy strategies.

Keywords: Microbial polymers; Biopolymers; Polyhydroxyalkanoates (PHAs); Microbial polysaccharides; Drug delivery; Biomaterials; Microneedles; Hydrogels; Tissue engineering; Skin health.

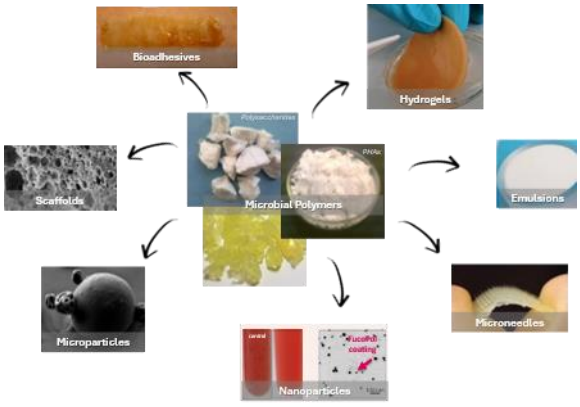

Figure 1: Figure illustrating the range of applications of microbial polymers.

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Mixed species biofilms on non-woven fiber pads - Characterizing a self-organizing, catalytic, living material

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Abstract:
Biofilms offer a range of beneficial properties, such as very high volumetric biomass concentrations and increased resistance to a whole range of negative environmental influences. These make them promising candidates in the existing toolbox of biocatalytic systems. However, to overcome usual scaling hurdles, these biofilms are ideally fixed in a sustainable, growth-promoting matrix. This combination creates self-organized catalytic living materials by combining 3D bio-based porous architectures with synthetic microbial consortia to valorize natural and waste resources and enable continuous chemical synthesis.
We characterize mixed-species biofilms made up of genetically modified *P. taiwanensis* VLB 120 and *Synechocystis PCC6803* growing on non-woven fiber pads made out of a range of different natural fibers, such as poplar, viscose cotton, and silk. Both strains encode the same reaction cascade from cyclohexanol to ε-caprolactone, a precursor in nylon production. However, they possess not just a different trophic mode but also differing susceptibility to the educts' toxicity and differing yield characteristics. Therefore, by utilizing the self-organization principles of this artificial community, one can control the general abundance as well as the spatial distribution of the individual strains on the fiber pads in a drip-flow reactor design and thereby enhance overall production efficiency.
This contribution curates insights gained through optical coherence tomography (OCT), confocal laser scanning microscopy (CLSM), and flow cytometric analysis of the catalytic biomass to tell a story of microbial self-organization for improved biocatalysis.

Keywords: catalysis, living materials, biofilms, optical coherence tomography (OCT), CLSM, flow cytometry

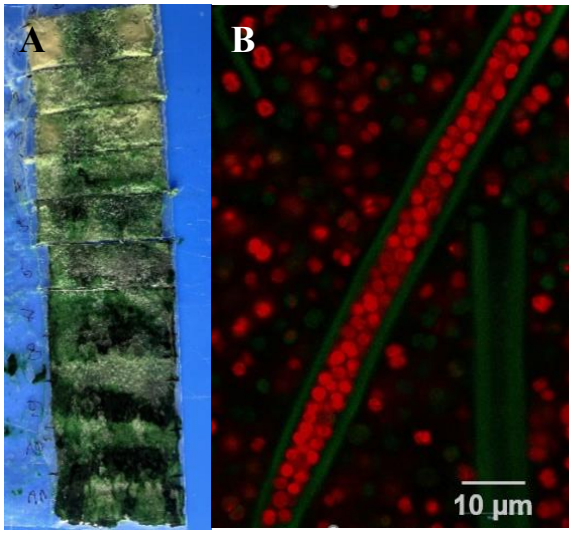

Figure 1: A) mixed species biofilm containing *P. taiwanensis* and *Synechocystis* growing on a non-woven fiber pad B) Slide of a 3D stack CLSM image of a Synechocystis biofilm on polar fiber / PET-fiber pads illustrating cell growth inside of the hollow poplar fibers.

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Polyphenolic surface functionalization of fluorinated contact lenses for peptoid grafting and enhanced properties

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Abstract:
Rigid gas permeable contact lenses containing fluorine show high potential in optical and mechanical propreties. However, their highly hydrophobic and chemically inert nature makes surface modification more challenging. This represents a major limitation when aiming to introduce bioactive functions for antifouling and wettability propreties. In this work, we developed a surface functionalization strategy based on polyphenolic coatings using dopamine, tannic acid, and pyrogallol to enable the grafting of thiolated peptoids onto fluorinated contact lens.

The polyphenolic layers form an adherent and reactive coating on the lens surface, allowing Peptoids to be grafted through thiol-click chemistry under mild conditions. The presence of the phenolic coatings was confirmed by X-ray photoelectron spectroscopy (XPS) through changes in surface elemental composition. The peptoid grafting was further confirmed by high resolution XPS analysis of the S_{2p} region, attributed to sulfur originated from the thiolated peptoids.

The functional effect of the polyphenolic coating and the peptoid grafting was evaluated using lipid adsorption exiprements with FITC-labeled albumin. Compared to unmodified lenses, the coated surfaces showed a clear reduction in lipid adsorption. In addition, water contact angle measurements indicated increase surface hydrophilicity after coating and Peptoid grafting.

These results show that polyphenolic surface modification and Peptoid grafting is an effective and flexible approach for surface functionalization of fluorinated contact lenses, by improving hydrophilicity and antifouling effect, which provided a promising platform for ophthalmic applications.

Keywords: Rigid contact lenses, wettability, phenolic coating, Peptoid grafting, antifouling, surface modification.

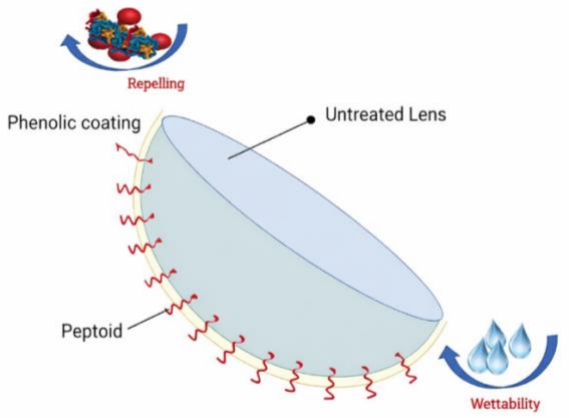

Figure 1: Schematic illustration of polyphenolic coating deposition on a fluorinated contact lens surface, followed by Peptoid grafting to impact antifouling and wettability properties.

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Tailored Bio-Based Plasticizers from Vegetable Oils: Design Toward Sustainable PVC Applications

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Abstract:
The development of sustainable plasticizers for polyvinyl chloride (PVC) is essential as conventional phthalate-based plasticizers, currently representing over 80% of the PVC market, raise increasing health and environmental concerns [1]. Although several fossil-based alternatives have been commercialized, they lack sustainability, while existing bio-based options derived from vegetable oils, citric acid, or gum rosin typically suffer from poor compatibility with the PVC matrix. Improving this compatibility remains a major challenge, requiring both optimal molecular design and the use of affordable, renewable raw materials [2].

This work focuses on the synthesis and structural optimization of bio-based plasticizers obtained from renewable resources such as vegetable oils. The objective is to enhance the compatibility and performance of previously identified vegetable oil–based plasticizers by tailoring molecular architecture. Fatty acid–based esters were synthesized through epoxide ring-opening reactions using epoxidized soybean oil (ESBO) as the primary precursor.

The synthesized structures were verified by ATR-FTIR and ^{1}H NMR spectroscopy, confirming the successful incorporation of the targeted functional groups. Key physicochemical properties relevant to effective PVC plasticization, acid value, dynamic viscosity, molecular weight and water content, were also determined to evaluate how molecular structure, polarity and branching influence the compatibility and overall performance of the bio-based plasticizers in PVC.

Our strategy involves controlled modification of epoxidized vegetable oils through reaction with selected alcohols of varying chain length and functionality. This approach enables systematic adjustment of molecular weight and polarity, parameters known to affect compatibility, volatility and plasticizing efficiency. Additionally, introducing branching via epoxy functional groups and targeted ring-opening reactions improves interaction with the PVC matrix.

Overall, the results demonstrate that biomass-derived structures can be tuned to yield effective, lower-toxicity, and potentially biodegradable plasticizers, contributing to the transition toward more sustainable PVC formulations.

Keywords:

Bio-based plasticizers, Epoxidized vegetable oils, Fatty acid derivatives, Epoxide ring opening, PVC compatibility, Sustainable polymer additives

Acknowledgements:

This study has received funding from the European Union's Horizon Europe research and innovation program under grant agreement No. 101178074.

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Polymers / Composites / 3Bs Materials 2026 Plenary Session II. A

Recycling and valorisation of textile waste through vitrimer chemistry

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Abstract:
Recently, textile industry has been singled out as one of the main contributor to global plastic production and consumption, and consequently environmental plastic pollution. The reason for this is the growing demand for new clothes followed by a shorter life span due to the ”fast fashion” phenomenon driven by social media. In fact, global fiber production has almost doubled since 2000, reaching the record of 124 million tonnes in 2023, and this number is expected to keep growing up to 160 million by 2030.

Polyester fibers (polyethylene terephthalate or PET) account for 54% of the market share, being the most used fiber worldwide. However, textile recycling remains a challenge due to the low cost of virgin fibers and clothing collects issues, but also the fact that most of actual clothes are composed by blended fibers. Therefore, 70% of the textile waste is either incinerated either landfilled[1]. Mechanical recycling remains the most widely used method for PET recycling due to its low cost and practicality but it presents limitations for textile recycling. Due to chain scission and thermal degradation, the mechanical properties of r-PET are deteriorated, leading to the addition of virgin PET or chain extenders during extrusion to recover better properties[2]. Another promising alternative is chemical recycling. But, usually, the price of the recycled product is higher due to the purification steps[3]. The use of enzymes has shown great potential for selective depolymerization of polyesters[4]. But the presence of pigments or blended fibers also limit the efficiency of enzymatic recycling.

The introduction of dynamic bonds to thermoplastics represents a promising approach to valorize textile waste in order to obtain high-value recycled products with enhanced properties. PET-based CANs were elaborated through reactive extrusion by adding bisphenol A diglycidyl ether (DGEBA) as crosslinking agent. According to the literature, most of the works focused on Zn(acac)2 as catalyst, but since PET extrusion takes place at high temperatures (260°C-280°C), this contributes to catalyst degradation, which can be accentuated during CAN recycling cycles. In this scenario, metal based ionic liquids present themselves as excellent candidates to replace conventional organometallic compounds[5].

Finally, the elaborated CANs will be used as building blocks in the mechanical recycling of PET. Different PET/CAN blend compositions will be processed and the rheological and mechanical properties will be studied in order to obtain a new generation of polyester fibers.

Keywords: Polyethylene Terephthalate, Textile, Recycling, Vitrimers, Transesterification, Ionic Liquids.

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Design and Processing of Suistanable Polymers – A POLYMERS-5B Perspective

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Abstract: Increasing environmental concerns about plastic waste and reliance on fossil fuels have driven the development of sustainable, bio-based polymer materials. In response, the POLYMERS-5B initiative has been launched to pioneer innovative approaches in this domain. It aims to address global sustainability challenges by focusing on the design, synthesis, and processing of sustainable polyesters and biodegradable polymers. Emphasizing green, energy-efficient technologies, POLYMERS-5B operates within a broad scope that includes research and development of biodegradable polymers from renewable resources. This research integrates advanced processing strategies for biodegradable polymer systems with the development of novel microwave-assisted bio-polyesters synthesized from renewable building blocks.

Conventional biodegradable polymers, including poly(lactic acid) (PLA), polyhydroxyalkanoates (PHAs), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), and poly(butylene succinate) (PBS), were investigated alongside newly synthesized aliphatic polyesters derived from tartaric, succinic, and malonic acids in combination with bio-based diols such as isosorbide, ethylene glycol, and 1,4-butanediol. According to microwave-assisted green organic snthesis, in solvent-free conditions, microwave irradiation allows substrates to directly absorb energy rather than the solvent, thereby enhancing the process's effectiveness and increasing the benefits of microwave-assisted polycondensation. A systematic experimental and statistical design, incorporating two-way ANOVA and Box–Behnken optimization, was implemented to correlate synthesis parameters with critical responses such as polymer yield and glass transition temperature (Tg)

In addition to synthesis, downstream processing was investigated through melt processing and extrusion of flat films. The extruded films were evaluated for processability, film-forming capability.

In summary, this integrated approach exemplifies the POLYMERS-5B strategy by combining green chemistry, microwave technology, statistically driven optimization, and industrially relevant processing methods. The resulting sustainable polyesters are presented as viable alternatives to conventional plastics for packaging, coatings, automotive, and advanced functional applications, in alignment with circular-bioeconomy and Safe-and-Sustainable-by-Design principles

Keywords: sustainable polymers, bio-based polyesters, microwave-assisted synthesis, green chemistry, flat-film extrusion, biodegradable films, polymer processing, statistical optimization, circular bioeconomy, POLYMERS-5B

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"The project 101157840 — Polymers-5B — HORIZON-JU-CBE-2023 is funded by the European Union and supported by the Circular Bio-based Europe Joint Undertaking and its members."

From Agri-Food Residues to Sustainable Polymers based on the Polymers-5B Pathway Toward Circular Bioplastics

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Abstract:
Polymers-5B (Figure 1) is an EU project that aims to develop novel alternative polymers and co-polymers synthesised from bio-based monomers (diacids, diols, diamines, hydroxyacids, amino acids, aromatic and phenolic compounds, fatty acids, oils, and others).

Figure 1. Symbol Polymers-5B project.
Website: www.polymers-5b.eu

These bio-based monomers are sourced from underexploited second-generation (2G) feedstocks, such as agri/food residues (e.g., Tomato and Olive) and biomass (e.g., wood pulp and lignin derivatives), as well as commercially available bio-based monomers in the EU.

The project resorts to Biocatalysis and Green Chemistry processes to generate novel bio-based polymers like polyesters and polyamides with pendent functional groups (e.g., hydroxy, carboxylic, amine, epoxy, thiol, others), polyphenols, and others that mimic fossil-based polymers' properties (e.g., polyethene terephthalate—PET, Polyurethanes—PUs, Acrylonitrile butadiene styrene—ABS, Amine, and other polymeric resins). These manufacturing processes are circular, environmentally friendly, and aligned perfectly with the Chemicals Strategy for Sustainability.

In the concept of Chemical Platform Biorefinery, Polymers-5B is also generating valuable bioactive compounds and molecules (i.e., antioxidants, soluble and insoluble dietary fibres, versatile polysaccharides, carbohydrates, proteins, etc.), obtained from the above feedstocks that can have further use in food, feed, chemical, biotechnology, and pharma/cosmetic applications.

Machine Learning (ML) and Artificial Intelligence (AI) tools will drive the optimisation of the processes for the extraction of bio-based monomers and bioactive compounds, and for polymer synthesis, towards minimum resource usage, “zero waste” and “zero pollution”. Environmental sustainability will be incorporated early in the design phase through Safe and Sustainable by Design (SSbD) approaches.

These new polymers and co-polymers will be blended with other bio-based materials to provide valuable bio-composites and polymeric materials for the textile, automotive, furniture, and polymeric resin markets (Figure 2).

Figure 2: Illustration of the sustainable strategy for producing alternative bio-based polymers & plastic materials synthesised in the EU.

Finally, the new polymers and co-polymers will also target improved biodegradability and depolymerisation and/or hydrolysis to monomers, oligomers, or small polymers, which can contribute to a Plastic Circular Economy in the EU. The Polymers-5B project also aims to achieve Green Deal targets by reducing the carbon footprint and the dependency on fossil-based raw materials and derivatives.

Keywords: bio-based monomers, biodegradable polymers, biocatalysis, Green Chemistry.

Novel Fully Bio-based Copolymers for Food Packaging Applications

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Abstract:
The use of bio-based and biodegradable polymers as packaging materials to replace petrochemical polymers is becoming an emerging trend due to their improved sustainability.[1] In this regard, polyamides have long been recognized as one of the major engineering thermoplastics, finding several applications in food packaging. Although polyamides have traditionally been synthesized from petroleum derived diacids and diamines, some partially and fully bio-based polyamides have also been developed recently using renewable monomers, endowing comparable physical properties to their petrochemical counterparts.[2] Thus, bio-based aliphatic polyamides, also referred as "green nylons", can offer the advantage of using biomass and the unique potential of carbon neutrality so that these perfectly align with the Bioeconomy principles.
It is described herein the polycondensation reaction at different contents of "nylon salts" derived from renewable putrescine, 1,10-decamethylenediamine, and sebacic acid monomers to produce copolyamide 1010/410.[3] Then, it is reported the chemical analysis of different copolyamide grades and their themocopression into films and, thereafter, complete characterization to ascertain the putrescine content effect on their crystallinity, thermal, optical, mechanical, and barrier properties. Finally, it is shown the application of the newly developed bio-based copolyamide as lid films in food packaging by determining the shelf life of minced beef for a period of 11 days in cold storage conditions (5 °C).

Keywords: Bioeconomy, biopolymers, polymerization, green nylons, meat packaging.

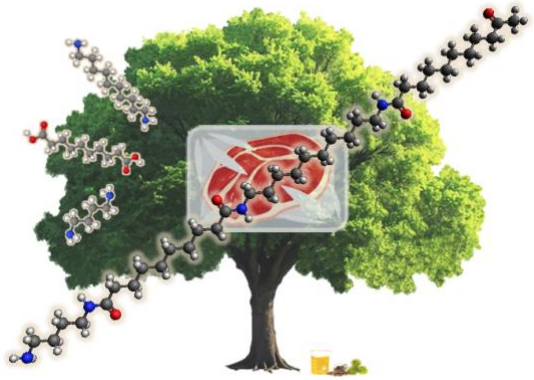

Figure 1: Fully bio-based copolymers applied as lid films in trays to preserve beef meat, showing high potential for use in sustainable food packaging applications.

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Biopolymer-based materials for packaging valorizing agricultural waste of the Mediterranean area

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Abstract:

The transition toward sustainable packaging for perishable foods demands materials that reconcile performance, functionality, and environmental responsibility. This keynote presents the outcomes of a material selection strategy for the development of biobased and biodegradable packaging for fresh fruit, focusing on three specific applications: mesh bags for citrus fruits, and films and thermoformed trays for strawberries and dates.The research is conducted within the framework of the Plaminpack project (www.plaminpack.com), where the University of Pisa leads the identification of suitable materials and processing routes for prototype production. The project aims to deliver innovative packaging solutions tailored to the needs of Mediterranean fruit supply chains[1], combining ecological sustainability with technical reliability. The proposed materials are polymer blends[2] and biocomposites composed of a biodegradable polymer matrix reinforced with fillers derived from pruning residues—primarily branches and leaves—generated during fruit cultivation. The incorporation of these agricultural by-products serves multiple purposes: enhancing stiffness, reducing production costs, improving biodegradability, and promoting the valorization of waste streams that would otherwise remain underutilized. In parallel, antioxidant extracts obtained from the same plant residues have been incorporated into selected formulations to explore their potential active role in extending fruit shelf life. The physical and functional properties of the developed materials were systematically analyzed, considering variations in matrix composition, the use of residues before and after extraction, and the presence of bioactive compounds. The comparative assessment of these parameters enabled the identification of the most promising formulations for the production of packaging prototypes for citrus and strawberries, advancing a circular and integrated approach to sustainable polymer-based packaging.

Keywords: poly(lactic acid), biopolyesters, polymer blends, biocomposites, agricultural waste, extraction, tangerine, strawberry

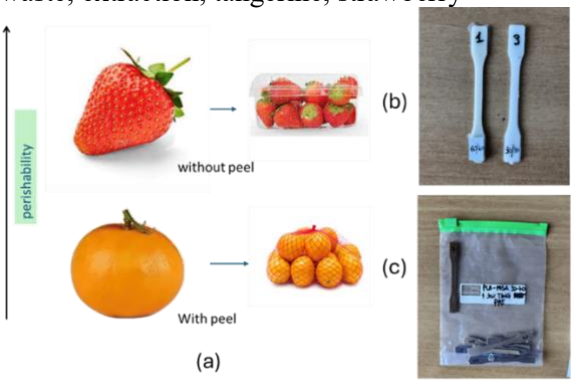

Figure 1: (a) Figure illustrating the correlation between perishability and the kind of packaging to protect perishable fruits of the Mediterranean area. (b) specimens of the investigated biopolymer blends; (c) specimens of a composite containing a reinforcement from tangerine agricultural waste

References:

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Polymers / Composites/ 3Bs Materials Session II. B: Biomaterials and Drug delivery applications

Ensuring Medical Device Success with Nano Composites: 40,000 Patients and Counting

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[3]School of Enginering, Saveetha University, Chennai, India

Abstract:
Nanomedicine is the use of nanomaterials to improve disease prevention, detection, and treatment which has resulted in hundreds of FDA approved medical products. While nanomedicine has been around for several decades, new technological advances are pushing its boundaries. For example, this presentation will present an over 25 year journey of commercializing nanomaterials for orthopedic implants now in over 40,000 patients to date showing no signs of failure. Current orthopedic implants face a failure rate of 5 – 10% and sometimes as high as 60% for bone cancer patients. Further, this talk will present future research directions into using atomic layer deposition (ALD) to create such nanostructures on implants to reduce infection and improve bone growth. Sensors grown off of orthopedic implants using ALD will also be discussed in which cell presence on orthopedic implants can be detected and quantified. Such information can also be communicated to a handheld device to better inform surgeons on chances of implant success or failure. Such sensors can also release pharmaceutical agents and/or nanoparticles on-demand to ensure implant success. Lastly, this talk will cover how Artificial Intelligence (AI) can be combined into today's orthopedic implants to predict implant success or failure in the years that follow.

Keywords: nanotchnology, nanomedicine, infection, medical devices

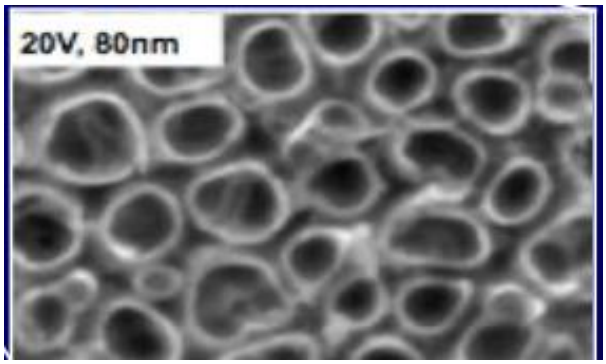

Figure 1: Nancomposites that have eliminated implant failure in over 40,000 humans.

Eco-Friendly Glycerol-Derived Polyesters: Advancing the Sustainability of Polymers in Liquid Formulations and Medical Applications

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Abstract:
Polymers in Liquid Formulations (PLFs) are essential in numerous everyday products, including cleaning agents, personal care items, agrochemicals, paints, and lubricants. Predominantly derived from fossil fuels, these polymers are non-biodegradable, contributing significantly to environmental pollution. The Royal Society of Chemistry estimates that over 36 million tonnes of PLFs are not recovered annually, presenting a substantial global environmental burden. Despite their societal and economic importance, there has been minimal coordinated effort to enhance the sustainability of PLFs. Our research addresses this critical issue by developing glycerol-based polyesters as sustainable alternatives. Glycerol, a byproduct of biomass processing, is highly functionalised, making it an ideal monomer for creating biodegradable and functional polymers. These polyesters, synthesised via lipase-catalysed polymerisation, offer amphiphilic balance and the potential for further functionalisation, improving their interaction with biological molecules and enhancing encapsulation efficiency.
These same glycerol-based polymers can also have an impact in the medical field where over 40% of active ingredients/drugs in development pipelines are poorly water-soluble, limiting their clinical applications. Encapsulating drugs in polymeric nanoparticles can enhance solubility, reduce toxicity, and ensure effective drug concentrations at target sites. Recent advancements in layer-by-layer additive manufacturing (AM) offer promising strategies for producing personalised medical devices. However, the limited availability of commercially viable polymers hinders the development of both AM for medicine and drug delivery.
These polyesters present a sustainable solution, offering biodegradability and functionality, thus addressing the urgent need for environmentally friendly PLFs. This innovative approach not only enhances drug delivery systems but also contributes to global sustainability efforts.

Keywords: Polymers in Liquid Formulations (PLFs), enzymatic polymerization, glycerol, sustainable polymers, 3D-printing, drug-delivery

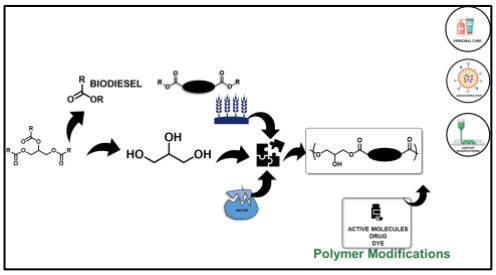

Figure 1: Figure illustrates the utilisation of glycerol from biodiesel by-product to key monomer for the chemo-enzymatic production of functionalised polymers. These new polymers can be then used as sustainable and degradable alternatives for PLFs, drug delivery carriers and 3D-printing resins.

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Formation of a scaffold based on silica-gelatin-polymer by supercritical technology for its use in biomedicine

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Abstract:
The development of biodegradable porous structures, known as scaffolds, represents an innovative strategy in regenerative medicine by providing mechanical support and a favorable environment for tissue regeneration. Nowadays, many studies [1] focus on the fabrication of hybrid scaffolds based on metal oxides and polymers to improve scaffold features and to avoid or minimize tissue rejection in tissue engineering applications. In this sense, it has been demonstrated that scaffold surfaces with peptide-specific hydroxyl and amino groups or other proteins like gelatin (or collagen) [2], which mimic the extracellular matrix, improve the adhesion properties of the implants. In this work, as a previous step, a sol-gel synthesis methodology was developed for the formation of silica-gelatin hybrid particles. The sol-gel solutions contained Tetraethyl Orthosilicate (TEOS) as silica precursor, combined with gelatin and the coupling agent GPTMS, which helped stabilize the covalent bonds between both components. Synthesis conditions such as pH and reagent ratio were adjusted to favor the formation of a stable silica-gelatin oxide network.
These particles were subsequently precipitated by SAS (Supercritical Anti-Solvent) technique, obtaining spherical particles characterized by various techniques including SEM scanning electron microscopy, energy dispersive X-ray spectroscopy EDX, dynamic light scattering DLS and Fourier transform infrared spectroscopy FTIR, confirming its morphology, its elemental composition, and the presence of gelatin in its matrix. These hybrid particles were impregnated into the scaffold by supercritical impregnation.
The results, such as the successful integration of gelatin into the hybrid particles and the homogenous incorporation into the polymer, support the potential of producing hybrid scaffolds with a defined porous architecture and uniform particle impregnation, which opens new possibilities for their application in tissue engineering.

Keywords: scaffold, microparticles, sol-gel, silica-based biomaterials, supercritical, biomedical applications.

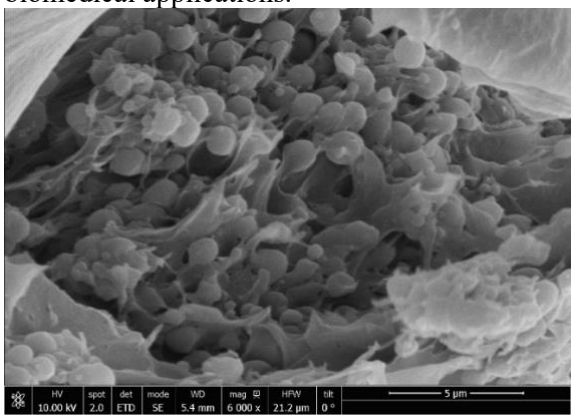

Figure 1: SEM images of silica-gelatin oxide particles entrapped into the scaffold structure

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Light-Responsive Self-Immolative Polymers Based on o-Nitrobenzyl Groups

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Abstract:
Self-immolative polymers (SIPs) are a new class of stimuli-responsive polymers, capable of on-demand depolymerization in response to external stimuli.[1] This unique behavior makes SIPs suitable for applications where a precise spatiotemporal control of the polymer degradation is required, such as drug delivery and other biomedical applications.[2,3] Among the different stimuli, light is highly attractive, as it allows remote application and control in space and time.[4] In this work, we report the synthesis of a light-responsive o-nitrobenzyl-protected aliphatic polycaprolactone via ring-opening polymerization and its polymerization kinetics. Upon deprotection of the o-nitrobenzyl group by UV light, the polymer successfully depolymerizes via intramolecular cyclization into small molecules in solution, as confirmed by NMR spectroscopy, UV/Vis, and SEC analyses. Additionally, the UV-triggered depolymerization was evaluated under different pH and temperature conditions. Finally, nanoparticles were fabricated from this polymer by electrospraying and characterized by SEM. The UV-triggered destruction of these nanoparticles was demonstrated, which is promising for applications in drug delivery.

Keywords: self-immolative polymers, UV-responsive polymers, o-nitrobenzyl group, depolymerization.

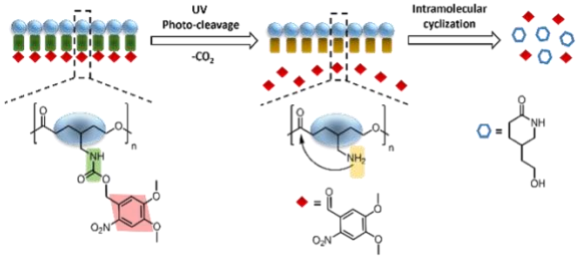

Figure 1: Light-responsive degradation of polycaprolactone functionalized with o-nitrobenzyl side chains into small molecules.

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Bio-Reinforced Hydrogels: Development and Characterization of Poly(sodium 2-acrylamido-2-methylpropane sulfonate)/Hemp Fiber Composites for Wound Dressings

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Abstract:
This research aims to develop hydrogel sheets for use as wound dressings. Hydrogels were prepared from sodium 2-acrylamido-2-methylpropane sulfonate (Na-AMPS) incorporating bleached and non-bleached hemp fibers (*Cannabis sativa L. subsp. sativa*) at 1, 2, 3, and 4 wt% relative to AMPS. The hydrogels were synthesized via UV-induced free-radical polymerization using 2-hydroxy-4'-(2-hydroxyethoxy)-2-methylpropiophenone as the photoinitiator and trimethylolpropane triacrylate as the crosslinker. Fourier-transform infrared spectroscopy confirmed successful hydrogel formation. Water transport properties, including water content, water vapor transmission rate (WVTR), and water retention, were evaluated. Fiber content did not significantly influence water content or water retention. WVTR values of hydrogels containing 0 - 2 wt% fiber were comparable, but increased notably at fiber contents above 3 wt%. Mechanical testing revealed that tensile stress and modulus increased with fiber loading, whereas strain remained similar at 0 - 2 wt% and decreased at higher fiber levels. Hydrogels containing non-bleached fibers exhibited higher modulus than those with bleached fibers, indicating that bleached-fiber hydrogels are softer and potentially more comfortable for wound-contact applications. Rheological measurements further showed increased storage modulus, confirming improved elasticity in fiber-reinforced hydrogels. Fluid affinity tests indicated that all formulations were more suitable for wet wounds than dry wounds. Overall, our findings show that incorporating hemp fibers, particularly bleached ones, enhances the Na-AMPS hydrogels, giving them the physicochemical and mechanical characteristics required for effective hydrogel wound dressings.

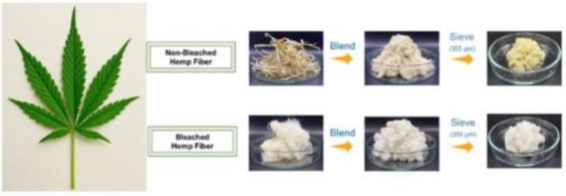

Figure 1: The physical appearances of hemp leaf and the preparation of the bleached and non-bleached hemp fiber.

Keywords:Poly(sodium-2-acrylamido-2-methylpropane sulfonate), hemp, hydrogel, wound dressing

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Synthesis and Properties Testing of P(Na-AMPS)/CMC/Glycerin Amorphous Hydrogels for Wound Dressing Applications

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Abstract:
This research aimed to synthesize and characterize poly(sodium 2-acrylamido-2-methylpropane sulfonate)/carboxymethyl cellulose/glycerin amorphous hydrogels for wound dressing applications. The hydrogels were prepared via free-radical polymerization using potassium persulfate as the initiator and poly(ethylene glycol) diacrylate as the crosslinker. Carboxymethyl cellulose (CMC) was incorporated at concentrations of 0-5 %w/v to enhance the mechanical properties., while glycerin was added at 2-10 %v/v to evaluate its effectiveness as a humectant.

The synthesized amorphous hydrogels were evaluated for their mechanical properties using migration testing and rheological analysis. The results demonstrated that increasing the CMC concentration enhanced the viscosity of the hydrogels, whereas higher glycerin concentrations led to a decrease in viscosity. The fluid absorption behavior of the hydrogels was assessed using the fluid affinity method in accordance with BS EN 13726, which compares absorption capability under different wound conditions (low-exudate vs. high-exudate wounds). The results indicated that the hydrogels were more suitable for wounds with low exudate levels. Cytotoxicity testing using L929 fibroblast cells showed that all hydrogel formulations exhibited cell viability above 70%, confirming no toxicity and good biocompatibility.
Therefore, the incorporation of CMC effectively improved the mechanical properties of the hydrogels, with 4 %w/v identified as the optimal concentration. Glycerin contributed to moisture retention without inducing cytotoxicity. Overall, the developed amorphous hydrogels demonstrated desirable characteristics and showed strong potential for application as wound dressing materials.

Keywords: Amorphous hydrogel, Poly(sodium 2-acrylamido-2-methylpropane sulfonate), Carboxymethyl cellulose, Glycerin, Wound dressing

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Formulation and Evaluation of a Neem-Loaded Dual-Responsive Pluronic F127/*N*-Succinyl Chitosan Sprayable Hydrogel for Wound Dressing Applications

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Abstract:
Sprayable hydrogels that undergo rapid in situ gelation offer a practical approach for wound care by enabling easy application, good surface conformity, and maintenance of a moist healing environment. In this study, a sprayable hydrogel dressing was formulated using dual-responsive polymers, namely thermo-responsive Pluronic F127 (PF127) and pH-responsive *N*-succinyl chitosan (NSC). Formulations containing PF127 (18–20% w/v) and NSC (0.25–0.50% w/v) were systematically optimized to achieve suitable sprayability and subsequently evaluated for sol–gel transition behavior, transparency, gelation performance, storage stability, and cytotoxicity. These properties were further fine-tuned by adjusting the polymer concentrations. The optimized formulation exhibited desirable physicochemical properties, including excellent clarity, physiological pH compatibility, and rapid gelation (~1 min) at 35°C, along with effective liquid and moisture management. In addition, the hydrogel remained stable for at least four months under 4°C storage, with no detectable changes in pH, precipitation, or gelation properties. MTT assay results confirmed that the hydrogel was non-cytotoxic to MRC-5 fibroblast cells, indicating its biocompatibility for topical application. To introduce additional bioactivity into the optimized hydrogel system, *Azadirachta indica* (neem) extract was incorporated into the formulation. The addition of neem extract enhanced the antioxidant capacity of the hydrogel and enabled dose-dependent release, with both the release amount and antioxidant activity increasing proportionally with the neem concentration (0.05–0.30 g/mL). In conclusion, the neem-loaded dual-responsive PF127/NSC sprayable hydrogels demonstrated favorable sprayability, appropriate gelation behavior, controlled bioactive release, and notable antioxidant activity, highlighting their strong potential as effective in situ–forming wound dressings.

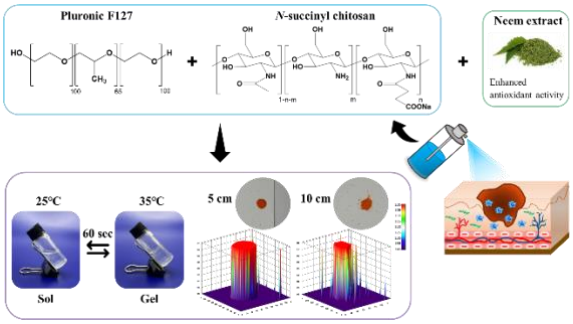

Figure 1: The optimized dual-responsive PF127/NSC sprayable hydrogels demonstrating sol–gel transition behavior, sprayability, and enhanced antioxidant capacity resulting from the incorporation of neem extract.

Keywords: sprayable hydrogel, thermo/pH responsive, Pluronic F127, *N*-succinyl chitosan; *Azadirachta indica* (neem)

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Workshop on Safe and Sustainable BioBased Polymers: from design to end of life in Circular Value Chains

BIO4PACK Cluster

Milad Mosallaei
VTT, Finland

Abstract:
The BIO4PACK Cluster is a collaboration of four Horizon Europe projects STOPP, MAGNO, REBIOLUTION, and ViSS—that collectively accelerate the transition toward sustainable, safe and circular food-packaging systems with the 5 objectives:

1. Replacing fossil-based plastics with bio-based materials.
2. Designing packaging for circularity from the start.
3. Ensuring safety and transparency for people and the planet.
4. Harnessing smart technologies to enhance traceability and recycling.
5. Contributing to European standards and policies that promote sustainable packaging.

ViSS: Innovative Sustainable Solutions for High-Value Plastic Waste Streams within a Circular Economy Framework

Lead by CETEC[1], ViSS consortium[2]
[1] Carmen Fernandez, CETEC, Footwear and Plastics Technology Center, Murcia, Spain
[2]15 partners from 6 countries: María Nicolás, CETECBIOtechnology (Spain); Ludovica Guerrieri, ICONS(Italy); Anna Arias, IRIS(Spain), Davide Crapanzano, Propagroup(Italy); Alba Matamoros, Kveloce(Belgium); Nydia Badillo, Helian Polymers(Netherlands); Alberto Larraz, IDENER(Spain); Antii Paajanen, VTT(Finland); Mariana Faraldi, Tecnolaimenti (Italy); Carlos Sanz, UA(Spain); Pedro Diaz, ZUKAN (Spain); Mike Jenkins, Birmingham(UK); Pablo López, AITEX(Spain).

Abstract:
The transition towards a more sustainable food packaging industry requires the development of innovative materials that can replace conventional fossil-based plastics while ensuring performance [1], safety and economic viability. In this context, the ViSS (Viable, safe and sustainable PHBV value chain for food packaging applications) project aims to transform the food packaging sector by promoting the use of bio-based and biodegradable materials within a circular economy framework [2].
ViSS[3] focuses on the development of polyhydroxybutyrate-co-valerate (PHBV), a copolymer of the PHA family, produced from industrial organic waste streams, enabling resource valorisation and reducing dependence on fossil raw materials.
The project targets key applications such as orange nets, trays and flexible films, demonstrating their technical and market feasibility. A central objective is to validate a complete circular value chain, from raw material sourcing to environmentally sustainable end-of-life, ensuring compliance with food safety requirements, controlled biodegradability and reduced environmental impact. In addition, ViSS applies a Safe-and-Sustainable-by-Design (SSbD) approach, integrating environmental, social and economic aspects from early stages to accelerate the adoption of PHBV-based solutions as viable alternatives to conventional plastics in the food packaging sector [4].

Keywords: Plastic waste recycling; circular economy; sustainable materials; resource efficiency; advanced recycling; secondary raw materials; plastic valorisation.

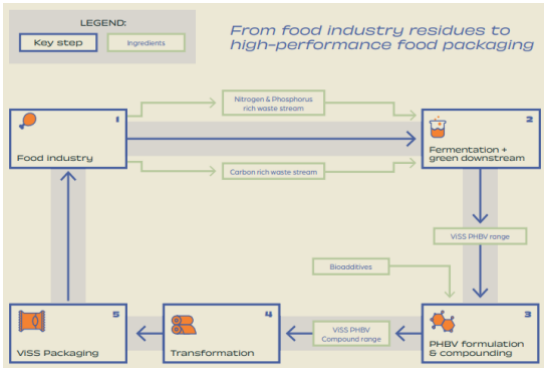

Figure 1: Conceptual overview of the ViSS approach, illustrating the transformation of food waste streams into high-quality secondary raw materials within a circular economy model.

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Novel biodegradable, **RE**cyclable, **BIO**-based and safe plastics with enhanced circu**L**ar properties for food packaging and agric**U**ltural applica**TION**s - **REBIOLUTION**

Y. Matt [1]
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Abstract:
The Rebiolution project is a EU funded project to develop a fully bio-based and biodegradable aliphatic-aromatic polyester based on FDCA and blends thereof, which can be used for food paper packaging or the production of mulch films. The project involves nine partners from across the European Union and covers the whole process from monomer production, over polymerization & blending to trial production and EOL scenarios, which offers an impressive insight into the process to develop new solutions for a sustainable agriculture.

The presentation will offer a look on the project from a higher perspective and cover the framework, scope and tasks of each project member. Another presentation in the workshop will then focus on the pathway to bio-based and biodegradable polyester for mulch films.

Keywords: polyester, biobased, biodegradable, composting, blends, PLA, mulch film

Figure 1: REBIOLUTION project partners (above) and short overview on the project (below). REBIOLUTION aims to develop bio-based and biodegradable polyesters and blends for mulch films and food paper packaging.

MAGNO EU Project: Conquering New Strategies To Prevent And Reduce Packaging Pollution

A. Pita-Milleiro[1*], A. I. Martín-Perales[1], J. M. Medianero-Martín[1], J. F. Gutiérrez-Antúnez[1], I. Fernández-Pacheco[1], L. Acevedo[1]
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Abstract:
The Horizon Europe MAGNO project (ID: 101135258) aims to increase the efficiency and sustainability of the packaging sector to boost food systems and advance the transition to a circular economy in the European Union. MAGNO will promote the adoption of solutions to effectively reduce the impact of plastic food packaging pollution in ecosystems (soil, water, air). As such, an Ecosystem Digital Twin (eDT) software will be designed to re-create different situations within the food packaging value chain across Europe. The findings of the study will be utilised to deliver the best strategies and recommendations to a vast array of actors in the food system (via consortium partners) that will allow the initiative to expand its scope and form valuable links with ongoing international activities, packaging strategies, and assess their implications for functional and environmental impacts.

Keywords: Circular economy; Food packaging; Plastic packaging; Digital twin; Value chain modelling; Sustainability; Plastics.

STOPP Project: Strategies to Prevent and Reduce Plas-tic Packaging Pollution from the Food System

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Abstract:
STOPP (Strategies to Prevent and Reduce Plastic Packaging Pollution from the Food System) is a Horizon Europe project that aims to drastically reduce the environmental impacts of plastic food packaging by transforming the entire packaging value chain. STOPP adopts a systemic 5Rs approach: Refuse, Reduce, Redesign, Reuse, Recycle to accelerate Europe's transition toward circular, low-pollution food packaging systems. The project integrates scientific research, technological innovation, behavioural insights and multi-actor collaboration to address the root causes of plastic leakage and to support the implementation of EU priorities including the EU Green Deal, the Circular Economy Action Plan, the Packaging and Packaging Waste Regulation (PPWR) and the Zero Pollution ambition.

By the end of the project, STOPP will deliver validated reuse and recycling solutions, evidence-based eco-design guidance, environmental impact data, policy recommendations and tools that support industry, municipalities and policymakers in transitioning towards safe, circular, and scalable food-packaging systems.

PHAntastic project: Sustainable Biodegradable PHA-Based Materials for Circular and Environmentally Friendly Agriculture

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Abstract:
The increasing use of conventional plastics in agriculture has generated significant environmental challenges, including soil contamination, microplastic accumulation and complex waste management at the end of product life (Ramanayaka et al., 2024). In response to these challenges, the PHAntastic project focuses on the development of innovative and sustainable solutions based on polyhydroxyalkanoates (PHAs), a family of biodegradable and bio-based polymers (Siddiqui and Bansal, 2017).
PHAntastic aims to design, produce and validate biodegradable agricultural products, such as mulch films and growth foams, that integrate bioactive compounds including biostimulants, natural fertilizers and plant protection agents. These multifunctional materials are designed to enhance crop performance while reducing the reliance on conventional agrochemicals and fossil-based plastics.
The project follows a circular economy approach, addressing the entire value chain from raw material sourcing to end-of-life biodegradation in soil. Special attention is given to material performance, processability, controlled release of active compounds and environmental impact. The developed solutions are demonstrated and validated under real agricultural conditions in different European regions.
From a technological centre perspective, PHAntastic contributes to bridging the gap between research and industry by supporting the development, validation and upscaling of sustainable plastic alternatives. The project highlights how innovation in biodegradable materials can support more resilient, efficient and environmentally friendly agricultural systems.

Keywords: Biodegradable plastics; polyhydroxyalkanoates (PHA); sustainable agriculture; circular economy; bio-based materials; mulch films; agricultural innovation.

Figure 1: Conceptual scheme of the PHAntastic approach, illustrating the development of PHA-based biodegradable agricultural products incorporating bioactive compounds and their integration into a circular agricultural system..

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Vine-Derived Bioactives as Encapsulated Biopesticides for Sustainable Viticulture

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[2]LABBELS-Associate Laboratory in Biotechnology and Bioengineering and Microelectromechanical Systems, University of Minho, Braga, Guimarães, Portugal

Abstract:
The transition toward sustainable viticulture requires innovative plant protection strategies capable of reducing synthetic pesticide and fertilizer inputs while preserving grape yield and crop quality. In this context, vine-derived bioactive compounds represent a promising yet underexplored resource for the development of eco-friendly biopesticides fully aligned with circular agriculture principles.
This work presents recent advances of the European project VINNY, focusing in the extraction, identification, and functional validation of bioactive compounds obtained from vine by-products, including pruning residues, leaves, and grape pomace. Green extraction methodologies were employed to recover phenolic compounds, stilbenes, flavonoids, and other secondary metabolites known for their antimicrobial and antifungal properties. Chemical characterization using advanced analytical techniques enabled the identification of key bioactive fractions associated with strong inhibitory activity against major grapevine pathogens.
In vitro assays demonstrated significant antifungal effects against economically relevant pathogens responsible for trunk diseases and grey mold, highlighting the intrinsic defensive potential of vine secondary metabolites. To enhance field applicability, selected bioactive fractions were encapsulated within biodegradable polymeric matrices designed for controlled release. Encapsulation improved molecular stability, protected oxidation-sensitive compounds, and enabled sustained release under vineyard-relevant environmental conditions.
The integration of vine-derived bioactives into controlled delivery systems represents a circular and locally sourced approach to plant protection, reducing reliance on synthetic fungicides while valorising viticulture residues. These findings support the development of next-generation biopesticides tailored for sustainable viticulture and aligned with European strategies for pesticide reduction and climate-resilient agriculture.

Keywords: vines, bioactives, biopesticides, nanoencapsulation, VINNY, viticulture

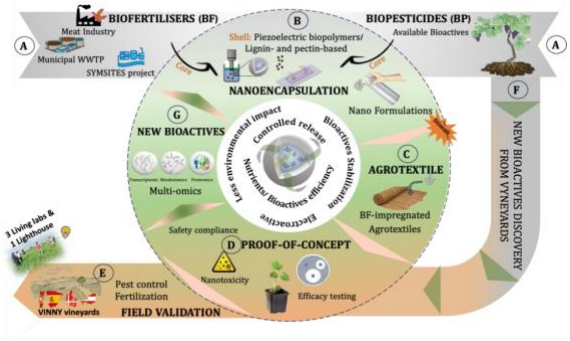

Figure 1: Figure illustrating the overall VINNY project layout, focusing on the mains objetives.

BioBIVE project

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Abstract: Today, the European Union seeks to safeguard biodiversity, ecosystems, and human health while advancing towards a greener and more resilient future. In this context, modern agriculture faces the challenge of reducing its dependence on synthetic chemicals and fossil-based materials, while identifying more sustainable and environmentally friendly alternatives. Two key strategies are emerging: (i) the use of alternative substances and (ii) the development of bio-based materials, both of which can enhance productivity, lower environmental impacts, and optimise the use of resources such as water.

The BioBIVE project proposes an innovative approach centred on the development of bio-based and bioactive delivery systems to control plant pathogens in a range of horticultural crops, while reducing the use of fossil-based materials and pesticides and minimising the overall environmental footprint. Three complementary delivery platforms will be developed and optimised: functionalised biochar systems, biodegradable mulch films, and sprayable mulch films.

Biochar-based systems will be designed as soil-improving materials enriched with antifungal bioactive agents, either directly incorporated or encapsulated, and optimised in terms of feedstock, production parameters, particle size, and functionalisation. These systems will enable controlled release of bioactive substances while ensuring material safety and agronomic performance.

In parallel, biodegradable mulch films based on polyesters, and their blends, will be developed in compliance with UNE-EN 17033, integrating bioactive compounds (free or encapsulated) into the polymeric matrix to provide both mulching and biocidal functions, while guaranteeing adequate mechanical, barrier, optical, and biodegradation properties at industrial scale.

In addition, BioBIVE will advance sprayable mulch films formed directly in the field from aqueous formulations of natural polysaccharides. These coatings will incorporate plasticisers, fibres, fillers, and bioactive agents to ensure mechanical stability, nutrient delivery, effective mulching performance, and controlled release of biocidal agents. Selected formulations will be validated from laboratory to pilot scale and applied under real cultivation conditions.

The effectiveness of the proposed systems will be validated through real-life case studies at TRL 5–6, focusing on three highly relevant European crops (tomatoes, carrots, and strawberries) selected based on key socio-economic criteria. BioBIVE will be aligned with the European Commission's Safe and Sustainable by Design (SSbD) framework to ensure the safety and sustainability of the developed bio-based materials.

Overall, the BioBIVE project represents a significant opportunity to promote more sustainable agriculture in Europe. It brings together a multidisciplinary consortium comprising materials engineers, computer scientists, chemists, biopolymer experts, biotechnologists, biomass specialists, agricultural engineers, agronomists, farmers, and economists to address the challenges outlined in the HORIZON-CL4-2023-RESILIENCE-01-34 call: Advanced (nano- and bio-based) materials for Sustainable Agriculture (RIA). Due to its scope and complexity, the project requires a European-level approach, as its objectives cannot be achieved by a single research centre, company, or country alone.

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ANIPH: Sustainable Production of Bio-Based and Biodegradable PHAs from Agro-Industrial Waste Streams

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Abstract:
The transition towards a more sustainable and circular plastics industry requires the development of bio-based and biodegradable materials produced from renewable and low-impact resources. The ANIPH project addresses this challenge by focusing on the production of polyhydroxyalkanoates (PHAs), a family of biodegradable polymers, using agro-industrial waste streams as raw materials.
ANIPH aims to valorise organic waste and by-products from the agri-food sector through biotechnological processes, converting them into high added-value biopolymers. This approach contributes to reducing waste generation, lowering dependence on fossil resources and promoting circular economy principles within the bioeconomy framework.
The project covers the entire value chain, from feedstock selection and fermentation processes to polymer recovery, characterisation and validation for industrial applications. Special emphasis is placed on improving process efficiency, material quality and environmental performance through a life cycle perspective.
From the point of view of a technological centre, ANIPH plays a key role in supporting the transfer of bio-based innovations to industry. By developing scalable and economically viable solutions, the project helps companies integrate sustainable materials into their products while meeting environmental and regulatory expectations.
ANIPH demonstrates how waste-based biopolymer production can contribute to a more resilient, resource-efficient and sustainable plastics value chain.

Keywords: Polyhydroxyalkanoates (PHA); bio-based plastics; biodegradable polymers; agro-industrial waste; circular bioeconomy; sustainable materials; industrial biotechnology.

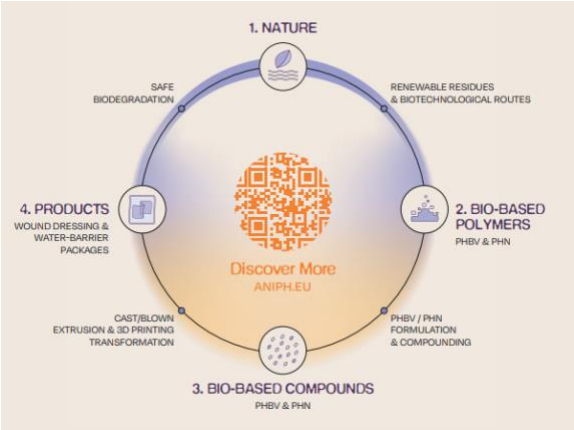

Figure 1: Schematic overview of the ANIPH concept, showing the conversion of agro-industrial waste streams into bio-based and biodegradable PHAs within a circular bioeconomy model.

References:

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Introduction of MAGICBIOMAT

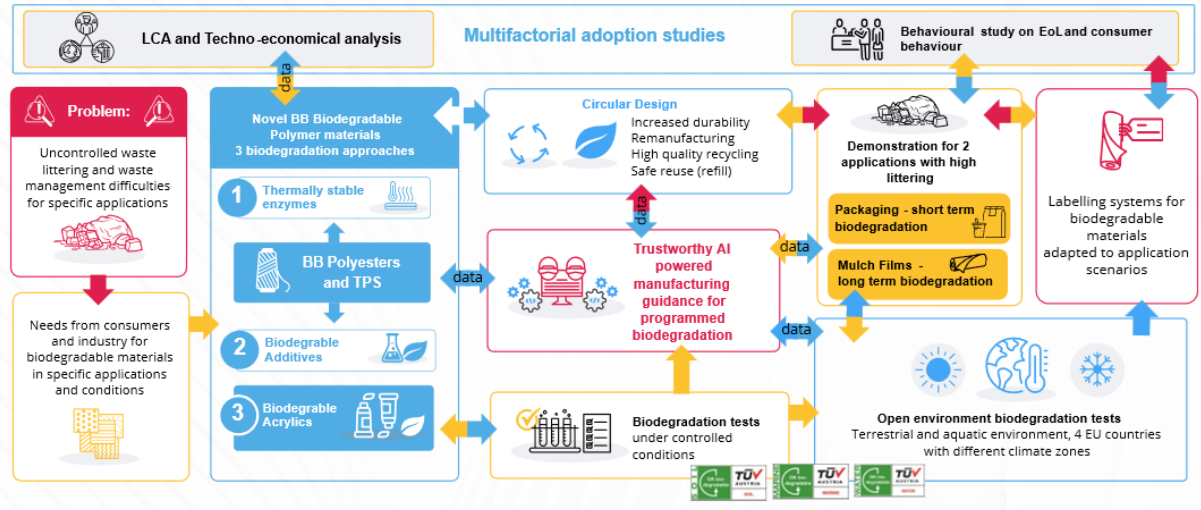
Yuanyuan Chen
Technological University of the Shannon (TUS), PRISM Research Institute, Athlone, Ireland

Abstract:
Plastic pollution remains a critical global challenge, exacerbated by the limited real-world biodegradability of many bio-based plastics. Although materials such as polylactic acid (PLA) are often classified as biodegradable, their degradation is typically restricted to controlled industrial conditions and does not occur efficiently in open environments such as soil, freshwater, or marine systems. This mismatch between material design and environmental performance contributes to persistent plastic accumulation and microplastic formation.
The Horizon Europe project MAGICBIOMAT addresses this challenge by developing a new generation of bio-based materials with programmed biodegradability, designed to degrade predictably under specific real-world environmental conditions. The project integrates polymer science, environmental testing, and artificial intelligence (AI) to create a manufacturing guiding tool that links material composition, processing parameters, and end-of-life scenarios. This AI-driven platform enables the design of materials with tailored lifetimes and degradation pathways, based on both experimental and open-access datasets .
MAGICBIOMAT focuses on two high-impact applications with significant littering potential: agricultural mulching films and plastic-coated paper packaging. These materials will be developed and validated across diverse European climates and environmental compartments, including soil, freshwater, and marine ecosystems, to ensure effective biodegradation under realistic conditions . In parallel, the project adopts a circular design approach by enhancing material durability during use while enabling recycling, remanufacturing, and controlled degradation at end-of-life .

Beyond material innovation, MAGICBIOMAT incorporates behavioural and socio-economic studies to promote user acceptance and responsible disposal through interactive labelling strategies. By combining advanced polymer design, AI-guided manufacturing, and environmental validation, the project aims to bridge the gap between laboratory

and real-world performance, contributing to the transition towards a circular and sustainable bioeconomy.

Keywords: polylactic acid, biodegradation, biodegradable plastics, enzymatic degradation, polymer additives, sustainable polymers



Managing research data for sustainable exploitation: accessibility, sustainability, and IP protection

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Abstract:
This contribution explores the relation between data accessibility, dataset sustainability, and intellectual property (IP) management as key cross-cutting dimensions in contemporary research and innovation (R&I) projects, including low-TRL, collaborative environments. As European-funded initiatives increasingly generate high-value datasets, digital tools, and co-created knowledge assets, the need to balance openness with appropriate forms of protection becomes both more complex and more strategic.

Open science policies promote the wide dissemination and reuse of research outputs in line with FAIR (Findable, Accessible, Interoperable, Reusable) principles, fostering transparency, reproducibility, and innovation uptake. However, the growing emphasis on data sharing does not eliminate the need for safeguarding the underlying assets, especially where datasets and digital assets represent significant investments and form the basis for future exploitation pathways. In this context, unmanaged openness may expose projects to risks such as loss of competitive advantage, unintended commercial use, or insufficient recognition of contributors.

The presentation examines how different IP mechanisms can support the responsible management of research data. Particular attention will be given to database protection regimes in the European framework, including copyright and the sui generis right. These instruments can enable controlled access, clarify conditions for reuse, and preserve the value of datasets while remaining consistent with open science principles.

Ultimately, the contribution argues that effective IP management should not be seen as a barrier to openness, but rather as an enabling framework for sustainable exploitation, responsible data sharing, and long-term impact.

Keywords: intellectual property (IP), research data management, open science, database protection, data governance.

Figure 1: The Figure illustrates the tension between open science and IP protection in research data management, highlighting the need to reconcile accessibility, controlled reuse, and sustainable exploitation of high-value datasets within collaborative R&I contexts.

Bioactive PHA-Based Polymers for Soil Health and Sustainable Agriculture in Europe

Suzan Naz Uzel
REVOLVE Media, Belgium

Abstract:
European agriculture faces increasing pressure to maintain productivity while reducing environmental impacts linked to synthetic agrochemicals and persistent plastic materials. Conventional agricultural plastics, along with some biodegradable alternatives, often fail to fully degrade under natural soil conditions, leading to long-term microplastic accumulation, soil degradation, and ecosystem disruption.

The PHAntastic project addresses these challenges through the development of innovative bioactive materials based on polyhydroxyalkanoates (PHAs), a class of fully bio-based and biodegradable polymers produced via microbial fermentation. These materials are designed as multifunctional agricultural systems, including mulch films, growth foams, and controlled-release platforms for fertilisers and plant protection agents. By embedding nutrients, amino acids, and beneficial microorganisms, they enable gradual release of active compounds during in situ biodegradation.

Field trials conducted across diverse European climatic regions demonstrate that PHA-based materials undergo rapid biodegradation, initiating within weeks and achieving substantial mass loss within a single growing season. Importantly, they do not generate persistent microplastic residues, as they are metabolised by soil microorganisms and reintegrated into natural biogeochemical cycles.

In addition to their degradation performance, these materials contribute positively to soil health. Their breakdown provides a carbon source for soil microbiota, enhancing microbial activity and supporting nutrient cycling. Simultaneously, controlled nutrient delivery improves fertiliser efficiency and reduces nutrient leaching and environmental losses.

Despite these advances, regulatory challenges remain, including limitations of existing standards (e.g., EN 17033), lack of harmonised definitions for soil biodegradability, and insufficient methodologies for assessing microplastic residues in soil. Overall, PHAntastic demonstrates a scalable, science-based solution that aligns with European sustainability objectives, supporting the transition toward more resilient and environmentally responsible agricultural systems.

Keywords: polyhydroxyalkanoates (PHA), biodegradable polymers, soil health, sustainable agriculture, controlled-release systems, microplastics.

Maximising EU Projects' Synergies and Policy Impacts

Salima Abu Jeriban
Research Executive Agency, European Commission- Brussels, Belgium

Abstract:
This presentation explores strategies to maximise synergies and policy impacts of EU-funded projects focused on safe, sustainable bio-based polymers and circular value chains. It highlights recent and upcoming EU policies and showcases selected projects.

Practical guidance is provided on engaging policymakers and on funding opportunities under Horizon Europe's Cluster 6.

Joint EU Project Workshop: Safe and Sustainable Bio-Based Polymers: From Design to End-of-Life in Circular Value Chains.

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Abstract:
The transition towards safer and more sustainable materials requires embedding safety and sustainability considerations at the earliest stages of innovation, moving beyond regulatory compliance. The European Commission's Safe and Sustainable by Design (SSbD) framework provides a structured approach to guide this transition by integrating life cycle thinking across hazard, safety, environmental, social and economic assessments.
This presentation introduces the SSbD framework as applied across European R&I projects (PHAntastic & ViSS) developing bio-based polymer solutions, including polyhydroxyalkanoate (PHA)-based systems for agricultural applications and high performance food packaging. Building on the JRC SSbD framework, these projects share a common assessment structure integrating hazard, human health and safety, environmental safety, and environmental impact with an extended socio-economic dimension incorporating Social Life Cycle Assessment (S-LCA) and Life Cycle Costing (LCC).
Within this integrated approach, S-LCA systematically evaluates social impacts throughout the entire life cycle—from raw material extraction to end-of-life—across diverse stakeholder groups (workers, local communities, value chain actors, and society). A foundational step is social hotspot screening using databases such as PSILCA across relevant industrial sectors, identifying which value chain stages and stakeholder groups carry the highest social risk. This screening prioritizes areas requiring in-depth research, including primary data collection and secondary source reviews, with particular attention to geographical variations in risks and regulatory contexts across international production regions.
This integrated approach ensures that innovation decisions are guided by holistic and transparent sustainability evidence, from material design through commercialisation, while identifying critical social risk hotspots and their implications for sustainable design choices. The presentation outlines methodological foundations, key implementation challenges, and project-specific findings on environmental, social, and economic assessments across different value chains and applications.

Keywords: biopolymers, Safe and Sustainable by Design (SSbD), Social Life Cycle Assessment (S-LCA), social hotspot screening, life cycle assessment

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LCA supporting sustainable design development

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Abstract:
Safe and Sustainable by Design (SSbD) framework established by European Comission (Caldeira et al. 2022) promotes the systematic consideration of safety and sustainability from early on in the material development and integrating it closely to design process. Life cycle assessment (LCA) methodology plays a central role in evaluating environmental sustainability in this framework.
LCA is an ISO standardised methodology (ISO 2006, 2020) for assessing potential environmental impacts across the entire life cycle of a product, from raw material acquisition to end-of-life treatment. It provides results across several impact categories covering e.g. climate impact, pollution, toxicity, and resource depletion.
The tiered LCA approach suggested by SSbD framework enables the application of LCA at all innovation maturity levels. Regardles at which innovation maturity level LCA is conducted, the results can be used to identify emission hotspots and provide suggestions for re-design measures to improve the sustainability. Importantly, identifying the most critical sustainability threats at early-stage of design helps avoid extensive redesign constraints that are more likely to arise later in the design process and maturity level.
The Horizon funded project ViSS* aims to create a safe, sustainable, fully functional and highly replicable circular value chain of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) bioplastic for high performance food packaging, utilizing food industrial residues as carbon and nutrient sources for PHBV production.
The technology development of ViSS follows SSbD framework. Along the project the environmental sustainability of PHBV production is assessed three times; at the lab scale production desing, at demo scale production design and finally at the end of the project. LCA results are used to guide sustainability-driven redesign of the ViSS innovation.
Based on the hotspot analysis of the first LCA iteration using mass balance based lab scale data, the process chain was redesigned to eliminate chemically intensive separation step, and the need for chemical recycling within the process chain was identified. Between the first and second LCA iteration, the potential environmental impacts decreased by 40-90% despite the inclusion of electricity consumption in the later assessment. The exception was ionisating radiation, which increased due to assumption of an electricity mix containing nuclear energy.
The results from the ViSS LCA iterations demonstrate that substituting virgin materials with industrial waste does not inherently ensure sustainability. Comprehensive life cycle assessment are therefore essential to guide sustainable product design and to verify progress towards sustainability targets. The application of the SSbD framework enables early identification of emission hotspots and supports timely redesign when changes are still technically and economically feasible.

Keywords: SSbD, LCA, environmental impacts, re-desing, biopolymers, PHA, PHBV.

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*https://viss-project.eu/

Stimuli-responsive PLLA nanovesicles for controlled delivery of grape cane extracts in sustainable viticulture

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Abstract:
Vine pruning generates large quantities of grape cane biomass that is largely underutilized, despite being a rich source of bioactive polyphenolic compounds[1]. In the context of sustainable viticulture, valorizing these by-products as natural biopesticides (BPs) represents a promising alternative to synthetic agrochemicals. This work presents the development of biodegradable poly(L-lactic acid) (PLLA) nanovesicles for the encapsulation and controlled delivery of *Vitis vinifera* grape cane extracts, targeting key phytopathogens responsible for significant economic losses in viticulture.

PLLA nanovesicles were formulated incorporating a grape cane extract at three loading concentrations (1, 5, and 10 wt%), and their physicochemical properties were characterized by dynamic light scattering (DLS) and scanning electron microscopy (SEM). Colloidal stability was monitored at different pH values (5.5, 6.5, and 7.5) in aqueous media, covering the range of conditions typically found in field applications and plant surface environments.

The system also exploits the intrinsic piezoelectric properties of PLLA as a stimuli-responsive release mechanism[2]. Mechanical actuation via a vibrating plate at 1 Hz was investigated as a trigger to promote active, on-demand release of the encapsulated bioactives, and results were compared against passive release profiles to quantify the piezoelectric contribution. Beyond release modulation, surface charge generation arising from piezoelectric stimulation provides an additional, synergistic antimicrobial effect. The biological performance of the nanovesicles was assessed through antifungal assays against *Botrytis cinerea* and *Penicillium spp*., and antibacterial assays against *Xylophilus ampelinus* and *Agrobacterium tumefaciens*, complemented by phytotoxicity evaluation to ensure crop safety.

This work lies at the interface of smart polymer systems and circular bioeconomy, contributing to the development of next-generation crop protection strategies that valorize agricultural waste streams.

Keywords: PLLA nanovesicles; piezoelectric polymers; stimuli-responsive release; grape cane extract; biopesticides; sustainable viticulture

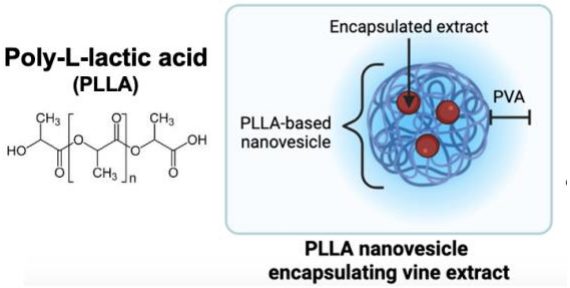

Figure 1: Schematic representation of PLLA-based nanovesicles stabilized with PVA and encapsulating *Vitis vinifera* grape cane extract for stimuli-responsive biopesticidal applications in sustainable viticulture.

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Biobased plastics compounding: from lab to pilot scale

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Abstract: The PHAntastic project aims to develop sustainable alternatives to current fossil-based plastics for use in agriculture. In this respect, the project focuses on the application of poly-hydroxyalkanoates (PHAs) as the main material for their polymeric matrix. PHAs are natural polymers with bio-based and biodegradable properties (Liang, Cha and Xie, 2024), (Li, Yang and Loh, 2016). These properties are key advantages in addressing current environmental challenges, including soil efficiency loss, crop growth issues, water usage and pollution (Campanale *et al.*, 2024), (Smyth *et al.*, 2025).

The PHAntastic project needs to develop mulch films. This type of agriculture product is processed by blown-film extrusion. Blends of PHAs are also a necessity (Le Delliou *et al.*, 2024), with the PHBV internally produced in PHAntastic (García-Chumillas *et al.*, 2026) being a key constituent of the mulch film product. In this respect, the current work will summarise the various challenges that have been addressed during the project's first 18 months. These included facing material shortages and opting for alternative technologies for material screening that will be key in future stages of the project. With this material development, industrial technologies will be used for the upscale of the product.

Keywords: film processing, mulch film, agriculture, PHA, PHA characterization, microcompounding, cast-film extrusion, blown-film extrusion.

Figure 1: Example of the blown-film process for the production of mulch film.

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Ecosystem Digital Twin for Circular Packaging Solutions: From Manufacturing to End of Life

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Abstract:
Europe's transition to climate neutrality and circularity is tightly linked to the way we produce, use, and manage materials. Yet, packaging remains a clear symbol of today's throwaway economy: packaging accounts for 44% of plastics use in Europe[1], while recycling rates for plastic packaging remain below the levels required to meet the EU target of 55% recycled plastic packaging by 2030[2]. At the same time, packaging must protect food quality and safety, in a context where a large share of food is lost or wasted along supply chains[3]. This creates a dual challenge: packaging must be optimised to reduce material demand and pollution, while maintaining (or improving) food preservation performance and ensuring safe, compliant food contact materials.

To address this challenge, an Ecosystem Digital Twin (eDT) is being developed within the EU-funded MAGNO project. The eDT is a modular, Python-based computational framework designed to evaluate the environmental and functional performance of packaging systems at a European scale (see Fig. 1).

This contribution presents the architecture and modelling approach of the eDT. The framework represents the end-to-end packaging value chain, integrating packaging design and manufacturing with GLEC-compliant[4] logistics, consumer behaviour, and end-of-life management. A central component of the framework is its hybrid data integration strategy, which combines industrial datasets and literature reviews with parameter information automatically extracted from scientific publications using a tailored large language model. Across the value chain, the model performs detailed mass and energy balances based on engineering formulas and empirical data to estimate key sustainability indicators, including greenhouse gas emissions, energy demand, and microplastic migration to food and the environment. To capture interactions between packaging design and food preservation, the framework also incorporates shelf-life estimation.

In this way, the eDT enables scenario-based comparisons of alternative packaging strategies by Within the MAGNO project, the framework will be applied to evaluate new circular plastic food packaging strategies and assess their implications for functional and environmental impacts.

Keywords: Circular economy; Food packaging; Plastic packaging; Digital twin; Value chain modelling; Sustainability; Plastics.

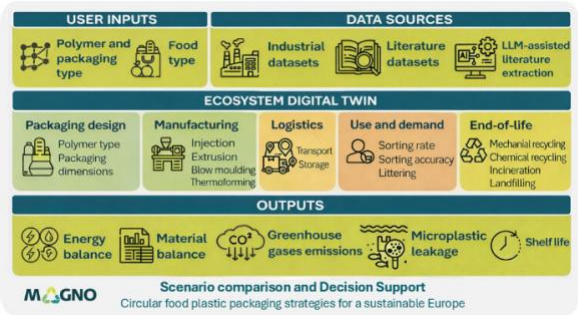

Figure 1: Conceptual architecture of the Ecosystem Digital Twin (eDT) for modelling the plastic food packaging value chain in the MAGNO project.

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Bio-based and biodegradable aliphatic-aromatic polyesters and blends for mulch films

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Abstract:
Mulch films (currently mostly made from conventional plastics like PE) are used to improve crop growth, save water, and reduce the need for chemicals. However, there is a risk of residual mulch film being left in the field during farming activities, especially when the film is too thin and hard to recover. Therefore, a bio-based and biodegradable alternative can contribute to less contamination of the environment with persistent plastic fragments.
The Rebiolution project is a EU funded project to develop a fully bio-based and biodegradable aliphatic-aromatic polyester based on FDCA and blends thereof, which can be used for food paper packaging or the production of mulch films. The project involves nine partners from across the European Union and covers the whole process from monomer production, over polymerization & blending to trial production and EOL scenarios, which offers an impressive insight into the process to develop new solutions for a sustainable agriculture.

Keywords: polyester, biobased, biodegradable, composting, blends, PLA, mulch film

Figure 1: Film blowing process of an FDCA-based polyester blend that was developed within the Rebiolution project to demonstrate feasibility of mulch film production at an early stage.

Polymers / Composites / 3Bs Materials Session III: Biomaterials and Drug delivery / Food and Agriculture application

Innovative Approaches to Bio-Based Membrane Design and Development

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Abstract:
The development of advanced biomaterials for transdermal drug delivery is a rapidly expanding field, particularly in chronic wound healing, skin regeneration, and controlled delivery of active pharmaceutical ingredients (APIs). Although biopolymers are widely studied, their full biomedical potential remains underexploited due to limited antimicrobial activity, insufficient control over drug release, and poor solubility in environmentally friendly solvents. Biopolymers such as bacterial cellulose (BC) and chitin–glucan complex (CGC) present additional processing challenges because of their limited solubility in green media.

Green solvents, namely ionic liquids (ILs) and deep eutectic systems (DES), have emerged as promising alternatives to conventional solvents. ILs are fully ionic compounds with tunable physicochemical properties, and third-generation ILs can incorporate bioactive functionalities directly into their structure. DES, formed by hydrogen bond donors and acceptors, can significantly enhance solubility, permeability, and bioavailability of poorly soluble APIs, especially when designed as therapeutic deep eutectic systems (THEDES).

This work integrates bio-based material design with ILs and DES to develop innovative transdermal drug delivery platforms.

In the first study, dual-functional ILs based on benzethonium and didecyldimethylammonium cations combined with short-chain carboxylic acids were synthesized and used to dissolve CGC up to 15 wt.%. Biomaterials were produced via phase inversion, yielding gels and films with tunable structures and IL content. In the second study, cellulose extracted from banana pseudostem was processed using the same ILs. The resulting films exhibited enhanced porosity, water uptake, hydrophilicity, and strong antibacterial activity against *Staphylococcus aureus*, highlighting their suitability for wound healing applications [1]. The third study developed bilayer fiber-based wound dressings combining biopolymers and bioactive APIs. A chitosan/DES layer (choline chloride:lactic acid and lactic acid:glucose:water) was prepared by solvent evaporation, while a PLA/lidocaine layer was fabricated via electrospinning (Figure 1). This bilayer design enables multifunctional performance, integrating structural support, antibacterial properties, and controlled drug release.

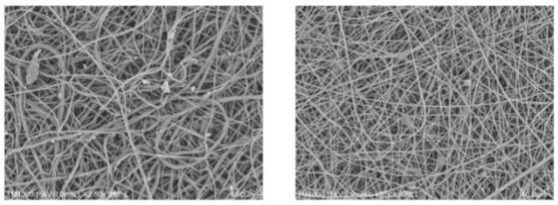

Figure 1. PLA with lidocaine fiber based membranes.

By combining green solvents, functional biopolymers, and advanced processing techniques such as electrospinning, this work paves the way for the development of sustainable, multifunctional membranes—aligning with the vision of *Greener Pathways for Bio-Based Membrane Design and Development* and offering innovative solutions for the next-generation of transdermal drug delivery systems.

Keywords: Biopolymers; Ionic Liquids; Deep Eutectic Systems;

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Innovation in Circular Packaging: Establishing a Recycling Chain for Yogurt Cups

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Abstract:
The transition to circular economy models has become a key pillar of European and national sustainability policies, aiming to reduce dependence on virgin resources, minimize waste generation, and promote the reintegration of materials into production cycles. In the food packaging sector, this challenge is particularly relevant due to the high volume of waste generated and the heterogeneity of the materials used. In light of the new EU regulatory framework, the Packaging and Packaging Waste Regulation (PPWR) came into force earlier this year — which requires all packaging placed on the EU market to be recyclable by 2030 and establishes increasing minimum recycled-content requirements for plastic packaging — the need for viable recycling routes for hard-to-recycle materials becomes especially urgent. Among these, yogurt cups made of polystyrene (PS) represent a significant waste stream that, until now, has lacked an effective valorization course. Despite their widespread use, these items are rarely subjected to dedicated selective collection or industrial processes that enable their recycling and subsequent reincorporation into new products. As a result, they are frequently diverted to low-value end-of-life solutions, perpetuating resource loss and hindering the advancement of circularity in this specific packaging segment.
The ReciCup project aims to fill this gap by proposing the creation and validation of a complete and dedicated value chain for post-consumer yogurt cups. The project develops experimental in-store collection models, analyzes consumer behavior, investigates recycling processes, and evaluates the feasibility of incorporating these recycled materials into the production of new yogurt cups, ensuring that performance and food safety requirements are met. In parallel, the project monitors the environmental, social, and economic impacts associated with the tested processes.
The project is still ongoing, but within just three months, this dedicated collection point enabled the recovery of half a tonne of material, demonstrating strong customer engagement.
Within this framework, the present study focuses specifically on the environmental and economic feasibility of establishing a recycling chain for PS yogurt cups and incorporating the recycled material into the production of new cups. This assessment was carried out through Life Cycle Assessment (LCA) and Life Cycle Costing (LCC), . The LCA and LCC followed ISO 14040:14044 standards, using the ReCiPe Midpoint (Hierarchist) method for impact assessment. The LCC considered both internal and external costs, with external costs calculated based on the monetized conversion factors from the Environmental Prices Handbook 2024. The system boundaries were defined as cradle-to-cradle, covering the entire circular loop from waste collection and sorting to recycling, yoghurt cup production, and its return to end-of-life.
By demonstrating the economic and environmental feasibility of a dedicated valorisation route for PS, waste streams that have until now lacked a circular destination, the ReciCup project aims to lay the groundwork for future replicable models of plastic collection and recycling, enabling their reintegration into the production of new food packaging containing recycled content. These efforts are expected to strengthen circularity in the food packaging sector and support the transition toward more efficient waste management systems aligned with European targets for waste reduction and recycled-content incorporation.

Keywords: circular economy, food packaging valorization, yogurt cups, sustainability, polystyrene recycling

Figure 1: Figure illustrating an example of the project's yogurt cups.

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3Bs Materials Tech 2026: AGRO4AGRI Project Workshop: Pathways to Impact in Sustainable Agrochemistry: A 360° Innovation Approach from Lab to Market

Nanocellulose-Based Advanced Fertilizer Systems for Controlled Nutrient Release in Sustainable Agriculture

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Abstract:
Nanocellulose is a biodegradable and renewable material obtained from lignocellulosic biomass that has gained significant attention as a potential matrix for controlled-release fertilizers (CRFs). Owing to its large specific surface area, remarkable water-holding capacity, and versatility for chemical modification, nanocellulose represents an eco-friendly substitute for traditional synthetic or mineral-based CRF carriers[1].
In this context, nanofibrillated cellulose (NFC) can be produced from biomass using sustainable methods such as pulping followed by mechanical fibrillation. Through targeted surface modifications, e.g. selective oxidation and the introduction of functional groups, the charge density of NFC can be tailored to facilitate the encapsulation of key macronutrients, including nitrogen, phosphorus, and potassium (NPK). Nutrient release can then be regulated via mechanisms like ion exchange interactions and crosslinked network formation.
These engineered systems enable a gradual and prolonged delivery of nutrients, reducing losses through leaching, improving nutrient uptake efficiency, and promoting better soil quality. Overall, nanocellulose-based fertilizer carriers offer a promising strategy to enhance agricultural productivity while mitigating environmental impacts, thereby contributing to more sustainable farming practices.

Keywords: Celulose nanofiber, Biorrefinery, biomass Chemical modification, Controlled-release fertilizers, NPK, sustainable agriculture.

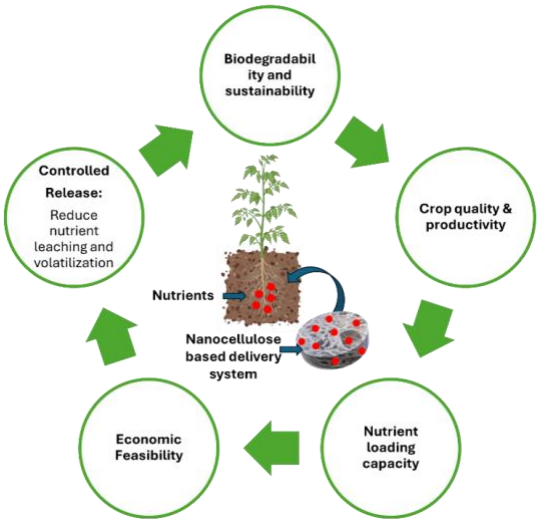

Figure 1: Diagram of a nanocellulose-based controlled-release fertilizer delivery system and its key benefits. The illustration shows how nutrients are gradually released into the root zone, reducing losses through leaching and volatilization. Surrounding the central image the main advantages are depicted: biodegradability and sustainability, improved crop quality and productivity, high nutrient-loading capacity, and economic feasibility.

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Engineering Forest-derived Biochar as a Nanoplatform for Sustainable Nutrient Delivery in Plants

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Abstract:
Forest biomass is a renewable resource with significant potential for sustainable valorization and production of high-value biomaterials. In this sense, gorse (*Ulex europaeus*), an invasive shrub native to Western and Southwestern Europe, regenerates rapidly after fires due to its highly flammable plant, presenting a major challenge for forest management. This problem can be transformed into a useful resource by processing the gorse residues through technological processes.

One example of this is the production of bio-based nanomaterials, such as biochar, through pyrolysis process. Gorse forest residues, after pre-treatment and pelletization, can be used as feedstock for the production of biochar. This thermochemical process decomposes biomass under an inert atmosphere (nitrogen atmosphere), preventing combustion, and yields biochar, bio-oil, and biogas. The produced biochar is an ideal candidate for designing of controlled nutrient delivery systems, which are essential for improving plant nutrition and enhancing fertiliser efficiency. Conventional fertilization methods often lead to nutrient losses through leaching or volatilization, reducing plant uptake and impacting both crop productivity and environmental sustainability. Biomaterial-based carriers, such as engineered biochar, can retain nutrients and release them gradually according to plant demands, minimizing losses and supporting sustainable agricultural practices (Figure 1).

Biochar exhibits high porosity and surface area, making it a nanoplatform capable of hosting and releasing active compounds in a controlled manner. In agriculture, this functionality enables its use as a nutrient nanocarrier, improving fertilizer efficiency and ensuring gradual nutrient availability for plants. The structural properties of the biochar depend on operational parameters such as temperature, heating rate, residence time, feedstock composition, and particle size. The control of these variables is essential to design well-defined porous structure of biochar with high surface characteristics suitable for nutrient delivery applications.

In this work, gorse residues collected from the Saja Nature Reserve (Cantabria, Spain) were used to produce biochar, which was evaluated as a sustainable platform for the controlled delivery of fertilizers in water. Our study was focused on the optimization of pyrolysis process and the evaluation of different impregnation process for conventional fertilizers into the biochar's porous structure. Also, fertilizer release was monitored using stablished analytical methods.

Keywords: biochar, forest biomass, pyrolysis, functional nanomaterial, bio-based nanocarrier, nutrients, advanced agrochemical, sustainable agriculture.

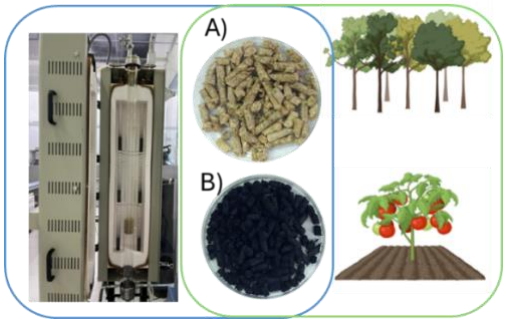

Figure 1: Biochar-based sustainable nanocarrier for nutrient delivery in plants. A) Forestry biomass pellets derived from gorse. B) Biochar obtained by pyrolysis.

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From Lab to Pilot: Process Design and Scale-Up of Wheat Straw Nanocellulose Production for Fertilizer Delivery Systems

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Abstract:
The development of advanced bio-based materials for agriculture requires not only laboratory validation but also robust strategies for industrial translation. Within the AGRO4AGRI project, nanocellulose derived from wheat straw is being developed as a bio-based carrier for controlled-release fertilizers, contributing to improved nutrient use efficiency and reduced environmental impact associated with nutrient losses.

While laboratory-scale development demonstrates material functionality, the transition to pilot scale is critical to assess process feasibility, reproducibility, safety, and scalability. This contribution focuses on the scale-up strategy and pilot plant design for the production of nanofibrillated cellulose from wheat straw.

The process integrates thermo-chemical pretreatment (alkaline pulping) in a rotatory digester, solid–liquid separation, washing, mechanical fibrillation using disc refining technology, bleaching, and final conditioning. Particular attention is given to the challenges associated with scaling lignocellulosic biomass fractionation, including handling of heterogeneous solid feedstocks, solid–liquid separation efficiency, foam formation, and management of alkaline effluents.

The contribution also presents the conceptual process design and development of the Process and Instrumentation Diagram (P&ID), defining equipment configuration, critical process parameters, safety elements (pressure relief, decompression systems), and strategies for solid–liquid handling at pilot scale.

By addressing scale-up from TRL 3–4 to TRL 5–6, this work demonstrates how early integration of engineering design enables the translation of bio-based nanomaterials from laboratory concept to industrially relevant production systems.

Keywords: process scale-up, nanocellulose, wheat straw valorization, pilot plant design.

Figure 1: Figure illustrating the transition from laboratory-scale development of controlled-release fertilizers to scale-up through pilot plant design at SYSPRO.

Stakeholder-aligned pathways to impact and exploitation in sustainable agrochemistry.

Dr. Jolanta Beinaroviča
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Abstract:
Delivering impact from research in sustainable agrochemistry requires more than scientific advances. Successful innovation must address the needs and decision criteria of multiple stakeholder groups, including industry, regulators, farmers, and broader society. This presentation introduces a practical framework for stakeholder aligned exploitation planning that links research activities with evidence generation, value propositions, and engagement strategies.

Using the Horizon Europe project AGRO4AGRI as an illustrative case, the presentation demonstrates how stakeholder priorities can guide the design of data generation plans and the translation of research outputs into meaningful value for different actors along the innovation pathway. The framework highlights how scientific metrics can be reframed as practical outcomes that address real world problems, thereby strengthening the pathway from laboratory research to regulatory approval, commercialisation, and adoption in agricultural systems.

Polymers / Composites 2026 Session III. A: Energy and Environmental Application

The application of polymers and polymer nanocomposites in electrical engineering

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Abstract:
Polymers and their nanocomposites have gained extensive attention since the emergence of nanofillers, which offer large specific interfacial areas. These advantages are not only be observable in controlled materials-science laboratories but are increasingly being realized in high-TRL, industry-relevant applications. Herein, the applications of polymer nanocomposites are discussed in the context of electrical transmission and energy generation, where large-scale deployment enables their exceptional functionalities to be exploited.
Case 1: The use of nanocomposites for enhancing gas barrier performance in sealing materials to mitigate SF_6 emissions. The incorporation of high-aspect-ratio 2D materials substantially increases diffusion tortuosity and exhibits synergistic effects on SF_6 sealing when combining with particular polymers. The enhanced barrier properties of sealing materials facilitate long-term sealing reliability for high-voltage switchgears, enabling potential leak-repair solutions that can significantly reduce environmental impact.
Case 2: The development of compliant electrodes for dielectric elastomer transducers (DETs). Advanced in nanocomposite elastomers, such as the inclusion of conductive nanomaterials to fabricate compliant electrodes. It was found that the conductive nanocomposites can replace traditional carbon grease to be used as high-performance compliant electrode. With selected fabrication methods such as spray coating or printing, conformal compliant electrode can be realized to have significantly enhanced mechanical durability. The development collectively support the creation of robust dielectric elastomer generator systems capable of reliable cyclic energy harvesting.

Keywords: elastomers; nanocomposites; gas barrier; dielectric elastomer generator; compliant electrodes.

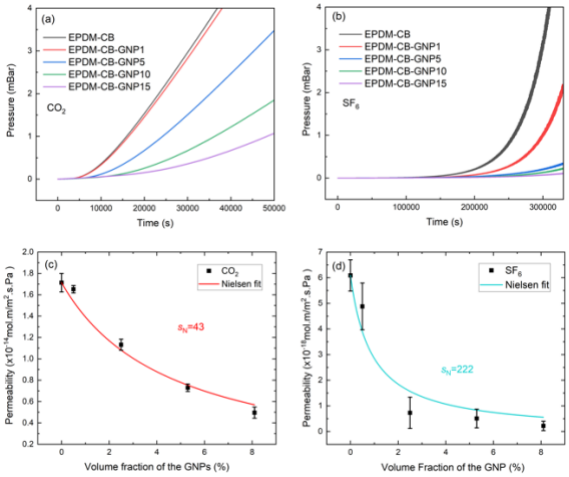

Figure 1. Gas permeability of a EPDM-based nanocomposites to CO_2 and SF_6: (a,b) pressure against time; (c,d) permeability against volume fraction of the 2D materials used.

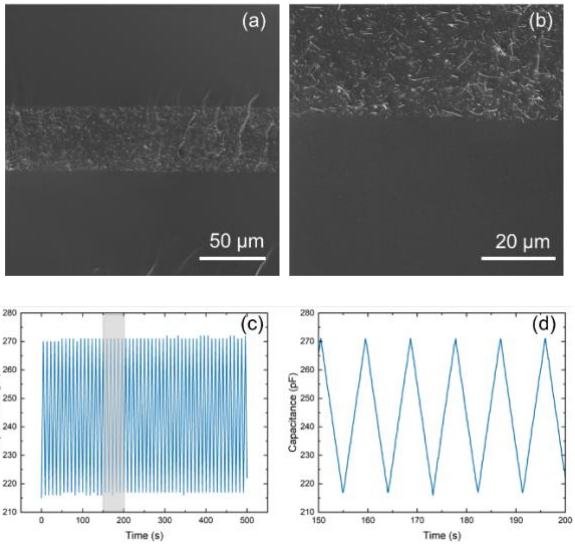

Figure 2. (a,b) microstructure of crossectional area of a DET, showing interfaces between the dielectric elastomer and the compliant electrode; (c,d) Capacitance vs time up to 100% deformation of the materials system.

Environmental and human hazard characterisation of biobased materials and products: the Biouptake case study

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Abstract:
European Union's transition toward a sustainable, circular bioeconomy hinges on developing renewable, recyclable biopolymer composites as alternatives to conventional plastics, leveraging flexible manufacturing processes that combine natural and bio-based synthetic fibres. The Bio-Uptake project advances EU green transition and circularity priorities by developing flexible manufacturing processes for bio-based products in construction, medical, and packaging sectors—already targeting reduced environmental footprints—while introducing a critical pillar: demonstrating the environmental and human health safety of materials, intermediates, and end-products through safe-by-design integration and life cycle assessment data to enable toxic-free, market-ready solutions, as required by EU (. In this context, the present work targeted the environmental and human health hazard characterization of innovative bio-based epoxy resins, fibres, polymers, and intermediate composites, developed within the Bio-Uptake project. Comprehensive ecotoxicity assessments using key freshwater species, together with *in vitro* tests for mutagenicity and skin sensitization, were performed according to international guidelines to support both scientific understanding and the safe, sustainable advancement of bio-based materials.
Overall, the results demonstrated that, although some individual bio-based components (notably carbon and wood fibres) exhibited limited ecotoxicity or cytotoxicity, their incorporation into composite materials markedly reduced or eliminated such responses. The bio-based polymers, composites, and biosheets developed within the Bio-Uptake project showed no evidence of mutagenicity or significant skin sensitization, and only minor, non-lethal effects in sensitive freshwater species. These findings highlight the overall environmental and human safety of the tested bio-based materials and support their sustainable use as safer alternatives to conventional polymers.

Keywords: Safe and sustainable by design, hazard characterization, environmental safety, ecotoxicity, mutagenicity.

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Integration of printed electronics into composites: advances towards smart and sustainable composites

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Abstract:
The increasing demand for sustainable and advanced manufacturing solutions, along with the shift towards more efficient urban mobility, is driving the development of innovative materials that combine structural lightness, intelligent functionality, and low environmental impact[1, 2]. In this context, the integration of printed electronics into more environmentally sustainable composites emerges as a key strategy for both the automotive industry and the development of autonomous, connected, last-mile vehicles. Technologies such as Compositronics enable structural components to be embedded with sensors and communication systems, enhancing energy efficiency, reducing emissions, and enabling advanced functions in transportation systems focused on zero-emission vehicles[3].

This approach integrates electronic circuits directly into composite materials during the lamination process, using recyclable, recycled, or bio-based polymer matrices reinforced with natural or glass fibers. This combination reduces the reliance on petroleum-derived composites, contributing to sustainability. The incorporation of printed electronics provides light, flexible, and cost-effective functionality to the materials while maintaining high mechanical strength. As a result, structural components serve dual purposes: mechanical support and intelligent capabilities. Notable applications developed in this work include capacitive sensors for selective compartment openings and proximity sensors for advanced systems.

The convergence of sustainable composites and printed electronics enables the development of intelligent, lightweight materials aligned with circular economy principles. Their integration into advanced manufacturing and autonomous vehicle systems supports enhanced efficiency, connectivity, and reduced environmental impact.

Keywords: sustainable composites, printed electronics, compositronics, smart mobility

Figure 1:. Autonomous electric car for last-mile delivery modified with sustainable composite car body. New flax car body part includes button panel with capacitive sensors in order to introduce the collection code.

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Longlife of organic sensors dedicated to ammonia monitoring for environmental applications: a two years study

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Abstract:
Monitoring ammonia (NH_3) becomes crucial in environment, energy and health fields. Toxic for human [1], ammonia is also involved in secondary aerosol formation [2]. Moreover, it is emerging as a clean alternative to fossil fuel, playing for example, a key role in the International Maritime Organization Net Zero Framework. Finally, it is a biomarker used in diagnostic tools based on the analysis of exhaled breath [3]. Indeed, a constant effort to develop new ammonia sensors is noticeable in the literature [4]. Among sensitive surfaces found in chimiresistive sensors dedicated to ammonia detection, conductive polymers - and polyaniline in particular - are promising given their high sensitivity, their appreciable specificity, their low-power consumption (working at room temperature) and their easy integration into electronic devices [5]. However, when the stability of the sensors is the bottle-neck of the commercial applications, it is still poorly discussed into the litterature. In this study, the variation of: i) the baseline resistance, ii) the sensitivity and iii) the limit of detection, of different sensitive surfaces based on doped polyaniline and polyurethane are studied over two years. The sensors, based on known formulations [6] are divided into two groups, one undergoing periodical exposure toward ammonia concentration varying from 50 to 1000 ppb at constant relative humidity (50% RH) and the other one undergoing ammonia exposure varying from 50 to 200 ppb, with humidity changing from ~50 to ~15 and from ~15 to ~70% RH (Figure 1). Between the exposures, part of the samples are stored at room temperature in dark air and the other part are stored into a oven at 20°C, 10 mbar and under natural light. The results show that independently of the storage conditions, the addition of polyurethane to polyaniline-based sensors enhances their stability for the two years studied. This period is consistent with the needs from markets linked to environment and energy fields. Finally, the sensing properties are discussed based on the impact of the formulation on the resulting thin-films morphologies.

Keywords: ammonia monitoring, conductive polymers, polyaniline, environmental application, biomedical applications.

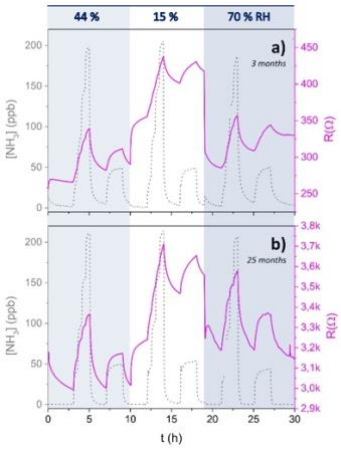

Figure 1: Example of the response of polyaniline-based sensors, toward ammonia under various humidity levels, 3 (a) and 25 (b) months after their fabrication.

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Surface modification of Carbon Nanofibers (CNFs) and their incorporation in polyester coating matrix for enhanced corrosion resistance of galvanized steel

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Abstract:
Carbon nanofibers (CNFs), with diameters of 50-100 nm and lengths of 0.5-100 µm, offer exceptional mechanical, thermal, electrical, and electrochemical properties owing to their high aspect ratio. However, a major challenge in their application is because of their high surface energy and strong van der Waals interactions which cause agglomeration, making uniform dispersion difficult.

In this work, the dispersion of CNFs was optimised using a range of surfactants, including cationic, anionic, and non-ionic surfactants in different concentrations. Non-ionic surfactant, Triton X-100 was found to be the most effective for stable dispersion and the first-ever visualization of Triton X-100 micelles on CNF surfaces was observed. Dispersion stability was confirmed through zeta potential, Surface Tension, pH and Viscosity analysis, while CNF morphology and elemental compositions were examined via TEM, XRD, XRF, SEM, EDS, FTIR and Raman spectroscopy.

The dispersed CNFs were subsequently incorporated into a polyester-based coating system, with optimized formulation ensuring their uniform distribution within the coating matrix. Performance evaluation revealed that CNF incorporated coatings exhibited significantly enhanced corrosion resistance, giving 4 times the protection compared to unmodified polyester coatings on GI substrates as validated by SST and EIS. Additionally, other coating properties, including SEM, EDS, FTIR, Raman, Gloss, Impact, Thickness and Scratch hardness were also performed.

This research study elucidates the substantial enhancement of corrosion resistance achieved when polyester coatings are augmented with dispersed CNFs. This finding presents a promising avenue for the development of next-generation, highly performance-oriented, and corrosion resistant coating systems.

Keywords: Carbon nanofibres, Corrosion, Dispersion, Triton X-100, Functionalization.

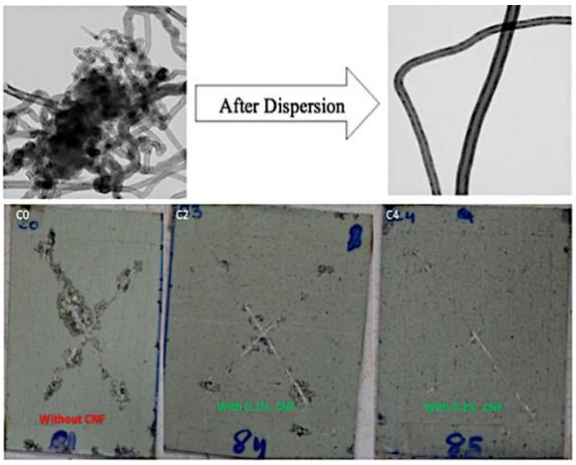

Figure 1: Figure illustrating the TEM micrographs of dispersed CNFs and SST results after 1224 hours (C0: without CNF, C2: with pristine CNF and C4: with modified CNF).

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Effect of Surface Treatment on the Water Resistance of Cardboard

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Abstract:
The durability and performance of cardboard materials in humid environments are strongly influenced by their surface wettability and liquid absorption properties. In this study, a surface treatment was applied to cardboard with the aim of enhancing water resistance and extending the material's service life under moisture exposure. Both treated and untreated samples were evaluated on the brown and white (pigmented) faces of the cardboard.

Contact angle measurements were performed after droplet deposition (T0), according to standard protocols, and repeated at 30 seconds (T30S) to assess the effect of prolonged direct water contact. Complementary drop absorption tests were conducted to evaluate liquid uptake dynamics and droplet spreading behavior. The results indicate that treated surfaces exhibited higher contact angle values than untreated samples, reflecting reduced surface wettability. Statistically significant differences were observed on the brown face at both T0 and T30 s measurements ($p<0.0001$), while the white face showed a significant difference at T0 ($p<0.05$) but no significant difference at 30 s.

Drop absorption tests further demonstrated that treated surfaces delayed liquid uptake and limited droplet spreading. These findings confirm that the applied treatment slows water penetration and effectively reduces surface wettability. Overall, the combination of contact angle and absorption data suggests that the treatment improves the moisture resistance of cardboard surfaces, which is especially relevant for applications in packaging and storage where exposure to humidity can compromise material integrity. By reducing water penetration and delaying absorption, such surface treatments have the potential to extend the functional lifetime of cardboard products in humid environments, contributing to enhanced durability and performance in practical applications.

Keywords: Cardboard, contact angle, durability, moisture resistance

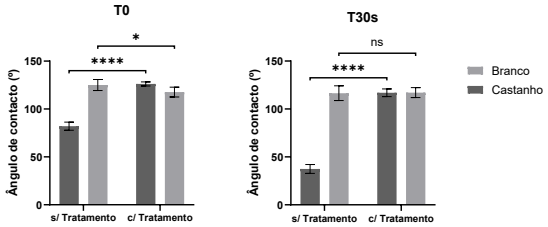

Figure 1: Contact angle of untreated and treated cardboard surfaces. Measurements were taken initially (T0) and 30 s after droplet deposition (T30s). Treated surfaces showed higher contact angles and slower absorption, particularly on the brown face, indicating reduced wettability.

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Enhanced Wastewater Treatment Using MOF-Modified Polysulfone Membranes

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Abstract:
This study investigates polysulfone (PSF)-based composite membranes (CMs) incorporating Ni-MOF for water purification. CMs were fabricated via phase inversion with varying Ni-MOF loadings. Structural and surface analyses revealed enhanced hydrophilicity with increasing filler content, reducing the contact angle from 59.7° to 49.7°. The CM-0.2 membrane achieved the highest pure water flux. Heavy metal removal was optimal at pH 6, with CM With 1 wt. % MOF showing rejection efficiencies of 95%. CM-0.1 also demonstrated superior oil–water separation performance, while CM-0.2 exhibited the highest flux recovery (85 %), indicating improved antifouling behavior. Overall, Ni-MOF incorporation significantly enhanced membrane performance, highlighting its potential for advanced water purification applications.

Posters Sessions

Polymeric Nanostructures from Biowaste: Formulation of Polymer Nanocomposites of Chitosan-Opuntia Ficus Nanoparticles and Investigating their Antioxidant and Antibacterial Activities

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Abstract

Opuntia Ficus indica peels (33-55% of the fruit mass) are an underexploited biowaste rich in bioactive phytochemicals, presenting a challenge for efficient valorization due to their lability. This study is based on developing a robust, polymer-based encapsulation system for the peel extract (OPE) from three color varieties (red, green, orange) and comprehensively characterize and investigate their antioxidant and antibacterial properties. We specifically chose chitosan (CS), a cationic biopolymer, for its biocompatibility, biodegradability, and inherent bacterial properties. The encapsulation of *Opuntia ficus*- peel extract (OPE) into chitosan nanoparticles (CSNPs)by ionic gelation method present an efficacious strategy to preserve the integrity of the extracts. Three systems were subjected to comprehensive characterization utilizing different tools. FTIR analysis indicated no spectral interference between the pure extracts and CSNPs confirming the entrapment of extract within the NPs systems and abundance of phenolic compounds. The nanoparticles imaged by TEM displayed an average size of 20–70 nm with a spherical shape and even distribution. The formulated nanoparticles are crystalline in nature as indicated by XRD. The TGA analysis revealed that the thermal stabilities of the NPs were higher than the pure extracts. Antioxidant assays (Total phenolic content, and DPPH assay) confirmed the successful encapsulation and controlled release profile. Antibacterial tests on the formulated CSNPs showed better results among various strains of bacteria. For E. coli(-ve), lower IC_{50} of G-extract and its relevant NPs (0.5, 0.06mg/ml) while for S-aureus (+ve), R extract and its NPs exhibited lowest IC_{50} (0.4, 0.002mg/ml) compared to the other specimen.

Keywords: Opuntia Ficus Peel; chitosan nanoparticles; antibacterial; antioxidant properties

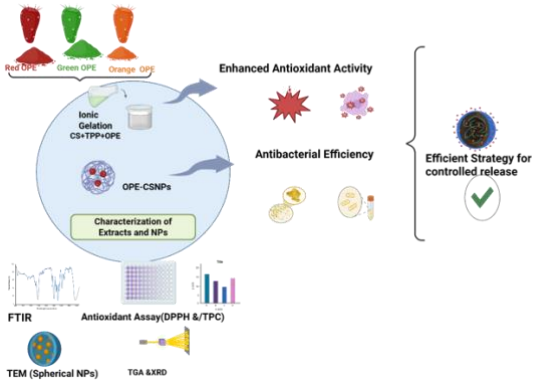

Figure 1: Schematic diagram for the Formulation and Optimization of Chitosan - three Opuntia ficus-indica Peels Nanoparticles and Detecting Enhanced Antioxidant, and Antibacterial activity

Enhancing the Hydrophilicity of Electrospun Polylactide Scaffolds via Polymaleate–N-acetyl-L-cysteine Conjugates

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Abstract:
Increasing the hydrophilicity of polylactide (PLA)-based scaffolds remains a major challenge in tissue engineering and is commonly addressed by incorporating hydrophilic additives [1].
In the present study, attempts were made to enhance the surface properties of electrospun PLA scaffolds by partially substituting PLA with newly synthesized biodegradable polymer–amino acid conjugates. These conjugates, based on linear polymaleates and N-acetyl-L-cysteine (NAC) (Figure 1), are believed to enhance the hydrophilicity of PLA scaffolds through the amine and carboxylic groups of NAC [2], while maintaining desirable thermal stability and mechanical integrity.
This assumption was verified for three electrospun scaffolds containing 50 wt.% PLA and 50 wt.% polymaleate – NAC conjugates by evaluating their i) water contact angle (*WCA*), ii) water sorption (*WS*), iii) glass transition temperature (*Tg*), iv) thermal stability (*Td*), v) tensile strength (σ), and modulus (E), and vi) degradation at physiological pH,
The modified scaffolds had i) a hydrophilic surface (*WCA* below 40°), ii) *WS* up to 5-fold higher than the unmodified PLA scaffold, iii) *Tg* and *Td* similar to the unmodified PLA scaffold, iv) lower than the unmodified PLA scaffold σ and modulus E, and v) higher than the unmodified PLA scaffold degradation rates. A more detailed analysis of the obtained values indicates that the PLA scaffold modified with the conjugate based on poly(propylene maleate) and NAC showed the highest application potential as it showed *WCA* of 20°, 5-fold higher *WS* than the unmodified PLA scaffold, *Tg* above 60 °C, Tm above 150 °C, lower by only 30 and 10% σ and E compared to unmodified PLA scaffold and the slowest degradation rate.

Keywords: polymer – amino acid conjugates, N-acetyl-L-cysteine, polylactide, tissue engineering scaffolds, electrospinning, enhancing hydrophilicity, physicochemical properties, mechanical performance

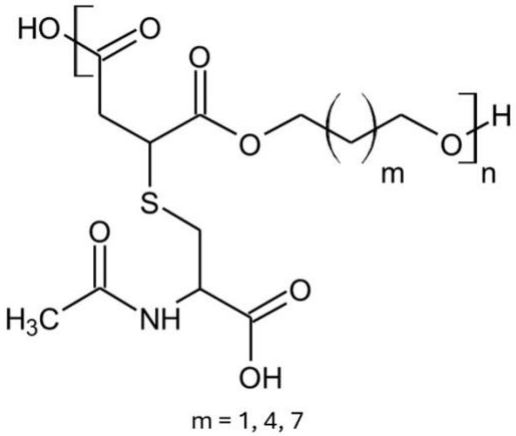

Figure 1: Chemical structure of polymer – amino acid conjugates based on linear polymaleates and N-acetyl-L-cysteine used in this study.

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Effects of Calcination and Acid Treatments for Fillers on Rheological and Mechanical Properties of PLA-based Blends

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Abstract:
Achieving compatibility between inherently immiscible polymers remains a central challenge in designing high-performance polymer blends, particularly when both processability and end-use durability must be secured without sacrificing sustainability. In this study, we systematically examined how surface-engineered inorganic fillers—modified through controlled acid etching followed by calcination—affect interfacial interactions and macroscopic property development in poly(lactic acid) (PLA)-based polymer blends. Rather than serving solely as conventional rigid reinforcements, the treated fillers are intentionally leveraged as interfacial regulators (compatibilizer-like additives) to promote finer phase dispersion, stronger interphase adhesion, and improved morphological stability during melt processing.
The surface treatments are designed to tailor filler chemistry and topography (e.g., removal of weakly bound surface contaminants, creation of reactive/adsorptive sites, and stabilization of the surface state after calcination), thereby enhancing affinity toward the polymer phases and encouraging preferential localization at or near the blend interface. The incorporation of the modified fillers produced clear gains in thermal stability and mechanical integrity, consistent with more efficient stress transfer and reduced defect sensitivity within the multiphase microstructure. Comprehensive characterization spanning structural, thermal, molecular, and rheological analyses demonstrated that the fillers did not act as passive spectators: changes in molecular weight distribution and melt viscoelastic responses closely tracked the evolution of interfacial interactions between the treated filler surfaces and the PLA-containing matrix. These observations imply that the engineered filler surfaces influence chain dynamics and interphase connectivity, ultimately reshaping the blend's phase behavior.
Enhanced phase homogeneity was evidenced by the appearance of a single melting transition and by microstructural observations showing suppressed interfacial gaps and improved continuity across phase boundaries. In addition, rheological signatures indicated improved melt elasticity and reduced phase slippage, supporting the formation of a more cooperative, interconnected morphology. Overall, the results demonstrated that surface-modified inorganic fillers can simultaneously reinforce and compatibilize biodegradable polymer blends, offering an effective and scalable strategy to overcome immiscibility while maintaining the green advantages of PLA-based systems. This approach provides a practical pathway toward advanced sustainable composites with balanced thermal/mechanical performance and improved morphological robustness.

Keywords: PLA, Calcination, Acid treatment, Filler, Mechanical properties.

Acknowledgement:
This work was supported by the Materials/Parts Technology Development Program (20024384, Development of a battery housing cover using high orientation composite material with a fiber content of 40% and using recycled fibers and engineering plastics) funded By the Ministry of Trade, Industry & Energy (MOTIE, Korea). This research was also supported by Advanced Materials Analysis Center, The University of Suwon.

X-Ray Computed Tomography for Microplastic Analysis in Textile sector

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Abstract:
Laundry effluents of synthetic textiles account for 35% of all microplastic contamination in oceans. Nowadays, ISO standard protocols (ISO 4484 series (1) are available for characterizing MPs released during washings, by gravimetric analysis and vibrational spectroscopy.
This experimental work aimed at using (microCT) analysis to distinguish fibrous microplastics of polyester (PET), polyamide (PA), and polypropylene (PP) from snippets of natural fibres such as cotton and wool inside a residue released from a textile during washing (Figure 1).
The work mainly focused on developing a sample preparation method from synthetic and natural filaments with known composition and characteristics. Four different supports were tested: 1) silicon filter between polystyrene septa, 2) cellulose ester filter wrapped by rigid kapton, 3) soft kapton films 4) MicroCT-HA Phantom containing various densities of Calcium hydroxyapatite (CaHA). The analyses were performed on fibres of the same polymer type or blended with natural fibres such as cotton and wool. The densities of the synthetic and natural polymers and materials used were as follows: PET (1.3 g/cm^3), PA (1.12 g/cm^3), PP (0.9 g/cm^3), Cotton fibres (1. 55 g/cm^3), Wool (1.3 g/cm^3), Silicon Filter (1.13 g/cm^3), Kapton (polyimide film 1.42 g/cm^3), MicroCT-HA phantom (1.13 g/cm^3), Parafilm (1.13 g/cm^3). The best results were obtained from specimens containing fibres that were prepared for measurement by placing them between two filters of cellulose and then covered with parafilm in MicroCT-HA Phantom. The experimental outcomes indicated that PET and PP fibres could be successfully identified when mixed with cotton. Using 16-bit grey scale imaging, cotton displayed higher grey values (9800) compared to PET (9400) and PP (9000) due to its relatively higher density. The optimal sample preparation involved placing the fibres between two cellulose
filters and encapsulating them in parafilm within the MicroCT-HA Phantom.
These findings demonstrated the potential of MicroCT analysis in distinguishing between different types of synthetic and natural fibers in environmental samples.

Keywords: microplastic fibres, X-ray micro-computed tomography (microCT), synthetic polymers, natural fibre, laundry residues.

Figure 1: X-RAY CT analysis of microplastics in textile wastewater.

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Acknowledgement
"This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101131765 (EXCITE2) for Transnational Access conducted at CEITEC Brno University of Technology."
Funded by the European Union

All synthetic fibres were supplied by Aquafil S.p.A

Ultrasensitive optical bionanosensors for detection of standard and low-concentration biomarkers in body fluids

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Abstract:
This work presents the development and preliminary validation of ultra-sensitive optical bionanosensors for the detection of standard and low-concentration disease biomarkers in liquid environments and wound exudates. The platform integrates functionalized nanomembranes composed of electrospun, biocompatible nanofibers with embedded pH-sensitive sensing elements and fluorescent labeling strategies. Electronic and optical detection modalities were prioritized to enhance sensitivity, linearity, and translational potential toward commercialization. Fluorescence measurements performed using a FluoroMax spectrofluorometer demonstrated high sensitivity for biotin–FITC model systems, with strong linear regression ($R^2 \approx 0.99$), supporting reliable quantification at low concentrations.
The sensing architecture is based on an integrated nano-receptor platform in which labeled biomarkers are immobilized within a high-surface-area electrospun nanofibrous matrix, enabling efficient optical signal transduction (Fig. 1). The proposed architecture enables detection of bioactive substances, including specific proteins and miRNAs, at picomolar levels. In parallel, a smart wound-dressing concept incorporating pH-responsive nanosensors was designed to enable non-invasive, real-time monitoring of wound status through colorimetric shifts or signal transmission to external devices. The multilayer nanofibrous structure ensures breathability, oxygen permeability, and biocompatibility, supporting both sensing performance and therapeutic functionality.
Preliminary results indicate that correlated biomarker panels may provide improved diagnostic specificity and enable early-stage disease detection. The system demonstrates proof of concept for integrated nano-receptor-based sensing and establishes a scalable framework for next-generation point-of-care diagnostic technologies.

Keywords: ultra-sensitive biosensors; optical detection; nanomembranes; electrospun nanofibers; fluorescence spectroscopy; biotin–FITC; pH-sensitive sensors; wound monitoring; miRNA detection; point-of-care diagnostics; low-concentration biomarkers; nano-receptors

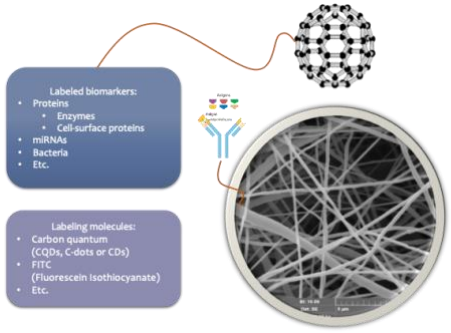

Figure 1: Integrated Nano-Receptor design for ultrasensitive detection of labelled biomarkers.

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Acknowledgements:
This work was supported by funds of institutional research (TA 29) FVM VETUNI and by the Internal Creative Agency of VETUNI project Nr. 2024ITA12.

Evaluation of multilayer PE film with addition of wood particles obtained by developed blow molding process

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Abstract:
Work focuses on innovative polymer composites based on polyethylene and wood particles obtained by advanced processing technology. Samples were obtained in form of polymer films with thickness up to 100 microns by blow molding process. In the process were used waste material in formof wood particles which has impact on economy, energy saving and minimization of waste problem. World spending of all plastics is still growing up. It can be observed in the world's annual consumption of these materials, which has increased from around 5 million tons in the 1950's to 450 mln tons in 2020 and according to forecast probably more than 600 million tons in 2030 [1]. Circular economy suggests to redesign materials, including waste and recycle materials, according to ISO/TR 14062:2002 - Environmental management — Integrating environmental aspects into product design and development [2]. Use of waste and/or recycled materials is important for the nature to, among other things, save energy and carbon emission. The work will contain study of structure and properties of obtained composites [3].

Keywords: waste materials, polymer composites, multilayer films, blow molding.

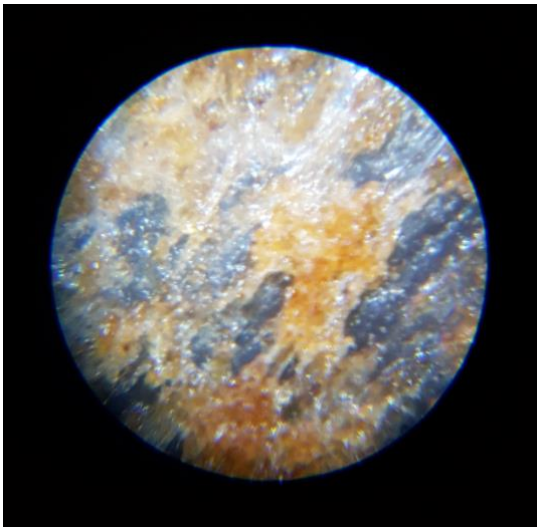

Figure 1: Figure illustrating the wood particles on the top of multilayer polymer film; composition of A-B-A layers, and outer layers (type A) were filled by wood particles.

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Advancing bio-based polymers from sustainable feedstocks: a clustered European approach to high-performance circular materials

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Abstract:
The development of high-performance bio-based polymers from non-food competing, second-generation biomass is critical for achieving circularity and reducing reliance on fossil-derived materials. Within the framework of the Circular Bio-based Europe Joint Undertaking (CBE JU), the BIOPOLY Cluster integrates complementary strategies for the valorisation of brewers' spent grain (BSG), agri-food residues, lignocellulosic biomass, and woody-derived intermediates into structurally diverse polymer systems.

POLYMEER valorises BSG via fractionation into cellulose, hemicellulose and lignin streams, followed by chemical modification, polymerisation and reactive blending to produce thermoplastic polymers, copolymers and blends tailored for mulch films, automotive textiles and packaging. Structure-property optimisation focuses on molecular weight control, interfacial compatibility, thermal stability, and barrier performance.

BIOPYRANIA develops novel aromatic monomers derived from glutamic acid and 5-amino levulinic acid obtained through fermentation of woody biomass. Polyamides and polybenzimidazoles containing this monomer have the potential to improve thermal resistance, mechanical strength and chemical stability for demanding applications such as lightweight automotive components and anion exchange membranes for fuel cells/electrolyzers.

POLYMERS-5B employs biocatalysis and green chemistry to synthesize bio-based diacids, diols, diamins and aromatic monomers from agri-food waste and lignin derivatives. These are polymerized into functionalized polyesters, polyamides and polyfurans with tunable pendant groups, enabling post-functionalisation and compatibility in bio-composites. Machine learning-assisted optimization and Sustainable-by-Design approaches guide process efficiency and performance tuning.

Thermal (DSC, TGA), mechanical (DMA, tensile) and rheological analyses demonstrate that second-generation biomass-derived polymers can achieve competitive performance while improving circularity potential. The BIOPOLY Cluster establishes a multi-feedstock platform for next-generation sustainable polymer materials.

Keywords: bio-based polymers, second-generation biomass, aromatic polymers, biocatalysis, lignocellulosic valorisation, polymer blends, circular materials.

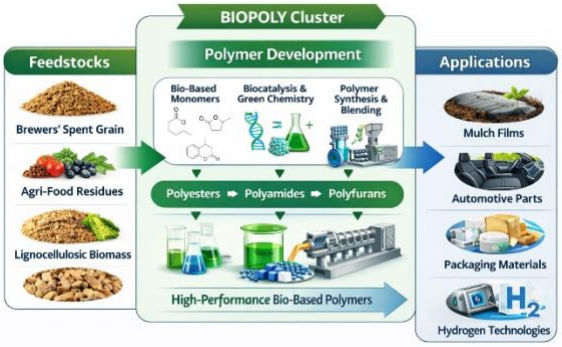

Figure 1: Figure illustrating an schematic overview of the BIOPOLY Cluster strategy to convert second-generation biomass into high-performance bio-based polymers for applications in agriculture, automotive, packaging and hydrogen technologies.

Molecular Dynamics Simulations to Predict the Thermo-Mechanical Properties of Bio-based Polyesters

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Abstract:
The demand for sustainable polyesters derived from non-fuel sources has raised due to the environmental burden and the need to move from a linear to a circular economy [1, 2]. Agri-food waste and biomass are valuable resources that can be reused to produce sustainable polymers.
In this work, bio-based dicarboxylic acids (succinic acid, itaconic acid, sebacic acid and oxalic acid) were combined with hydroxytyrosol to obtain four bio-based polyesters as naturally derived alternatives to polyethylene terephthalate (PET). The behavior of these novel polymers was modeled using Molecular Dynamics (MD) simulations, enabling the prediction of macroscopic thermo-mechanical properties before the actual synthesis. For comparison, the thermo-mechanical properties of PET were first evaluated.
For each polymer, after an equilibrium step, different representative volume element (RVE, figure 1) are obtained by varying the number and the length of the chains, maintaining the number of atoms constant between all polymers.
The MD simulations were carried out in Amsterdam Modeling Suite, using the ReaxFF reactive force field. For the thermal properties, the temperature ranged from 150 K to 1000 K and in the mechanical properties, the polymers were stretched up to 10 %. The thermal properties analysed were the glass transition temperature, melting temperature, degradation temperature and coefficient of thermal expansion, while the mechanical properties were the Young's modulus, yield stress and Poisson's ratio.
The different sizes of the dicarboxylic acids were shown to have a significant impact on the density and thermal properties of the resulting polymers. When combining hydroxytyrosol with either succinic acid or itaconic acid, the results showed that the density and the thermal properties matched the MD predictions obtained for PET, which are in agreement with experimental results [3]. On the other hand, for the combination of hydroxytyrosol with sebacid acid, the density and thermal properties were lower than the ones obtained for PET. The opposite trend was observed for a polymer containing hydroxytyrosol and oxalic acid, which showed higher density and thermal properties than the reference PET values. The mechanical properties of all simulated bio-based polymers fall within the range of those reported for PET, with no statistically significant differences.
The combination of hydroxytyrosol with either succinic or itaconic acid yield thermo-mechanical properties similar to those of PET. Therefore, they are the most experimentally viable option for synthesis as bio-based alternatives to the fossil-derived PET.

Keywords: Polyethylene terephthalate, Bio-based dicarboxylic acids, Hydroxytyrosol, Molecular Dynamics, Thermo-mechanical properties.

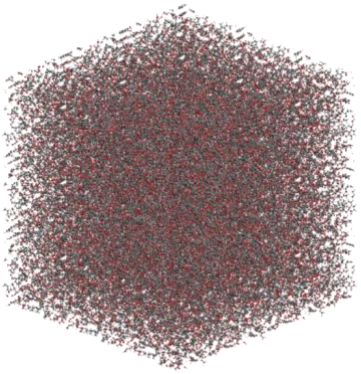

Figure 1: Representative volume element of a bio-based polymer after equilibrium used to determine the thermo-mechanical properties.

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Safe-and-Sustainable-by-Design (SSbD) from packaging decoration perspective

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Abstract:
The EU STOPP project aims to reduce the environmental and health impacts of plastic food packaging by developing methodologies and tools that support Europe's transition toward safe, circular, and regulation-aligned polymer systems. STOPP takes a lifecycle-wide perspective covering design, use, waste management, and recycling and integrates environmental assessment, material science, behavioural research, and industrial collaboration. By addressing challenges such as microplastic generation, chemical safety, design-for-recycling, reuse models, and sorting efficiency, the project provides evidence-based guidance to help industry comply with EU 2030 targets and the Packaging and Packaging Waste Regulation (PPWR). Through coordinated work across research partners, recyclers, and value-chain stakeholders, STOPP delivers practical protocols, testing methods, and decision-support tools that foster the adoption of safe-and-sustainable polymer packaging solutions.
Within the STOPP project, the presented work focuses on improving recycling compatibility of inks and decoration technologies used on contact-sensitive rigid polypropylene (PP) and polystyrene (PS) packaging. Decorations can hinder recycling performance and compromise the safety of recycled food-contact materials. In this study, four major decoration categories are assessed through redesign and recycling routes, supporting future RecyClass guidelines. After flake pretreatment, VTT's advanced extrusion line—equipped with in-line VOC, color, viscosity, and spectroscopic monitoring, is used to process the material. Three decontamination scenarios (sodic hot wash, steam stripping, and IR radiation) are evaluated, and chemical safety is assessed using the CosPaTox NIAS testing approach. The methodology and representative outcomes demonstrate how decoration removal and optimized recycling protocols can support the production of high-quality, compliant recyclates for sensitive packaging applications, contributing to STOPP's ambition of enabling safe and circular polymer value chains.

Keywords: Rigid plastic food packaging, Recyclass, inks and decorations, NIAS, recycling

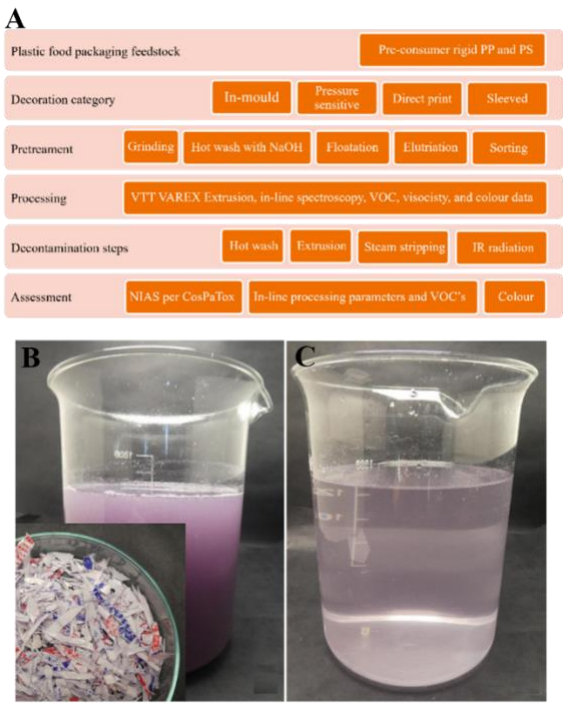

Figure 1 (A) Overview of the methodology applied for decoration removal and recycling. Decoration removal was carried out by sodic hot washing of directly printed polypropylene (PP) flakes. (B) Snapshot of the wash water after the washing step. (C) Snapshot of the rinse water after the washing process.

Mycelium-Based Composites from Invasive Biomass: Low-Carbon Materials for Circular Manufacturing

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[2] School of Applied Science, Edinburgh Napier University, UK

Abstract:
Mycelium-based composites (MBCs) are an emerging class of biogenic materials with significant potential to replace petroleum-derived polymers in packaging, construction, and product design. Formed through the controlled growth of fungal mycelial networks that bind lignocellulosic particles into a cohesive matrix, MBCs offer low embodied energy, full biodegradability, and compatibility with circular manufacturing models. This project investigates the viability of using invasive biomass, specifically water hyacinth, as a sustainable substrate for MBC production while benchmarking performance against a conventional agricultural substrate (straw). Two fungal species, Pleurotus citrinopileatus (Golden Oyster) and Ganoderma curtisii (Reishi), were cultivated on both substrates, and the resulting composites were evaluated through mechanical compression testing.

The straw–oyster combination produced the strongest composite, achieving a Young's modulus of 190.5 kPa, reflecting well-developed hyphal bonding and uniform substrate colonisation. Although water hyacinth-based samples exhibited lower compressive strength, they formed structurally cohesive composites across both fungal species, demonstrating the feasibility of invasive biomass utilisation. These results highlight a dual benefit: generating functional bio-composites while providing a valorisation pathway for managing invasive aquatic plants in regions where disposal poses environmental and economic challenges.

The study has informed ongoing research at Edinburgh Napier University focused on optimising substrate processing, species selection, and functional performance. Current investigations include developing mycelium composites for biogenic thermal insulation using four fungal species and exploring high-value packaging applications using distillery byproducts. Collectively, these efforts underscore MBCs as promising, low-carbon alternatives within sustainable polymer science and circular bioeconomy innovation.

Keywords: mycelium, susutainable, water hyacinth, circular bioeconomy

Figure 1: Figure illustrating the MBC samples prepared for mechanical and thermal testing (a)-(d); and (e) the prototype of a MBC packaging fitment for a beverage product

References:

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2. https://doi.org/10.3390/en18164225

Can nature support the recovery of High-performance polymers from composite wastes?

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Abstract:
Composite recycling has multiple issues: efficiency of separation, purity of the separated components, and combined commercial value of process and recovered materials themselves. In our 108 years of activity, the Teijin group has developed many solutions that are commercially available today (i.e. Sereebo®, Twaron® pulp, ECOPET®), while others are entering the respective markets.
When purely chemical processes are incompatible with any of the issues above, a solution that is commonly explored is biochemistry, with its highly selective enzymatic routes. In this special case, we address the separation between Polyurethanes (PU) and Poly(imino-1,4-phenyleneiminocarbonyl-1,4-phenylenecarbonyl) PPTA, commercially known as Twaron®, where it is still unknown the chemistry that can selectively depolymerize PU, with no effect on PPTA fiber quality.
We attempted to address this issue with enzymatic degradation of the binder, combining 2 microorganisms capable of feeding selectively on PUs. Here we present our preliminary investigation: 6 strains who gave mixed results are combined to work in synergy. The data proves how some strands seem to cooperate in degradation very well, while others show signs of negative interference, despite being more active when alone.
We hypothesize that the most successful combinations of strands include a strand more active on the surface and a strand more active below it, whereas the two do not appear to influence each other activity.

Keywords: Composites, Twaron, Polyurethanes, Bacteria, Enzymatic Degradation, Biodegradation.

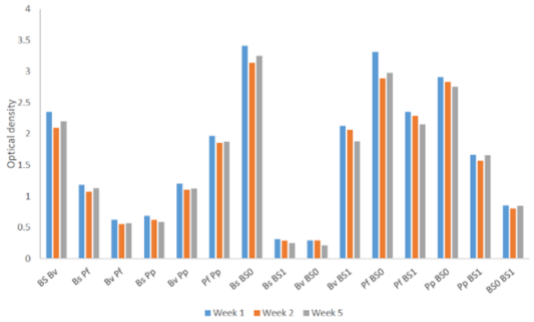

Figure 1: Optical density of liquid co-cultures determined by measurement of absorption at 600nm after 1, 2 and 5 weeks of incubation at 28 ˚C and 180 rpm.

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From Waste to Technological Products: Bioplastics Production from Proteins Extracted from the Black Soldier Fly

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[2] Italian National Research Council, Institute of Intelligent Industrial Technologies and Systems for Advanced Manufacturing, Biella, Italy

Abstract:

Hermetia illucens. also known as Black Soldier Fly (BSF), is an insect of the Diptera order that is currently widespread and cosmopolitan and is often bred in pilot plants. BSF larvae have the great ability to bioconvert unused nutrients left in organic waste into lipids, proteins, and chitin which could be extracted to produce bio-based materials for technical applications. In our study, proteins were extracted from defatted BSF larvae using water under pressure at 160 °C for 1 h as a green solvent. Advantages of using superheated water for protein extraction are that the proteins are extracted in water medium only at neutral pH and are sterilized so that they can be used without any further purification [1]. Proteins extracted were mixed with polyvinyl alcohol (PVA) in different proportions (i.e. 100/0, 90/10, 70/30, 50/50, 30/70, 10/90, 0/100 PVA/ BSF protein percentage) to obtain bioplastics. The results obtained show that as the BSF protein content increases, the films show a reduction in thermal stability and mechanical properties, and also, they exhibit higher biodegradability, correlated with higher wettability, solubility and ability to absorb moisture. PVA/BSF protein bioplastics can be used as biodegradable packaging or as agricultural mulches, modulating the relative amount of PVA and BSF protein and taking advantage of the increased mechanical strength of films with higher concentrations of PVA and the increased biodgadability of films with a higher content of BSF protein, which during biodegradation release organic carbon and nitrogen into the soil [2]. This research highlights the value of using organic waste-fed insects as a resource for bioplastic production, offering an alternative to traditional polymers and contributing to the transition to sustainable materials.

Keywords: bioplastics, Black Soldier Fly, proteins, polyvinyl alcohol, bio-factory.

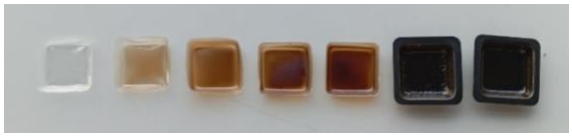

Figure 1: Biodegradable films (from left to ringht in PVA/BSF protein percentages: 100/0, 90/10, 70/30, 50/50, 30/70, 10/90, 0/100).

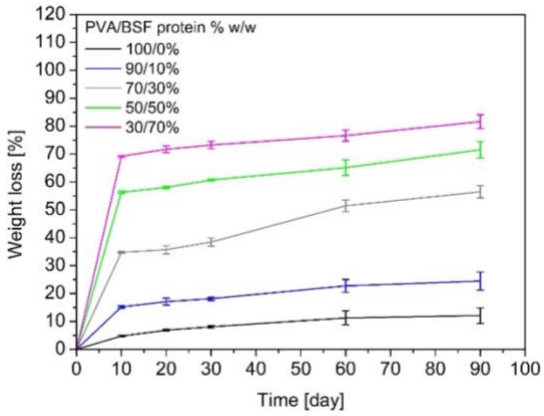

Figure 2: Weight loss of PVA/BSF protein films with different compositions after 10, 20, 30, 60, and 90 days of burial in the soil.

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Acknowledgements:

the authors thank the for his financial support of the project HI-Tech "Hermetia illucens biofactory: from waste to high value technological products"(PRIN 2022 - D.D. MUR n.104 02/02/2022, Italy).

Efficient Microwave Processing for the Preparation of Acrylated Soybean Oil Thermosetting Foams

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Abstract:
Vegetable oils represent ideally renewable, abundant, and low-cost feedstocks for the synthesis of sustainable polymers exhibiting diverse structures, properties, and applications. Their inherent molecular complexity, stemming from their carbon backbones, unsaturations, and array of functional groups, offers a significant opportunity for the development of novel materials.[1] Furthermore, the utilization of waste cooking oil as a precursor for bio-based materials presents a compelling alternative to the consumption of virgin vegetable oils, offering substantial cost reductions while aligning with principles of waste valorization and sustainability.[2]

In the present study, acrylated epoxydized soybean oil (AESO) was employed in the preparation of thermosetting foams cured via a free-radical polymerization mechanism initiated by a peroxide under microwave (MW) irradiation.[3] Unlike conventional heating, MW energy directly couples with polar molecules, enabling rapid and volumetric heating of the resin. Therefore, MW irradiation offers a precise and efficient method for temperature control during the crosslinking of foams. The influence of rheological properties during the pre-curing and the MW processing parameters on the resulting cellular morphology of AESO foams was investigated (Figure 1). Specifically, cellular growth was observed to be promoted under conditions where the viscosity of the liquid phase was sufficiently elevated to reduce coalescence and coarsening, and where the crosslink density was adequately low to permit foam expansion. Finally, the thermal stability and mechanical properties of AESO-based foams were studied by thermogravimetric analysis and compression tests.

Keywords: Microwave heating, bio-based foams, soybean oil, rheological properties, sustainable process, thermosets, cell morphology.

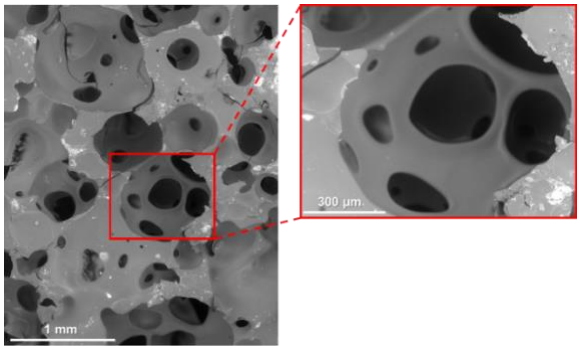

Figure 1: SEM morphologies of AESO foams.

References:

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Acknowledgements:
Thanks are due to the Extended Partnership PE00000004 "Made in Italy Circolare e Sostenibile" (MICS) project, funded by the European Union-Next Generation EU, for financial support.

Valorization of Green Seaweed Biomass through a Multi-Step Biorefinery Approach

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National Research Council (CNR), Institute of Chemical Science and Technologies "G. Natta", Milan, Italy

Abstract:
Rapid green seaweed proliferation in eutrophic coastal waters, known as "green tides", causes severe hypoxia, harming marine ecosystems and coastal economies.[1] This necessitates valorizing this underutilized marine biomass for novel materials within a sustainable biorefinery framework.[2]
This investigation explored a multi-stage process designed for the comprehensive utilization of the entire seaweed biomass (Figure 1).

Figure 1: General illustration of the process.

The process facilitated the recovery of three distinct fractions with potential industrial applications:
i) a liquid fraction rich in minerals (MRE), representing about 35% of the input biomass dry weight, was obtained from initial biomass washes. This fraction exhibits potential for application in the agricultural sector as a biostimulant.
ii) an anionic sulfated polysaccharide, ulvan. This polysaccharide constitutes 10–36% of the seaweed's dry weight and is recognized for its potential utility across diverse sectors, including agriculture, human health, and biomaterials.[3]
Depolymerization of ulvan with acidic heterogeneous catalysts and chemical modifications of ulvan are currently under investigation with the aim of tailoring its properties and broadening its potential applications.
iii) the residual biomass fraction (PRF), obtained after polysaccharide extraction, was subsequently utilized as a feedstock for the preparation of innovative bioplastics.
These biomaterials were prepared via extrusion and compression molding techniques, incorporating various plasticizing agents (Figure 2). Moreover, the thermal and mechanical properties of the bioplastics were evaluated.

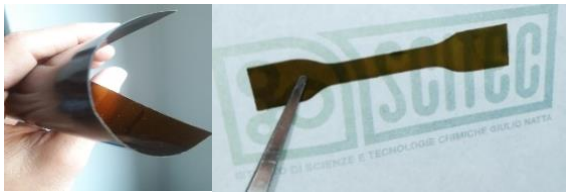

Figure 2: Bioplastics based on PRF.

Keywords: Green seaweeds, biorefinery, ulvan, bioplastics, blue economy.

Acknowledgements:

Thanks are due to the Extended Partnership PE00000004 "Made in Italy Circolare e Sostenibile" (MICS) project, funded by the European Union-Next Generation EU, for financial support.

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Safe and sustainable by design PHBV from waste streams

Lead by CETEC[1]
[1] Carmen Fernandez, CETEC, Footwear and plastics technology center, Murcia, Spain

Abstract:
The transition towards a circular and bio-based economy requires sustainable alternatives to conventional plastics. In this context, three EU-funded projects: ViSS[1], ANIPH[2] and PHAntastic[3], focus on the production and application of polyhydroxybutyrate-co-valerate (PHBV), a biodegradable polymer from the PHA family, obtained from agro-industrial waste streams.
These projects demonstrate a complete circular value chain, from feedstock valorisation to final applications. Various waste streams, such as poultry residues, sugar-rich liquors and brewery by-products, are converted into PHBV with tailored properties by controlling the 3HV content (15–30%), enabling adjustments in flexibility, crystallinity and biodegradability.
The developed materials are applied in packaging, healthcare and agriculture, including trays, films, medical products and biodegradable agricultural solutions with controlled-release functionalities. Environmental assessments show reduced CO_2 emissions, lower use of hazardous substances and decreased environmental impact compared to conventional plastics.
Overall, these projects highlight the potential of waste-derived PHBV as a versatile and safe-and-sustainable-by-design solution, supporting the transition towards more resource-efficient and environmentally friendly plastic value chains.

Keywords: Plastic waste recycling; circular economy; sustainable materials; resource efficiency; advanced recycling; secondary raw materials; plastic valorisation.

Figure 1: Conceptual overview of ViSS, PHAntastic and ANIPH projects

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Dynamic Characterization of Fiber-Reinforced Thermoplastic and Steel Hybrid Materials for Automotive Applications

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Abstract:
Fiber-reinforced thermoplastic (FRTP) composites are increasingly adopted in lightweight and sustainable structural applications, specifically for automotive hybrid components combiningFRTP with steel and adhesive joints. Their high specific stiffness and strength, combined with intrinsic recyclability, make them attractive alternatives to conventional thermoset-based composites. While the quasi-static mechanical properties of hybrid materials have been widely investigated, their dynamic mechanical behavior, relevant to vibration and noise control, especially in the presence of bonded joints, remains largely unexplored.
This work introduces a non-destructive experimental methodology applicable to manufactured FRTP hybrid components incorporating adhesive joints. The proposed approach allows the frequency-dependent evaluation of the complex Young's modulus and shear modulus, enabling a consistent description of the frequency response of the material-joint-material system. The use of complex moduli naturally introduces structural damping into the analysis, allowing both stiffness and energy dissipation mechanisms to be captured within a unified framework.
The dynamic response of the hybrid material is analyzed over a broad frequency range, with particular emphasis on the contribution of the adhesive joint to the overall stiffness and damping behavior. The results demonstrate that composite and joint-induced damping, play a significant role in governing vibration attenuation and dynamic performance of hybrid automotive components. This characterization framework provides relevant insights for the design and optimization of thermoplastic composite structures with bonded joints, supporting improved vibration mitigation, noise reduction, and structural integrity in engineering applications.

Keywords: thermoplastic matrix, fiber-reinforced, hybrid material, dynamic characterization, vibrations, damping, automotive applications.

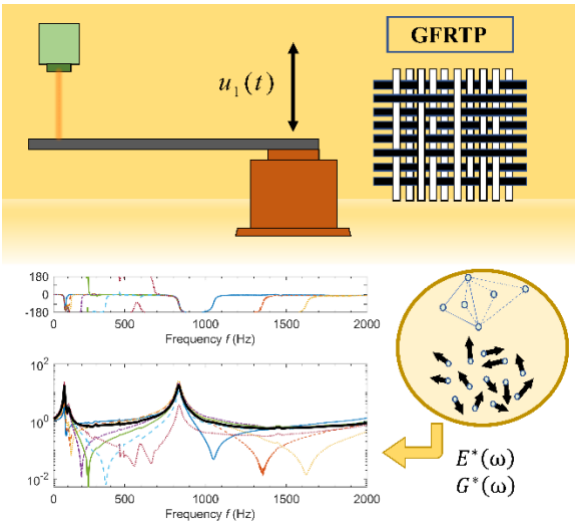

Figure 1: Figure illustrating the experimental procedure using an electrodynamic shaker and PDV laser. And the numerical procedure which enables to characterize the dynamic performace of the FRTP hybrid material.

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Advancing Timber–Composite Systems for Sustainable and Green Building

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Abstract:
As a major contributor to global greenhouse gas emissions, the building sector highlights the urgent need for low-carbon construction solutions. In order to achieve carbon neutrality in the built environment, we need structural materials that balance mechanical performance with environmental sustainability. Timber–composite systems, which combine engineered wood with fibre-reinforced polymers (FRP), are attracting attention as high-performance, resource-efficient alternatives to traditional concrete and steel structures. These systems offer the potential to reduce embodied carbon and promote circularity.

As a renewable and carbon-sequestering green material, wood plays a crucial role in sustainable construction. This is due to the fact that it stores atmospheric CO_2 throughout its service life and enables circular use. However, its anisotropic nature—defined by direction-dependent mechanical properties [1], i.e. low transverse elastic modulus, limited tensile strength across the grain, and complex shear behaviour—limits its application in demanding structural contexts. The utilisation of fibre-reinforced polymer (FRP) composites, such as carbon (CFRP), glass (GFRP), or basalt (BFRP) fibres embedded in polymer matrices, has been demonstrated to significantly enhance the mechanical properties of timber, including stiffness, ductility, and load-bearing capacity. This enhancement is achieved while maintaining the material low weight and corrosion resistance.

LCA results show that using timber and FRP together produces less carbon than using steel or reinforced concrete. Using pre-made hybrid parts means less waste, faster assembly, and better quality control, which fits with sustainable and circular construction principles. Using FRP instead of steel reduces the need for maintenance due to rust and makes the structure last longer, which is better for the environment.

Recent developments have shown how Design for Disassembly (DfD) can be used to connect things in a way that makes it easy to take them apart and reuse the parts. This helps to keep materials in use by supporting reuse and recycling in modular timber buildings. This makes it easy to replace parts and reduces demolition waste and the use of resources.

Furthermore, the integration of Building Information Modeling (BIM) and digital twin technologies with environmental assessment tools enables designers to optimise sustainability metrics, material circulation, and adaptive reuse potential from the earliest design phases. BIM facilitates the precise documentation of material quantities and connection types, thereby supporting the development of end-of-life dismantling plans [2]. Digital twins further facilitate real-time monitoring of building performance and prediction of maintenance needs, enhancing lifecycle management and circularity.

The challenges that persist in relation to the fire resistance, durability, and recyclability of polymer-based FRP composites, as well as the lack of harmonised standards for structural design and LCA assessment, are well documented. Future research directions include the development of bio-based and recyclable FRP matrices, the creation of adaptive hybrid joints, and the establishment of standardized Environmental Product Declarations (EPDs) for timber and composite materials. It is anticipated that these innovations will establish timber–composite systems as pivotal enablers of low-carbon, resilient, and circular construction [3].

This study will provide a detailed discussion of all aspects of the latest advances in timber-composite structures for sustainable and green building.

Keywords: wood, timber composites, fiber-reinforced polymers (FRP), sustainable construction, circular economy, life cycle assessment (LCA), hybrid structures, bio-based materials.

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Environmentally Friendly Sustainable Thermoset Vitrimer-Containing Polyrotaxane

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Abstract:
Durable green plastics with extended lifespans have self-healing properties and shape memory andare chemically recyclable and marine biodegradable. These plastics are attracting attention in applications such as adhesives and carbon fiber composite materials. Vitrimers satisfy many of these requirements, interms of reprocessability and self-healing. Herein, we report significant improvements in the properties of vitrimers induced by the ester-exchange reaction between polyester-grafted polyrotaxane (PR) and the ester bonds of epoxy resin vitrimer to achieve the uniform molecular dispersion of PR. The optimal epoxy resin vitrimer incorporated with PR (VPR) exhibited enhanced toughness, with an elongation at break 5.3 timesgreater than that of a vitrimer devoid of PR; it also showed self-healing properties, was chemically recycled 10times faster, and was recovered twice as fast. These results can be ascribed to the sliding diffusion motion of the PR, which lowers the energy required for transesterification. Furthermore, VPR showed 25 wt% biodegradation following exposure to seawater for 30 days. These findings may lead to the development of environmentally friendly plastics that exhibit most of the properties required for a circular economy.

Keywords: Vitrimer, Polyrotaxane, Circular economy, Supramolecular, Toughness.

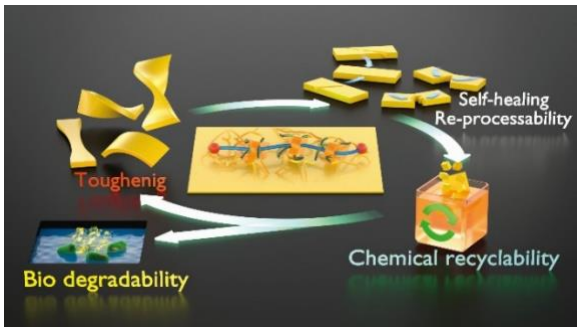

Figure 1: Vitrimer containing poryrotaxane for circular economy.

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Sustainable Hybrid Composites from Recycled PETG, TPU, and Tennis Strings Reinforced with Carbon, Glass, and Tenron Mineral Fibers via Hot Compaction

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Abstract
This work reports the design, fabrication, and characterization of sustainable hybrid composites derived from post-consumer 3D printing waste (PETG and TPU) and recycled tennis strings, reinforced with chopped carbon (CF), glass (GF), and Tenron mineral Fibers. The polymer powders were consolidated via hot compaction at 200 °C under 35 MPa for 20 minutes, followed by a low-temperature healing treatment (60 °C for 6 h) to promote interparticle bonding and enhance matrix–fiber cohesion. Microstructural and morphological analyses revealed improved matrix continuity, fiber wetting, and overall densification. Various composite formulations were developed to achieve optimal mechanical performance, and both experimental testing and finite element analysis (FEA) of mechanical behaviour demonstrated significant improvements in tensile strength, flexural modulus, impact resistance, and damage tolerance compared with unreinforced recycled polymer blends. This study highlights that PETG toughened with TPU delivers an optimal combination of processability, interfacial adhesion, toughness, and sustainability. These findings demonstrate a feasible route for converting polymer waste into high-performance, engineering-grade composites, supporting circular economy strategies in polymer recycling.

Novelty statement: This work presents a first demonstration of combining recycled PETG, TPU, and tennis strings with multi-fiber reinforcement (CF/GF/Tenron) in a hot-compaction process to achieve mechanically robust, sustainable hybrid composites suitable for engineering applications. The approach simultaneously addresses waste valorization, circular material flow, and structural performance, offering a practical pathway for high-value polymer reuse.

Keywords: Recycled polymers; PETG; TPU; Hybrid composites; Hot compaction; Fiber reinforcement; Circular economy; Mechanical performance

Rheological behavior and Dynamic-Mechanical properties of Polyamide 11 composites filled with Bamboo Flour

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Abstract:
Polyamide 11 (PA11), a bio-based thermoplastic derived from renewable feedstocks, has gained prominence as a sustainable alternative to petroleum-based polymers. When reinforced with natural fillers such as bamboo flour (BF), PA11 offers the possibility of developing biocomposites with improved environmental performance while tailoring their rheological and dynamic-mechanical behavior for specific applications. This study investigates the influence of bamboo flour incorporation on both the melt rheology and viscoelastic properties of PA11, with the aim of understanding the structure–property relationships governing processing behavior and mechanical performance.
Composites with varying BF loadings (10 and 20 percent by weigth) were produced through melt compounding and subsequently characterized under dynamic oscillatory conditions taking the neat PA11 and PA11 processed under the same conditions as the reference materials. The introduction of bamboo flour led to an overall increase in melt viscosity, more pronounced at low shear rates, indicative of restricted molecular mobility and the formation of micro-scale interactions between filler particles and the polymer matrix. All formulations displayed clear shear-thinning behavior, which intensified with increasing BF content, demonstrating that despite the viscosity rise, the composites maintain processability under typical industrial shear fields. This rheological response reflects the transition from a predominantly polymer-controlled flow to a system influenced by particle–particle and particle–matrix interactions.
Dynamic-mechanical analysis revealed significant modifications in the viscoelastic spectrum of PA11 upon BF addition. Both storage modulus (G′) and loss modulus (G″) increased across the evaluated frequency and temperature ranges, confirming the stiffening effect imparted by the filler. At higher loadings, the composites exhibited a tendency toward pseudo-solid-like behavior at low frequencies, associated with the onset of a weakly percolated microstructure. The reduction in damping factor (tan δ) with increasing BF further emphasized the shift toward more elastic-dominated behavior. Temperature-sweep measurements showed an enhancement in the rubbery-plateau modulus, suggesting improved resistance to thermomechanical deformation.
Overall, the results demonstrate that bamboo flour is an effective natural reinforcement for PA11, enhancing rigidity and elastic response while still enabling favorable processing characteristics. These findings contribute to the development of high-performance, bio-based composites suited for structural, automotive, and consumer-product applications where sustainability, mechanical robustness, and manufacturability are simultaneously required.

Keywords: Polyamide 11, Bamboo flour, Rotational rheology, Dynamic-mechanical tests, Structure-property relationships

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Tribocatalytic Degradation of Paracetamol Using Sol–Gel and Hydrothermally Synthesized ZnO and Ho-Modified ZnO

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Abstract:
In this study, ZnO and Ho-doped ZnO nanoparticles (1 and 2 mol%) were synthesized via two different methods: hydrothermal and sol–gel synthesis. The prepared materials were investigated for their tribocatalytic activity toward the degradation of paracetamol, a widely detected pharmaceutical contaminant in aquatic environments. The morphology and elemental composition of the nanopowders were examined by SEM–EDS, revealing significant differences between the samples, with hydrothermally synthesized materials exhibiting a rod-like morphology. Structural and optical properties were further analyzed using XRD, UV–Vis spectroscopy, and PLS analysis. To evaluate the influence of synthesis method, dopant concentration, and water composition on tribocatalytic performance, degradation experiments were carried out in different aqueous media, including distilled, tap, and mineral water, as well as using rods of different shapes. Among the investigated samples, hydrothermally synthesized ZnO doped with 2 mol% Ho demonstrated the highest catalytic activity, achieving 97% degradation of paracetamol within 24 h. This enhanced performance can be attributed to improved charge separation induced by Ho doping and the rod-like morphology of the particles. Furthermore, the degradation efficiency was found to be higher in distilled water compared to tap and mineral water.
These results highlight the combined effect of synthesis method, Ho doping, and water composition on the tribocatalytic degradation efficiency of paracetamol.

Keywords: tribocatalysis, paracetamol, sol-gel, hydrothermal method, water, ZnO/Ho powders.

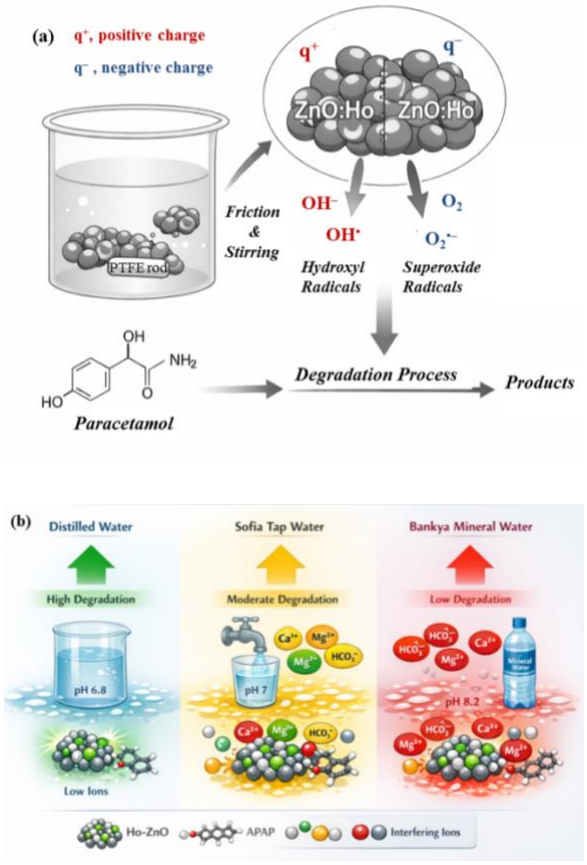

Figure 1: (a) iagram of a potential reaction mechanism using Ho-modiffied ZnO catalysts; (b) Effect of aqueous medium composition on tribocatalytic degradation of paracetamol using ZnO/Ho powder.

Comparative Study of Albumin Nanoparticles Loaded with Resveratrol or Curcumin

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Abstract:
The use of natural antioxidants in the treatment of different diseases is a widely research topic nowadays. For instance, resveratrol and curcumin are natural polyphenols with a significant antioxidant activity. However, both substances are characterized by low aqueous solubility that hinders their bioavailability. The incorporation of hydrophobic substances in polymeric nanoparticles is considered a suitable strategy for boosting their application. Therefore, in the current study resveratrol and curcumin were loaded in bovine serum albumin polymeric nanospheres via the desolvation method. The encapsulation efficiency was approx. 76% for resveratrol and 88% for curcumin. The resveratrol-loaded nanoparticles possessed average size of 145 nm, PDI of 0.251 and zeta potential of -22.6 mV, while the values for the curcumin-loaded particles were 163 nm size, 0.234 and -28.5 mV, respectively. TEM confirmed the small size of the systems. In vitro release tests revealed slower release of curcumin (56h) vs. resveratrol (8h) (Figure 1). Molecular docking between resveratrol or curcumin as ligands and albumin as a receptor revealed biding energies of -7.8 and -8.8, respectictively. DPPH and ABTS assays for evaluating the radical scavenging activity of the systems were also performed. The encapsulation of both resveratrol and curcumin enhanced their radical scavenging activity compared to their free forms, especially against the ABTS radical (Figure 2). Moreover, the encapsulated curcumin showed higher antioxidant activity than the encapsulated resveratrol. Thus, the hydrophobic polyphenols resveratrol and curcumin were successfully incorporated in albumin nanoparticles. Curcumin showed stronger interactions with albumin, confirmed by higher encapsulation efficiency, slower release and higer binding energy, as well as stronger radical-scavenging activity.

Keywords: resveratrol, curcumin, albumin, nanoparticles, drug delivery, sustained release, molecular docking, antioxidant activity

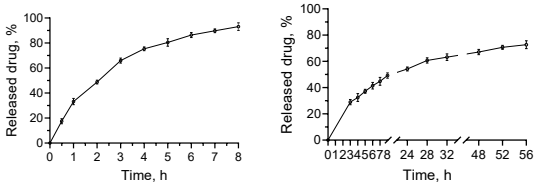

Figure 1: In vitro release study of resveratrol or curcumin loaded albumin nanoparticles.

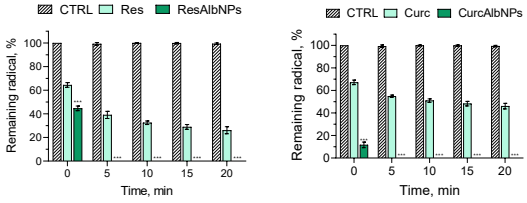

Figure 2: Scavenging activiy of resveratrol or curcumin loaded albumin nanoparticles against ABTS radical.

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Acknowledgements:
This research was funded by the European Union-NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, Project BG-RRP-2.004-0004-C01.

Incorporation of Curcumin-Albumin Nanoparticles in PVA Patch for Dermal Application

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

Abstract:
The polyphenol curcumin is a widely researched natural antioxidant due to its abundance of pharmacological effects. However, its limited aqueous solubility worsens its biopharmaceutical characteristics and hinders its application. The encapsulation of curcumin in nanoparticles could be considered an appropriate approach to increasing its solubility and enhancing its application. Therefore, the aim of our study was to develop curcumin-albumin nanoparticles and subsequently incorporate them into a polyvinyl alcohol (PVA) patch, producing a suitable form for dermal application. The nanoparticles were prepared via the desolvation method at different curcumin-albumin rations, resulting in approx. 88% encapsulation efficiency. The systems were characterized by small mean diameter of 162 nm, narrow size distribution (PDI = 0.234) and negative zeta potential (-28.5 mV). TEM confirmed the small size and showed near-spherical shape of the particles (Figure 1). In vitro release test revealed sustained release for more than 50 h. Protein-ligand docking indicated strong interactions between curcumin and albumin (Figure 2). This was confirmed by diffuse-reflectance UV–vis and XRD analyses. The encapsulation of curcumin enhanced its scavenging activity against ABTS and DPPH radicals. Moreover, the curcumin-albumin nanoparticles were successfully incorporated in a PVA hydrogel patch and complete release of crucrumin from the patch was observed. Taking into consideration the results, the curcumin-albumin nanoparticles-loaded PVA patch could be considered an appropriate dermal form for the delivery of curcumin for treatment of skin diseases, related to oxidative stress.

Keywords: curcumin, albumin, nanoparticles, polyvinyl alcohol, drug delivery, sustained release, molecular docking, antioxidant activity

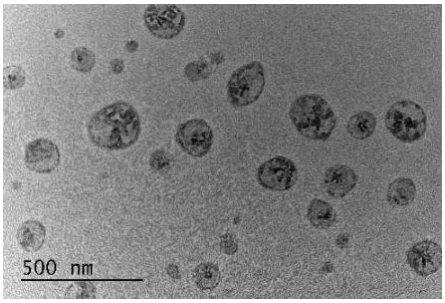

Figure 1: TEM of curcumin-albumin nanoparticles.

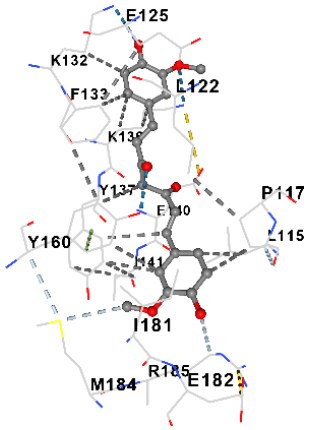

Figure 2: Presentation of the interactions between curcumin and albumin.

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Acknowledgements:
This research was funded by the European Union-NextGenerationEU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, Project BG-RRP-2.004-0004-C01.

Synthesis, Characterization, and Fabrication of a Poly(L-lactide-*co*-ε-caprolactone) Block Copolymer for Absorbable Nerve Conduits

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[2]Bioplastics Production Laboratory for Medical Applications, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand
[3]Center of Excellence in Materials Science and Technology, Chiang Mai University, Chiang Mai, Thailand
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[5]Department of Chemistry, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand

Abstract:
This study presents the synthesis and characterization of a poly(L-lactide-*co*-ε-caprolactone) (PLCL) tapered block copolymer using ring-opening polymerization (ROP) with stannous octoate ($Sn(Oct)_2$) as a catalyst. The resulting copolymer, with a composition of 48.9 mol% L-lactide and 51.1 mol% ε-caprolactone, was noted for its transparency and elastomeric properties. Molecular weight analyses via Gel Permeation Chromatography (GPC) yielded values of 8.04×10^4 g mol^{-1} for number-average molecular weight (M_n) and 1.36×10^5 g mol^{-1} for weight-average molecular weight (M_w). Low elastic moduli were observed, measuring 0.91 MPa and 1.16 MPa at 100% and 300% strain, respectively. Rheological assessments at 150 °C indicated a Newtonian viscosity of 6754 Pa·s and a Power Law index of 0.35, highlighting its potential for biomedical applications, especially in nerve tube fabrication where porous tubular scaffolds with pore sizes of 2.3–2.5 μm were successfully produced through a combination of leaching and phase immersion precipitation techniques.

Keywords: biodegradable aliphatic polyesters, PLCL copolymers, rheology, ring-opening polymerization, thermal properties

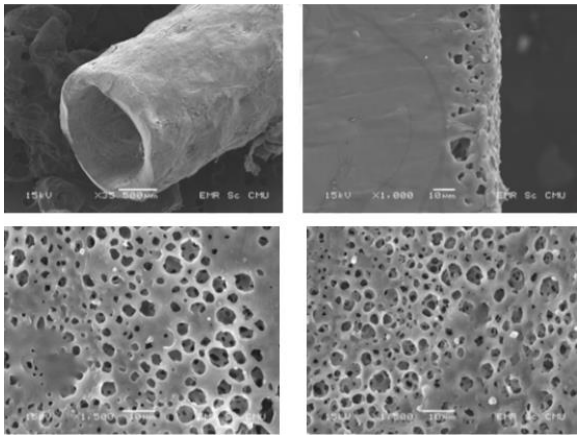

Figure 1: SEM images of the favored porous PLCL tubes produced by melt extrusion/phase immersion precipitation methods at room temperature (30 °C) using DMF/1,4-dioxane as solvent and ethanol/chloroform (9:1) as non-solvent.

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Integration of anthocyanins into bacterial cellulose films for food safety enhancement in fish

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Abstract:
Anthocyanins are water-soluble pigments that display distinct color variations depending on the pH of their environment, appearing red to purple under acidic conditions and shifting to blue in alkaline conditions. Traditionally, anthocyanins have been employed as natural food colorants, and they are widely present in red, purple, and blue fruits and vegetables, including grapes, blueberries, and purple cabbage. This pH-responsive property offers significant potential for applications in food preservation. One promising application is the monitoring of fish freshness. Compared with mammalian meat, fish muscle possesses a looser structure and lower fiber content, which facilitates bacterial invasion and proliferation. Consequently, fish products deteriorate more rapidly than meat. During spoilage, fish release volatile nitrogenous compounds such as biogenic amines, ammonia, dimethylamine, and trimethylamine. These compounds alter the pH of the fish tissue, thereby inducing visible color changes in pH-sensitive indicators. By integrating bacterial cellulose (BC) with natural pH-sensitive pigments such as anthocyanins, a smart packaging film was developed to enable intuitive monitoring of fish freshness. The physicochemical properties of the film were characterized using scanning electron microscopy (SEM), Brunauer–Emmett–Teller (BET) surface area analysis, Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and water vapor transmission rate (WVTR) measurements. In addition, the film's performance was evaluated during fish storage by monitoring pH, total volatile basic nitrogen (TVB-N), and total bacterial count, along with the corresponding color difference (△E) of the film.

Keywords: Anthocyanins, bacterial cellulose, color difference, fish freshness, pH-sensitive.

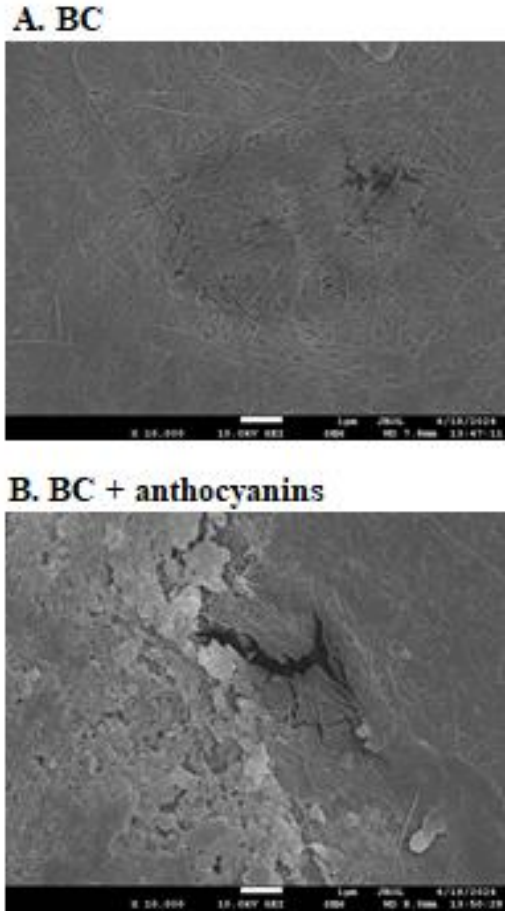

Figure 1: SEM images (× 10 k) of the BC film and the BC + anthocyanins film.

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Enhanced cell adhesion on poly-e-caprolactone for heart valve tissue engineering by H_2-N_2 plasma treatment

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Abstract:

Tissue engineering (TE), a multidisciplinary alternative solution, provides a sustainable and reliable substitution of damaged tissues by combining engineering with biomedicine. A tissue-engineered heart valve is a fully functional tissue facilitated through the cultivation of autologous cells on appropriate scaffolds. Scaffold's surface charge and wettability are the main factors to significantly affect cell adhesion[1], which is known to be favourable on hydrophilic surfaces[1]. Moreover, biocompatible scaffolds that induce minimal immunogenic response are also essential for successful tissue engineering[2,3]. However, commonly used biocompatible polymers in industry with preferable bulk properties lack desirable surface properties. For example, biomedical polymers, such as poly-ε-caprolactone (PCL) or polylactic acid (PLA), which are widely used as scaffolds in TE, are known for their satisfying structural and mechanical properties, but due to their surface characteristics, cell attachment and consequently cell growth on these polymers are limited[4]. A promising strategy is to select a biomaterial with ideal bulk properties and optimize the surface characteristics, such as hydrophilicity, charge, and energy. In this study, we investigated the possible effect of H_2-N_2 plasma treatment on the optimization of PCL surface wettability to see the feasibility of improvement in cell adhesion and proliferation. Our results showed an increase in the hydrophilicity of the 650 nm-PCL specimens after plasma treatment, which was followed by a significant enhancement in cell attachment without altering PCL mechanical properties. Plasma surface modification using H_2-N_2 plasma is an effective approach that can be used to improve PCL cell adhesion and, consequently, cell growth without altering its bulk properties and fibre morphology.

Keywords: Heart valve tissue engineering, biocompatible polymer, plasma treatment, wettability, cell attachment.

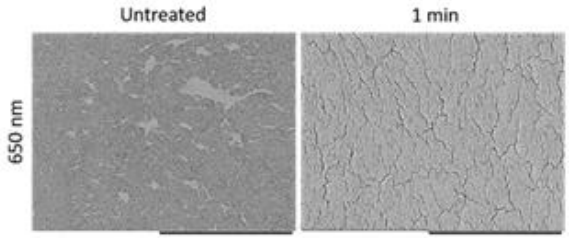

Figure 1: Representative SEM images of PCL with 650 nm fibre diameter, seeded with 250k cells after 48h of incubation. Scale bar 1mm. Light grey = cells; dark grey=PCL

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Novel Dental Implants via Hybrid Ceramic Reinforcements and Dual Manufacturing Routes

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Abstract

This work presents a unified materials design strategy that integrates bioinspired polymer-ceramic composites with advanced additive manufacturing routes to engineer structurally stable and biologically compatible dental constructs. Two complementary reinforcement concepts were explored to address distinct functional demands in restorative and regenerative dentistry. In the first approach, collagen-derived gelatin matrix was reinforced with clinically established calcium phosphate phases to emulate the hierarchical architecture of natural dental tissues. SSE 3D printing was employed as a near-ambient fabrication route, enabling precise architectural control while preserving bioactive functionality [1]. The influence of particle geometry, thermal history and dispersion on scaffold integrity and cytocompatibility was systematically examined, establishing that un-sintered ceramic oxides bring higher increase in mechanical performance.

In parallel, an oxide ceramic hybrid composed of barium zirconate, yttria and strontium titanate was introduced as a novel reinforcement phase in a high-performance polyetherimide matrix [2]. Mechanochemically activated ceramic powders were incorporated via solution processing to promote interphase formation and segmental mobility restriction within the polymer network. By combining bioactive mineral systems for tissue-regenerative scaffolds with strain-tolerant oxide ceramics for mechanically demanding applications, this study establishes a dual-route platform for dental implant materials design. The proposed strategy bridges additive manufacturing, interfacial engineering and hybrid reinforcement concepts, offering a scalable pathway toward durable, cytocompatible and architecturally tailored dental implants.

Keywords: Dental implants; Hybrid composites, Additive manufacturing; Gelatin scaffolds; Oxide ceramics

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Porous inorganic nanoparticles for Improved Nutrient Delivery and Environmental Sustainability

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Abstract:
In precision agriculture, the development of sustainable systems for the efficient delivery of plants nutrients is a key challenge, due to the losses associated with conventional fertilization methods and their environmental impact.
Conventional agrochemicals have low bioavailability and low precision to reach the target. This causes not only large economic losses but also significant environmental impact. A demand in the optimal use of agrochemicals in agriculture is a must. In this context, porous inorganic nanoparticles have emerged as promising nanoplatforms to enhance nutrient release efficiency while reducing the negative environmental effects.
Nanoclays have been widely proposed in various industrial applications owing to their broad range of properties, including high resistance to adverse environmental conditions, chemical and mechanical stability, easy access to near-surface deposits, and low cost.
In addition, nanoclays have high specific surface area, layered structure, and high cation exchange capacity (CEC) make these nanomaterials excellent adsorbents.
In particular, montmorillonite, a naturally clay, may contain different interlayer cations such as sodium (Na^+), potassium (K^+), and calcium (Ca^{2+}), further expanding its potential for nutrient retention and exchange applications.
On the other hand, inorganic nanoparticles as porous silica stands out due to its tunable porous structure and high biocompatibility, making them a suitable nanoplatform for controlled nutrients release. Owing to its generally inert and porous nature, the release of nutrients, such as phosphate, ammonium, or potassium mainly occurs through diffusion from the nanopores of silica nanoparticles into the soil water, enabling a controlled and sustained availability.
In this work, porous inorganic nanoparticles included montmorillonite (bentonite) nanoclay and porous silica nanoparticles were explored as sustainable systems for nutrient delivery in water tests by electrical conductivity and spectrophotometric measurements (Figure 1).
Furthermore, the porous structure and chemical composition of these nanomaterials were characterized using conventional experimental techniques, such as thermogravimetric analysis (TGA-DSC), BET isotherms, CO_2 isotherms, and fourier-transform infrared spectroscopy (FTIR).
The results highlight the potential of both inorganic nanoparticles as efficient and environmentally friendly nanoplatforms to control the nutrient release in agricultural practices.

Keywords: porous silica-based nanomaterial, nanoclay, sustainability, nanofertilizer, delivery system applications.

Figure 1: Delivery system for nutrients in plants based on inorganic nanoparticles.

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Synergistic effect of Hypoxic Conditioning and Cell-Tethering Colloidal Gels enhanced Productivity of MSC Paracrine Factors and Accelerated Vessel Regeneration

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Abstract
Microporous hydrogels have been widely used for delivering therapeutic cells. However, several critical issues, such as the lack of control over the harsh environment they are subjected to under pathological conditions and rapid egression of cells from the hydrogels, have produced limited therapeutic outcomes. To address these critical challenges, cell-tethering and hypoxic conditioning colloidal hydrogels containing mesenchymal stem cells (MSCs) are introduced to increase the productivity of paracrine factors locally and in a long-term manner. Cell-tethering colloidal hydrogels that are composed of tyramine-conjugated gelatin prevent cells from egressing through on-cell oxidative phenolic crosslinks while providing mechanical stimulation and interconnected microporous networks to allow for host-implant interactions. Oxygenating microparticles encapsulated in tyramine-conjugated colloidal microgels continuously generated oxygen for 2 weeks with rapid diffusion, resulting in maintaining a mild hypoxic condition while MSCs consumed oxygen under severe hypoxia. Synergistically, local retention of MSCs within the mild hypoxic-conditioned and mechanically robust colloidal hydrogels significantly increased the secretion of various angiogenic cytokines and chemokines. The oxygenating colloidal hydrogels induced anti-inflammatory responses, reduced cellular apoptosis, and promoted numerous large blood vessels in vivo. Finally, mice injected with theMSC-tethered oxygenating colloidal hydrogels significantly improved blood flow restoration and muscle regeneration in a hindlimb ischemia (HLI) model.

Keywords: keyword 1; Colloidal hydrogel 2; Vessel Regeneration 3; Paracrine Factors

Acknowledgement:
This research was supported by Korea Institute for Advancement of Technology (KIAT) grant funded by the Korea Government (MOTIE) (RS-2025-25396348).

Novel fluorinated polynorbornene dicarboximide for gas separation

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Abstract:
Nowadays, air pollution due to fossil fuel combustion and industrial emissions is one of the biggest environmental challenges society faces and membrane technology has experienced significant growth as a method that can be used to separate gas pollutants in a more convenient way, in contrast to other existing methods [1]. Polymer-based membranes have been widely used for gas separation due to their efficiency, low energy consumption and versatility. Among the materials employed, polynorbornene stands out because of its facile synthesis, good thermal and mechanical stability and specially their ease of chemical modification and functionalization, in order to tailor its properties for different applications [2]. Previous studies have shown that the incorporation of fluorinated substituents in the chemical structure of the monomer increases free volume, enhances gas permeability and can improve selectivity [3].
In this work, a new fluorinated polynorbornene dicarboximide was synthesized and characterized with the goal of developing high-performance membranes for gas separation. The monomer was synthesized from norbornene-*5, 6*-dicarboxylic anhydride (NDA) and a fluorinated amine through a two-step synthetic route and subsequently polymerized via ring opening metathesis polymerization (ROMP) using second generation Grubbs catalyst. Structural characterization of both monomer and polymer was performed using FT-IR and NMR (^{1}H, ^{13}C, ^{19}F). Dense membranes (**Figure 1**) were prepared by solvent casting and evaluated through thermal and mechanical analysis. Density measurements were obtained and fractional free volume was estimated using the Bondi method. Gas permeability measurements would give useful information about the structure-property relationships that define gas transport in fluorinated polynorbornene membranes and validate the expected performance enhancements in permeability and ideal selectivity for different gas pairs, from the incorporation of these groups into the polymer chemical structure.

Keywords: ROMP, polynorbornene dicarboximide, gas separation, membrane technology.

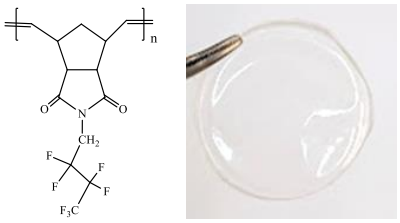

Figure 1: Chemical structure of the synthesized polymer and the membrane prepared by casting.

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