POLYMERS 2025, COMPOSITES 2025 AND 3BS MATERIALS TECH 2025

INTERNATIONAL JOINT CONFERENCE

16 - 18 APRIL 2025 | ALBUFEIRA, PORTUGAL

Book of Abstracts

Organizer

SETCOR Conferences & Exhibitions

Polymers / Composites / 3Bs Materials Tech 2025 Joint International Conferences Program

16 - 18 April 2025, Albufeira - Portugal

Wed. 16 April 2025		
08:00 - 12:00	**Conference Registration / Welcome Coffee Break / Posters Installation**	
	Conference Room Balaia	
	Polymers / Composites / 3Bs Materials 2025 Plenary Session I. A	
	Session's Chairs: **Prof. Robert J Young, University of Manchester, UK** **Prof. Maria Beatrice Coltelli, University of Pisa, Italy**	
10:00 - 10:30	Towards 100% circularity of plastics, a road map **G. Mitchell**	**Prof. Geoffrey Mitchell**, Polytechnic Institute of Leiria, **Portugal**
10:30 - 11:00	Mechanical Behavior of PLA/Fe3O4-Np Nanofibrous Materials Prepared by Electrospinning and Solution Blow Spinning N. Nikolić and **J. González-Benito**	**Prof. Javier Gonzalez-Benito**, University Carlos III de Madrid, **Spain**
11:00 - 11:30	3D printing technology for bone tissue engineering: biomimetic apatites as osteoinductive ingredient for nanocomposite inks design E. Campodoni, G. Vicinelli, A. Elsebahy, K. Mustafa, M. Muraro, I. Martin and **M. Sandri**	**Dr. Monica Sandri**, CNR-ISSMC-Faenza, **Italy**
11:30 - 12:00	GRAM®, the winding technology for space structures **G. Pommatau** and D. Macieira	**Dr Gilles Pommatau**, Thales Alenia Space France, **France**
12:00 - 14:00	**Lunch Break**	
	Polymers 2025 Session I. B: **Synthesis, Processing and Characterization**	
	Session's Chairs: **Prof. Javier Gonzalez-Benito, University Carlos III de Madrid, Spain** **Prof. Geoffrey Mitchell, Polytechnic Institute of Leiria, Portugal** **Prof. Sergio Torres-Giner, Polytechnic Univ. Valencia, Spain**	
14:00 - 14:30	Amine functionalized polymers and compounds for protective coatings in safe applications **M.B. Coltelli**, V.Gigante, L. Aliotta and A. Lazzeri	**Prof. Maria Beatrice Coltelli**, University of Pisa, **Italy**
14:30 - 14:45	Processing and Mechanical Characterization of ASA/PET Blend with Compatibilizing Agents for Large Format Additive Manufacturing **B.G. Silva-García**, P. Burgos, D.L. Sales and S.I. Molina	**Mrs. Blanca G. Silva-García**, University Cádiz, **Spain**
14:45 - 15:00	Development of infrared polymer optical filters based on sulfur and cross-linking agents **M. Guerchoux**, O. Muller, C. Bruder, V. Allheily, B. Lallemand, A-S. Schuller, C. Delaite and L. Merlat	**Mrs. Morgane Guerchoux**, French-German Research Institute of Saint-Louis, **France**
15:00 - 15:15	Validation of the Karrenberg/Wortberg Melting Model for Polyamide in Polymer Injection Molding **S. Schaufler**, S. Kleindel, U. Stritzinger, D. Altmann, T. Köpplmayr and G. Berger-Weber	**Ms. Sarah Schaufler**, Johannes Kepler University **Austria**
15:15 - 15:30	Structure-property relationships in coil coatings: Assessing the capability of molecular dynamics simulation for the prediction of glass transition temperature **Z. Thebault**	**Mr. Zahir Thebault**, Imperial College London, **UK**
15:30 - 15:45	Poly(3-octylthiophene-2,5-diyl) – based composite material as high-capacity layer in potentiometric sensor – synthesis and application **N. Lenar**, R. Piech and B. Paczosa-Bator	**Dr. Nikola Lenar**, AGH University of Krakow, **Poland**
15:45 - 16:00	Analysis of Consumption Data and Migration calculations for ensuring Safety in Recycled Polystyrene Food Packaging **D. Mittermayr** and J. Fischer	**Mr. David Mittermayr**, Johannes Kepler University, **Austria**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session**	

16:30 - 16:45	Real-time X-rays investigation on the structural evolution of polyethylene during tenter-frame biaxial stretching **I. Squillante**, F. Gentile, R. Pantani, A. Guida, F. Auriemma and G. Portale	**Ms. Ilaria Squillante**, University of Groningen, **The Netherlands**
16:45 - 17:00	Modeling the Drying Kinetics of Polymer Volatile Systems Using Thermogravimetric Analysis Data **E. G. Viehböck**, T. Ehrmann, G. R. Berger-Weber, A. Hammer and C. Paulik	**Mr. Ernst Georg Viehböck**, Competence Center CHASE GmbH, **Austria**

Wed. 16 April 2025		
Conference Room Santa Eulália		
Composites Session I. C: Synthesis, Processing and Characterization		
Session's Chairs: **Dr. Monica Sandri, CNR-ISSMC-Faenza, Italy** **Prof Gintaras Denafas, Kaunas University of Technology, Lithuania** **Dr. Olga Sacco, University of Salerno, Italy**		
14:00 - 14:30	Hybrid toughening techniques for enhancing interlaminar fracture toughness and mechanical performance of thermoplastic composites **A. Ivankovic**, Y. Chen, V. Prasad, M. Yasar and N. Murphy	**Prof. Alojz Ivankovic**, University College Dublin, **Ireland**
14:30 - 15:00	Experiments and analysis of fatigue delamination in UD Layered composites **J. Botsis**	**Prof. John Botsis**, EPFL, **Switzerland**
15:00 - 15:15	Preliminary Design of COPV: Material Enhancement, Structural Design, and Manufacturing Process L. Bouhala, A. Laachachi and S. Klein. **L. Bouhala**, A.i Laachachi and S. Klein	**Dr. Lyazid Bouhala**, Luxembourg Institute of Science and Technology, **Luxembourg**
15:15 - 15:30	Folding of flax/polypropylene composites based on comingled fabric: Feasibility study S. Provost-Mattmann, **V. Dos-Santos-Martins**, V. Person and F. Hennebelle	**Dr. Valérie Dos Santos Martins**, Bourgogne Europe University, **France**
15:30 - 15:45	Human Robot Collaborative Draping of Carbon Fibre Composite Parts: Results of Three Case Studies **C. Eitzinger**, D. Zielinski and C. Frommel	**Dr. Christian Eitzinger**, Profactor GmbH, **Austria**
15:45 - 16:00	Segmentation Aware Attention Mechanism for Defect Classification of both Virgin and Recycled Carbon Fiber Fabric A. Kolli, M. Carpentieri, **D. Krajnc** and C. Eitzinger	**Mr. Denis Krajnc**, Profactor GmbH, **Austria**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session**	
Session's Chairs: **Prof. John Botsis, EPFL, Switzerland** **Prof. Alojz Ivankovic, University College Dublin, Ireland**		
16:30 - 17:00	Challenges on Multilayer Composites Disintegration and Materials Recovering for Waste Printed Circuit Boards **G. Denafas**, G. Miliauskas , E. Andriukonis, E. Griškonis, I. Pitak, V. Makarevičius, A. Baltušnikas, R. Kriukienė, A. Šleiniūtė, R.Ivanauskas, D. Goljandin and E. Blumbergs	**Prof Gintaras Denafas,** Kaunas University of Technology, **Lithuania**
17:00 - 17:15	Defects analysis and microstructural characterization of 3D-printed sintered parts of ceramic matrix composites (cordierite-graphene) Á. García Juarez, **I. Esguerra Arce**, J. García-Martínez, J. Hidalgo García, L. Illán Andrés, R. Giménez Pérez, A. Pastor Muro, C. Berges Serrano, G.H. Sánchez-Cosgalla and M. García-Martínez	**Mrs. Ingrid Esguerra Arce**, National Institute of Aerospace Technology, **Spain**
17:15 - 17:30	Predictive Modeling of Porosity Characteristics in High-Pressure Hydrogen Tanks using Augmented Fuzzy Cognitive AI **L. Achour**, Z. Zalila, Z. Aboura, B. Lorentz, D. Ruggi and K. Khellil	**Mrs. Lina Achour**, Univ. of Tech. Compiègne, **France**
17:30 - 17:45	Material characteristics of reused carbon fibre-reinforced polymers from wind turbine blades **S. Gerdes**, I. Möllmann and C. Lauter	**Mr. Sönke Gerdes**, PHWT Private University of Applied Sciences, **Germany**
17:45 - 18:00	Determinaton of the Aging State of Resin Systems in Wind Turbine Blades at the End of Lifetime with IR-Spectroscopy **I. Möllmann**, S. Gerdes, A. Brunner and, C. Lauter	**Ms. Imke Rita Moellmann**, PHWT Private University of Applied Sciences, **Germany**
18:00 - 18:15	Optimizing Recycling: Fragmentation and Sorting of GFRP Components in Battery Housings - Impact on Recyclate Properties **J. E. Grimmenstein**, T. Krampitz and H. Lieberwirth	**Mr. Julius Grimmenstein**, TU Bergakademie Freiberg, **Germany**

Wed. 16 April 2025		
Conference Room Algarve		
3Bs Materials Session I. D: Synthesis, Processing and Characterization		
Session's Chairs: **Prof. Michele Bianchi, University of Modena and Reggio Emilia - Unimore, Italy** **Prof. Luis Fonseca, Lisbon University, Portugal** **Dr. Elisabetta Campodoni, CNR-ISSMC, Italy**		
14:00 - 14:30	Extrusion-based 3D printing of multifunctional bioceramics for biomedical applications P.M.C. Torres and **S.M. Olhero**	**Prof. Susana M. Olhero**, University of Aveiro, **Portugal**
14:30 - 15:00	A bone substitute for dental use functionalized with hydrotalcite ZnAl and gallic acid prevents osteoclast formation in vitro **M.L.. Belladonna**, C. Suvieri, M. Bastianini, M.Sisani and L.Canton	**Prof. Maria Laura Belladonna**, University of Perugia, **Italy**
15:00 - 15:15	Chitosan derived from Hermetia illucens as a novel biomaterial for the production of nanofibrous scaffolds for wound healing **M. Giani**, B, Vigani, G. Sandri, A. Guarnieri, P. Falabella and S. Rossi	**Dr. Micaela Giani Alonso**, University of Pavia, **Italy**
15:15 - 15:30	Rheology-driven designing of high-performance bioinks for effective implementation of 3D-bioprinting in tissue engineering **L. Di Muzio**, V.C. Carriero, B. Bigi, S. Cesa, S. Petralito, P. Paolicelli and M.A. Casadei	**Dr. Laura Di Muzio**, Sapienza University of Rome, **Italy**
15:30 - 15:45	Fabrication of Hydrogel Composite for Tissue Engineering Applications; incorporating Magnetite nanoparticles **A.Vadakken Gigimon**, H. Machrafi and C. S. Iorio	**Ms. Anet Vadakken Gigimon**, Université Libre de Bruxelles, **Belgium**
15:45 - 16:00	Sandalwood-Reinforced Composites for Personalised 3D-printed Arm Fracture Fixation Braces Using Finite Element Analysis **Y. Zheng**, C. Vallés and C. Abeykoon	**Ms. Yashi Zheng**, University of Manchester, **UK**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session**	
Session's Chairs: **Prof. Maria Laura Belladonna, University of Perugia, Italy** **Prof. Susana M. Olhero, University of Aveiro, Portugal**		
16:30 - 16:45	PLGA based electrospun membrane for accelerated wound healing **A. Scarciglia**, G. Ferrauto, E. Di Gregorio, P. E. Porporato, P. Bracco and C. Cecone	**Mr. Angelo Scarciglia**, University of Turin, **Italy**
16:45 - 17:00	Isolation and characterization of polysaccharides from Colombian agro-industrial by-products as biomaterials from 3D Bioprinting **M. Osorio**, D. Muñoz, J. Moreno, D. Artunduaga, E. Correa, T. Naranjo, M. Martinez, C. Páramo, R. Valencia, A. Rodríguez, M. Ochoa, N. Montoya, O. Ochoa, C. Gómez and J. Velásquez-Cock	**Prof Marlon Osorio,** Pontificia Bolivariana University, **Colombia**
17:00 - 17:15	Exploring the structure and composition of Black Soldier Fly pupal shells throughout chitin extraction **A. Falgayrac**, V. Pellerin, C.Terrol, S. Faucher, P. Moonen, C. Courrèges, L. Rubatat and S.C.M. Fernandes	**Mr. Alexis Falgayrac**, IPREM/CNRS, **France**

Thu. 17 April 2025		
Conference Room Santa Eulália		
Polymers / Composites / 3Bs Materials 2025 Plenary Session II. A		
Session's Chairs: **Dr. Elisabetta Campodoni, CNR-ISSMC, Italy** **Dr. Antonietta Mancuso, University of Salerno, Italy** **Dr. Nikola Lenar, AGH University of Krakow, Poland**		
09:30 - 10:00	The Reinforcement of Polymer Nanocomposites with Carbon-Based Nanofillers **R.J. Young**	**Prof. Robert J Young**, University of Manchester, **UK**
10:00 - 10:30	Development of functional biopackaging from pomegranate wastes **S. Cesa**, F. Cairone, I.Arpante, M.Antonetti, S. Petralito, P. Paolicelli, L. Di Muzio	**Prof. Stefania Cesa**, "La Sapienza" University of Rome, **Italy**
10:30 - 11:00	**Morning Coffee Break / Posters Session**	
11:00 - 11:30	Synthesis of Fully Bio-based Copolymers with Tailor-Made Properties for Sustainable Food Packaging Applications Y. Flores, M. Pacheco-Romeralo, Martínez de Ilarduya and **S. Torres-Giner**	**Prof. Sergio Torres-Giner**, Polytechnic Univ. Valencia, **Spain**
11:30 - 12:00	Novel eco-friendly composites with mineral particles derived from ocean shells and eggshells on a matrix of biobased poly(ethylene terephthalate) **S. Kuciel** and K. Rusin-Żurek	**Prof. Stanislaw Kuciel**, Cracow University of Technology, **Poland**
12:00 - 14:00	**Lunch Break**	
Group Photo at 13:45		
Polymers / Composites 2025 Session II. B		
Session's Chairs: **Prof. Geoffrey Mitchell, Polytechnic Institute of Leiria, Portugal** **Prof. Robert J Young, University of Manchester, UK** **Prof. John Botsis, EPFL, Switzerland**		
14:00 - 14:30	Electrostatic Spraying for Additive Manufacturing **M.K.Patel**, Ritu and M.K. Gupta	**Dr. Manoj Patel**, CSIR-Central Scientific Instruments Organisation, **India**
14:30 - 15:00	Influence of Supplementary Cementitious Materials on the Strength of Sustainable Cementitious Concrete Composites **O. Corbu**, A.G Popa, L. Anastasiu and M.L. Dragomir	**Dr. Ofelia Corbu**, Technical University of Cluj-Napoca, **Romania**
15:00 - 15:15	Incorporation of carbons into PP/PBE blend for obtaining 3D-printable conductive polymer composites **S. Ursescu**, S. Grugeon, A. Ferri, A. Da Costa and L. Dupont	**Mr. Sebastian Ursescu**, Picardie Jules Verne University, **France**
15:15 - 15:30	Improving Process Stability in Mechanical Recycling of Thermo-plastic Composites with a Lab-Scale Dosing System **T. Mayrhofer**, J. Birtha, C. Marschik, G.R. Berger-Weber and K. Straka	**Ms. Tina Mayrhofer**, Johannes Kepler University, **Austria**
15:30 - 15:45	Novel composites reinforced with different types of fibers (basalt, quartz, aramid and polymide) on a biobased polyethylene terephthalate matrix **K. Rusin-Żurek** and S. Kuciel	**Ms. Karina Rusin-Zurek**, Cracow University of Technology, **Poland**
15;45 - 16:00	The effect of the reinforcement of ceramic tile waste powders on the microstructure and mechanical properties of composites based on epoxy vitrimer **P. Kozera**, S. Furgoł, J. Kamińska, K. Dydek and D. Kiełkiewicz	**Dr. Paulina Kozera**, Warsaw University of Technology, **Poland**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session**	

Thu. 17 April 2025		
Conference Room Algarve		
Polymers / Composites/ 3Bs Materials Session II. C: **Biobased Materials / Biopolymers / Biocomposites / Bio interfaces / Biomaterials applications**		
Session's Chairs: **Prof. Stefania Cesa, "La Sapienza" University of Rome, Italy** **Dr. Valérie Dos Santos Martins, Bourgogne Europe University, France** **Prof. Stanislaw Kuciel, Cracow University of Technology, Poland**		
14:00 - 14:30	Electroactive micropatterned materials for advanced biointerfaces **M. Bianchi**	**Prof. Michele Bianchi,** University of Modena and Reggio Emilia - Unimore, **Italy**
14:30 - 14:45	Brewers spent grain as main by-product for development of novel, high-performance bio-based polymers, polymer blends, and co-polymers **C. D'Aleo**, I. Canesi and D. Spinelli	**Mrs. Carlotta D'Aleo**, Next Technology Tecnotessile, **Italy**
14:45 - 15:00	Increasing the resistance of PLA-starch composites **V. Goetjes**, J-C. Zarges and H-P. Heim	**Mrs. Victoria Goetjes**, University of Kassel, **Germany**
15:00 - 15:15	Chemical Resistance of Regenerated Cellulose Fiber-Reinforced Bio-Polyamide 5.10 **C.K. Falkenreck**, J-C. Zarges and H-P.Heim	**Mrs. Celia K. Falkenreck**, University of Kassel, **Germany**
15:15 - 15:30	Development of Clays/Chitosan Nanocomposites for Microneedles Preparation **D. Ianev**, T. Rodrìguez, B. Vigani, M. Mori, C. Valentino, M. Ruggeri, G. Sandri, C. Aguzzi and S. Rossi	**Dr. Daiana Ianev**, University of Pavia, **Italy**
15:30 - 15:45	Composite scaffold based on Poly(lactic acid) and Chitosan/Hydrolyzed Collagen for the treatment of peripheral nerve injuriy **C. Valentino**, B. Vigani, M. Ruggeri, G. Sandri and S. Russi	**Dr. Caterina Valentino**, University of Pavia**, Italy**
15:45 - 16:00	Enhanced Targeting of Pancreatic Cancer Using N6L-Functionalized Lipid Nanocarriers Encapsulating Paclitaxel **L. Larue**, C. Chesneau, C. Houppe, B. Brissault, J. Penelle, I. Cascone and S. Belbekhouche	**Mrs. Laura Larue**, ICMPE/ CNRS-UPEC, **France**
16:00 - 16:30	**Afternoon Coffee Break / Posters Session**	
Session's Chairs: **Dr. Monica Sandri, CNR-ISSMC-Faenza, Italy** **Dr. Valérie Dos Santos Martins, Bourgogne Europe University, France**		
16:30 – 17:00	Development of Biomimetic Bi-Layered Hybrid Patches for Chronic Wound Management: Integrating Antimicrobial and Regenerative functions **E. Campodoni**, S. Bernardoni, G. Vicinelli, M. Saqawa, F. Bonvicini, G.A. Gentilomi, A. Grimaldi, M. Montesi and M. Sandri	**Dr. Elisabetta Campodoni,** CNR-ISSMC, **Italy**
17:00 - 17:15	Silencing AP-1 Signaling Accelerates Ischemic Wound Healing in the Elderly **L. Zhang** and P. Yu	**Dr. Luke Zhang**,The University of Texas, **USA**

Fri. 18 April 2025		
Conference Room Santa Eulália		
Polymers / Composites 2025 Session III. A: Energy and Environmental Applications		
Session's Chairs: Prof Gintaras Denafas, Kaunas University of Technology, Lithuania; Dr. Nikola Lenar, AGH University of Krakow, Poland; Dr. Lyazid Bouhala, Luxembourg Institute of Science and Technology, Luxembourg		
09:00 - 09:30	Carbon dioxide Conversion to Fuels and Chemicals using Polymer-Photocatalyst composites **O. Sacco**, A. Mancuso, V. Venditto and V. Vaiano	**Dr. Olga Sacco**, University of Salerno, **Italy**
09:30 - 10:00	Lignins extracted from banana pseudosteam: oxidation and evaluation on the removal of heavy metals from effluents A.F. Abreu, J.S. de Souza, T.C. Taha, F.D. Silva, A.C.R. da Silva, R.A. Maia, P. Benar, **A.R. Gonçalves**	**Dr. Adilson Roberto Goncalves**, São Paulo State University, **Brazil**
10:00 - 10:30	**Morning Coffee Break**	
10:30 - 11:00	Functionalized SBA-15 for Enhanced Copper and Cobalt Sorption in Contaminated Environments **M. Dulski**, A. Strach, R. Zaleski, M. Gorgol, K. Pawlik, P. Pawlik, M. Laskowska, A. Viskna, V. Grebnevs and Ł. Laskowski	**Dr. Mateusz Dulski**, University of Silesia, **Poland**
11:00 - 11:15	Electromagnetic shielding efficiency of composite laminates **M. Srivastava** and S. Basu	**Mr. Mukul Srivastava**, Indian Institute of Technology Kanpur, **India**
11:15 - 11:30	A Sustainable Approach to Phenol Production: Photocatalytic Benzene Hydroxylation Using Visible-Light-Active Photocatalyst/Polymer Aerogel Composites **A. Mancuso**, O. Sacco, V. Venditto and V. Vaiano	**Dr. Antonietta Mancuso**, University of Salerno, **Italy**
11:30 - 11:45	Prediction of Proof Test Outcomes for Type 4 High Pressure Hydro-gen Vessels with Composite Layers Using Machine Learning Models **L. Achour**, S. Destercke, B. Martus, D. Charry, Z. Aboura and K. Khellil	**Mrs. Lina Achour**, University Tech. Compiègne, **France**

Polymers / Composites / 3Bs Materials 2025 Posters Sessions

16 and 17 April 2025 at the Grande Real Foyer

(No posters sessions on 18 April 2025)

N.	Poster Title	Author, Affiliation, Country
1.	Recycling of mixed plastic waste: the effect of melt blending tempera-ture on the structure and mechanical properties **I. Rasilainen**, V. Lahtela and T. Kärki	**Ms. Ida Rasilainen**, Lappeenranta-Lahti University of Tech., **Finland**
2.	Synthesis of new polymeric materials for use as coatings of a "homemade" SPME fiber for the analysis of toxic and hazardous compounds I. Jakubowska , **B. Przybyła** and P. Marć	**Ms. Iwona Jakubowska**, Military University of Technology, **Poland**
3.	Polymethylacrylate with High Molecular Weight Obtained via Radical Polymerization with Iron Hydrometallation Initiation **A. Vignali**, B. Palucci, F. Bertini and S. Losio	**Dr. Adriano Vignali,** Institute for Chemical Sciences and Technologies, **Italy**
4.	Synthesis of Bio-based and Biodegradable polymers from monomers from renewable Biowastes via Biocatalysis and Green Chemistry **L. P. Fonseca**	**Prof. Luis Fonseca**, Lisbon University, **Portugal**
5.	Bio-based Thermosetting Resins from modified Epoxidized Soybean Oil S. Silvano, A. Vignali, F. Zaccheria, L. Boggioni and **F. Bertini**	**Dr. Fabio Bertini**, CNR-Institute of Chemical Science and Technologies, **Italy**
6.	Is the adsorption of styrene on clay enhanced by polymer? **E. Scholtzova**	**Mrs. Eva Scholtzova**, Institute of Inorganic Chemistry, **Slovakia**
7.	Numerical Simulation of Mechanical Properties of Hybrid Composites **E. Stankutė** and R. Janulionis	**Ms. Emilija Stankute**, Lithuanian Energy Institute, **Lithuania**
8.	Enabling nanocomposite synthesis from nanoparticle-based bimetallic reactive systems **N.A. Isaac**, S. Biswas, J. Rangaraj, J. Pezoldt and H.O. Jacobs	**Mr. Nishchay Angel Isaac**, TU Ilmenau, **Germany**
9.	Hybrid Metal Oxide Heterostructures for Thermoelectric and Photovoltaic Applications M. Volkova, R. Meija, D. Gavars, A. Sarakovskis, A. Kons, D. Erts and J. Andzane	**Dr. Margarita Volkova**, University of Latvia, **Latvia**
10.	Eco-Friendly Biocomposites from Chestnut Waste: Production, Optimization, and Characterization **O.M. Freitas**, S.B. Silva, P. Esfandiari, J. F. Silva and V.F. Domingues	**Prof. Olga M. Freitas**, ISEP-Polytechnic of Porto, **Portugal**
11.	Driving Sustainability in the Automotive Industry: Hybrid Yarns for Thermoplastic Biocomposites **C. Oliveira**, I. Costa, S. Silva, M. Silva and F; Oliveira	**Mrs. Cristina Oliveira**, Technology Centre for Textile and Clothing, **Portugal**
12.	Recovery of continuous carbon fibers from composites via plasma-enhanced solvolysis D. Marinis, **E. Farsari** and E. Amanatides	**Dr. Ergina Farsari**, University of Patras, **Greece**
13.	Cattail fiber as an alternative material for insulation panels: properties and variation in different harvest season **S. Bibbo**, M. Gibier, P. Alao, S.A. Käärmelahti, L. Bedel and S. Adamopoulos	**Mrs. Silvia Bibbo**, Univ. of Agricultural Science Uppsala, **Sweden**
14.	Bacterial cellulose-based antioxidant biodegradable composite films for food-sustainable packaging **C. M. Kuo**, S. Q. Huang, B. C. Shi, Y. R. Chang and Y. T. Chen	**Dr. Chiu-Mei Kuo**, Chung Yuan Christian University, **Taiwan**
15.	Bacterial Nanocellulose Based Materials for Oral Tablet Formulation in Colon Targeted Delivery of 5-Fluoruracil **E. Martínez**, A. Guarín, V. Villada, M. Osorio, Y. Vélez, M.E. Morales and C. Castro	**Ms. Estefanía Martínez**, Pontifica Boivariana University, **Colombia**
16.	Application of multi-detection GPC Chromatography for detailed structural characterization of biodegradable synthetic polymers **T. Baković**, I. Šoljić Jerbić, L. Mandić and F. Faraguna	**Ms. Tatjana Baković,** Pliva Croatia Ltd, **Croatia**
17.	Development and Characterization of Crocin-Loaded Hyaluronic Acid/κ-Carrageenan Hydrogels for Enhanced Topical Therapy in Chronic Wounds **N. Genicio**, A. Martins, E. Niza, L. Diego, A. Ribeiro, L. Pastrana, J. Gallo, S. Sillankorva and M. Bañobre-López	**Mrs. Nuria Genicio** INL - International Iberian Nanotechnology Laboratory, **Portugal**

18.	Development of Bacterial Cellulose-Based Cell Culture Platforms Incorporating Bifunctional Peptides for Enhanced Biological Properties and Biomedical Applications **P. A. Fernandes**, A. R. Aragão, M.L. Fontes, N.A. Santos Filhos and H. S. Barud	**Ms. Paula de Abreu Fernandes**, University of Araraquara, **Brazil**
19.	Intratumoral Therapy of Prostate Cancer with Docetaxel Nanomedicines in Nude Mice E. Rivero-Buceta A. Bernal-Gómez, C. Vidaurre-Agut, J. María Benlloch, C.D. Vera Donoso and **P. Botella**	**Dr. Pablo Botella**, Politechnic University València, **Spain**
20.	Sonosensible liposomes development for transport and release of Gd-piclenol **A.Mangia,** M. Gagliardi and E. Terreno	**Dr. Alberto Mangia**, University of Turin, **Italy**
21.	The Influence of Nitrocarburization on the Functional Properties of Implants used in Thoracic Surgery **A. Kajzer**, W. Kajzer and G. Wielgus	**Prof. Anita Kajzer**, Silesian University of Technology, **Poland**
22.	The effect of PVD coatings on physicochemical properties of AZ31 magnesium alloy **M. Kiel-Jamrozik**, W. Jamrozik and J. Górka	**Dr. Marta Kiel-Jamrozik**, Silesian University of Technology, **Poland**
23.	Micro-Computed Tomography in the Qualitative Assessment of a Ceramic Prosthetic Crown Manufactured by the Pressing Method and CAD/CAM **A. Ziębowicz,** J. Oskroba, J. Juszczyk and J. Górski	**Prof. Anna Ziebowicz**, Silesian University of Technology, **Poland**
24.	3D Artificial Skin Model as a Novel Strategy for the Detection of Inflammasome-cascade Activation to Predict Amyotrophic Lateral Sclerosis **E. Scarpa**, U. D'Amora, I. Bonadies, N. De Cesare, R. Dubbioso, M. Nolano and I. Fasolino	**Dr. Enrico Scarpa**, CNR IPCB, **Italy**
25.	Epitope Mapping and DNA-Scaffold Sensors for Improved Diagnosis of Infectious Diseases **M. Cambra-Pellejà**, Q. Yang, L. Karadurmus, J. Marrugo, L. Baptista-Pires, C. Delgado, M. Vilaplana, J. Muñoz, J. Gandasegui and C. Parolo	**Ms. Maria Cambra**, Barcelona Institute for Global Health, **Spain**
26.	Towards new breast tumor models for personalized medicine: synthesis and characterization of marine biopolymer-based hydrogels **R. Bouhaya**, V. Pellerin, I. Séraudie, R. Iggo and S.C.M. Fernandes	**Ms. Rizlène Bouhaya,** Univ. Pau et des Pays de l'Adour, **France**
27.	Study of the antibacterial and hemocompatibility properties of hydroxyapatite obtained by sonochemistry for applications in biomedicine **J. Mendoza**, **C. Parra**, M. Sabino, M. Gomes, Z. Rivas, E. Cañizales, D. Soto, M. Fernández, R. Lugo, A. Bendayan, Y. Gutiérrez, J. Rodríguez, C. Alvarado, D. Suárez, R. Alezones, L. Teixeira and D. Melendres	**Dr. Cristina Parra**, Venezuelan Institute for Scientific Research, **Venezuela**
28.	Biomedical Potential of Chitosan extracted from the Suillus Mushroom Granulatus: Analysis of its Physicochemical Properties and Antibacterial Potential. **A. Balcazar**, **C. Parra**, C. Chinea, E. Cañizales, Z. Rivas, M. Fernández, R. Lugo, A. Bendayan, Y. Gutiérrez, J. Rodríguez, E. Catarí, R. Alezones, L. Teixeira and D. Melendres	**Dr. Cristina Parra**, Venezuelan Institute for Scientific Research, **Venezuela**
29.	Selenium Nanoparticles Stabilized in Tannic Acid: Toxicology Studies and Antibacterial Properties **Z. López-Cabaña**, M. Pariguana- Begazo, J. Alderete-Triviños and K. Juárez-Moreno	**Dr. Zoraya E. López Cabaña**, University Talca, **Chile**
30.	pH-sensitive release of biopharmaceuticals from halloysite nanotubes D. Acosta, I. Meneau, C. Campos, K. O. Juárez-Moreno, J. B. Alderete and **Z. López-Cabaña**	**Dr. Zoraya E. López Cabaña**, University Talca, **Chile**

Polymers / Composites / 3Bs Materials 2025 Plenary Session I. A

Towards 100% circularity of plastics – a road mapN

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Abstract:
After a century of the rapid development of plastics, attention has been redirected to the important question of sustainability. Many of the attributes of plastics, such as durability have turned out to be negative factors in the light of the poor management of plastics waste which has led to world-wide catastrophes both in the ocean and on the land [1]. Bioplastics are seen as one solution and chemical recycling is another. However, the success of plastics in the 20th Century poses many questions for the current use of materials, polyolefins and other thermoplastics have been found to be highly quality engineering plastics in terms of producing high quality parts for the safe distribution of water and electricity, lightweight materials for electric vehicles and so much more. These materials are easy to mass produce with high level of repeatability, surface finish and precision. Newer materials, including biobased materials lack one or more of these qualities. One route forward, is to increase the circularity of plastic parts [2]. In other words the granulated plastic materials at the end of the life of the part can be reused to make a new part with equivalent properties. Current practice leads to a fraction of plastic waste being recycled [2]. We explore the issues related to the practice of dealing with waste as a single stream from which materials are sorted. We contrast this with the possibilities which are available in closed loop recycling, where the product life is monitored throughout the life time of the product including its manufacturing pathway, so that the materials arriving for reuse have a well established origin, fabrication and product use cycle so that reuse becomes a much more straightforward process, than attempting to recycle a mixture of the same polymer type but with different compositions, processing pathways and product life cycles. We have set out a roadmap for such a system which we expect to explore with industrial partners in the near future. We believe that it is critical to understand all steps of the path from the feedstock pellets to the granulated plastic part to the end of life in order to understand how to design for recycling. Currently reuse and recycling is an afterthought when the end of life is reached. If we do not understand where property degradation occurs - in the manufacturing cycle? Or the product life cycle?, then how can we hope to design plastic parts which can be reused so as to achieve 100% circularity.
A key part of our road map is to explore in more detail the processing life cycle of the plastic part and we have chosen X-ray scattering as the technique with which to explore the transformations which take place in an injection moulding system We introduce this technique of operando x-ray scattering during injection moulding of plastics [3] and give examples of how we believe that it will provide much needed data on the effects of the processing life cycle and thereby help with design for recycling.
Keywords: circular economy, thermoplastics, end of life of plastic parts, property downgrading, operand X-ray scattering during injection moulding.

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Mechanical Behavior of PLA/Fe_3O_4-Np Nanofibrous Materials Prepared by Electrospinning and Solution Blow Spinning

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Abstract:
Due to their unique properties such as high surface-volume ratio, porosity, and small size, nanofibrous materials are promising candidates for a wide range of applications, including biomedical fields, tissue engineering, wound dressing, and food packaging. This study investigates the mechanical behavior of nanofibrous materials, with a focus on how factors like fiber size and orientation, structure and composition affect the mechanical performances of fibrillar nanocomposites.
Mechanical properties were evaluated through tensile testing and analyzed using fibrillar models to understand the impact of each factor on the material's mechanical behavior. The nanofibrous materials were prepared using two widely used techniques Solution Blow Spinning (SBS) and Electrospinning (ES). While these methods share similarities, they differ in processing conditions used to fabricate the nanofibers, more precisely the force that induce polymer stretching. To explore the influence of various parameters on mechanical behavior, we report the results of: 1) morphology, studied by scanning electron microscopy (SEM), 2) nanoparticle concentration, 3) structure, examined by Fourier transformed infrared spectroscopy (FTIR), 4) spinning conditions that causes polymer stretching, and 5) load direction (parallel/perpendicular, Figure 1). This study allow us to discuss how these factors influence tensile strength, elongation at break and Young's modulus, each of plays a distinct role in defining the mechanical properties of the final material.

Keywords: nanofibers, solution blow spinning, electrospinning, nanocomposites, polylactic acid.

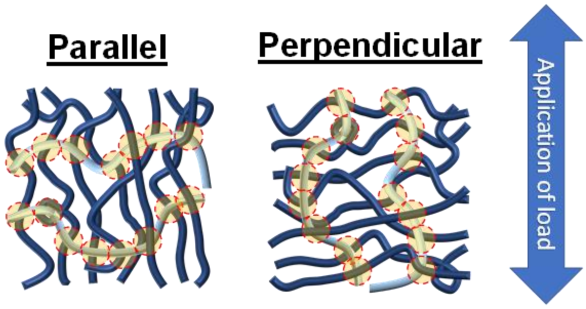

Figure 1: Figure illustrating the fibrous specimens when they are cut parallel and perpendicular to the collector's rotation.

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3D printing technology for bone tissue engineering: biomimetic apatites as osteoinductive ingredient for nanocomposite inks design

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Abstract:
Due to the increasing needs for 3D constructs for tissue engineering (TE) approaches, the 3D-printing process has attracted even more interest to better fulfil the TE demands and to improve the model fidelity in reproducing the complexity of biological architectures. In the common hope, 3D printed tissues will overcome many of the shortcomings of traditional tissue engineering ensuring precise control over structural design. However, advancement of bio-printing technology is limited by the availability of materials facilitating bio-printing process and providing tissue-specific cues.
In this contest, this research addresses the challenging task of formulating nanocomposite bioinks for the development of biomatrices functioning as bone tissue substitutes capable of promoting regeneration processes and as porous scaffold for the design of 3D in vitro models aimed at the study of biological mechanisms related to pathologies and the discovery of precision drug therapies. Biomimetic synthesis approaches were exploited to engineer hydroxyapatite nanoparticles (nHAs) functioning as bioactive ingredient into printable inks mimetic of bone tissue. The incorporation of nanoscale materials, has allowed for significant tunability of the mechanical, rheological, structural, and biological properties of inks and printed constructs. nHAs demonstrate to enhance the printability of inks and the stability of the 3D structures representing a valid strategic tool for the development of printable bioactive inks. This approach enables the 3D printing of highly mimetic composite constructs of the bone ECM. The constructs were tested in a dynamic bioreactor with MSCs demonstrating to induce osteogenic differentiation and to be promising for creating 3D models of bone disease and for bone regeneration applications. Furthermore, they address standardization and scalability issue, which are among the most common challenges in developing organ-on-a-chip models.

Keywords: injectable biomaterials, biomimetic nanocmposite, 3D printing, tissue engineering, biomedical applications, in vitro models, bone organoids.

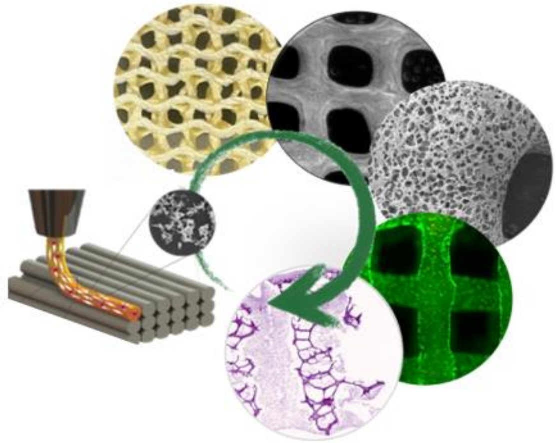

Figure 1: 3D prinded structure obtained form the developed injectable composite formulations. The freeze-dried process performed post-printing allow to decorate the macroporous structure with micro-texture implementing the scaffold interconnectin, and fluids and cells penetration during the TE approaches in perfusion bioreactors.

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GRAM®, the winding technology for space structures

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Abstract:
The well-known endless continuous fiber winding technology has now been robotized to become GRAM® technology, for Gradel Robotized Additive Manufacturing. This paper synthesizes the recent developments of this innovative technology applied to a lightweight antenna supporting structure for a satellite application. The design to manufacturing engineering methodology will be presented. Then, it will be discussed the microscale fiber/matrix physical tests, the part manufacturing process and the results of parts mechanical and thermomechanical test. Finally, thanks to the experience gained on this development, the conclusion will present the different foressen applications for space structures.

Keywords: Composite, Carbon fiber, Additive Manufacturing, Mechanical Performance, Finite Element Analysis, Experimental Tests, Robotic, Additive Manufacturing, GRAM®.

Figure 1: Figure illustrating the design of Carbon fiber / aluminium satellite Telemetry and Telecommand antenna support. This design has been manufactured with GRAM® technology and has been submitted to mechanical tests and thermos-elastic distorsion tests.

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Polymers 2025 Session I. B: Synthesis, Processing and Characterization

Amine functionalized polymers and compounds for protective coatings in safe applications

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Abstract:
Functional biopolymers are increasingly studied due to their renewability and enhanced biocompatibility. Chitin, the second most abundant biopolymer on Earth after cellulose, can be sourced from various terrestrial and marine organisms, including crustaceans, insects, and fungi. The advancement of biotechnology and the need to valorize agro-food waste are expected to increase the availability of chitin for various applications. Chitin derivatives, such as chitin nanofibrils and chitosan, exhibit notable antimicrobial properties. These properties are attributed to the presence of amine groups, which, when protonated in acidic environments, interact with bacterial lipid membranes, neutralizing their infective capabilities [1]. The application of chitin nanofibrils and chitosan to various biopolymeric surfaces (e.g., cellulose, biopolymer blends) has been extensively researched for use in personal care, hygiene, cosmetics, and packaging [2].The development of appropriate coatings has been achieved through liquid or hot-melt coating techniques, utilizing diverse manufacturing processes.
Fatty amines, known for their hydrophobic nature, are widely used in detergents, cosmetics, and agricultural products due to their antimicrobial properties. The sustainable enzymatic production of fatty amines from agro-food waste is nearing practical application [3]. Compared to chitin and chitosan, these compounds are more hydrophobic, potentially enhancing compatibility with bioplastics and non-polar surfaces. However, the preparation of blends can be challenging due to the differing solubility of chitosan and fatty amines in water. This study explores the combination of fatty amines and chitosan by preparing films and characterizing their spectroscopic, thermal, and mechanical properties.

Keywords: fatty amines, chitin, chitosan, biopolymers, anti-microbial, coating, crustaceans, fungi, insects, agro-food waste

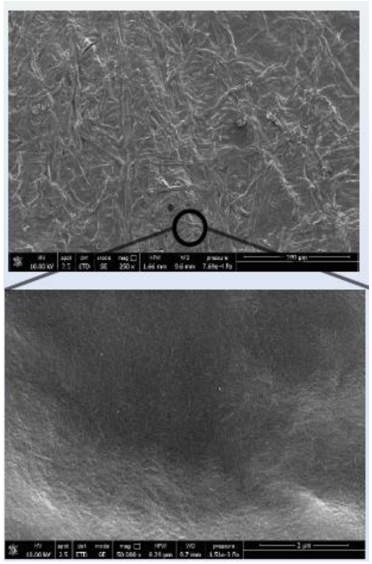

Figure 1: SEM micrographs of cellulose surface coated with chitin nanofibrils: (top) low magnification, showing cellulose fibres; (bottom) high magnification, showing the chitin nanofibrils

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Acknowledgements:

The authors thank Circular Biobased Europe Joint Undertaking that partially supported this research in the framework of the project "Construction of a FLEXIble and adaptable enZYMatic biotechnological platform for sustainablE industrial production of bio-based fatty amines from side stream materials" (Flexizyme), Grant agreement ID: 101157528.

Processing and Mechanical Characterization of ASA/PET Blend with Compatibilizing Agents for Large Format Additive Manufacturing

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Abstract:
This work focuses on the processing and evaluation of acrylonitrile-styrene-acrylate (ASA)/poly(ethylene terephthalate) (PET) blends, incorporating copolymeric compatibilizers in different compositions, including poly(styrene-b-butadiene-b-styrene) (SBS), in both radial and linear forms, and poly(styrene-b-ethylene-co-butylene-b-styrene) (SEBS), with a linear structure. The objective is to develop a high-performance polymer suitable for large-format additive manufacturing.

Different compositions were selected and justified to achieve this, from which specimens were fabricated using additive manufacturing. These specimens were mechanically tested to assess their performance. The thermal properties of the compatibilizing agents were analyzed using differential scanning calorimetry (DSC) to understand their effect on the polymer blends. Additionally, processing parameters were optimized to obtain granules compatible with Fused Granular Fabrication (FGF) 3D printing, ensuring proper material flow and printability. The manufacturing conditions for producing FGF test specimens were also defined and justified.

As shown in Figure 1, the tensile tests performed in the Z orientation highlight how the addition of radial and linear SBS, as well as SEBS, affects both strength and Young's modulus.

After conducting mechanical tests and analyzing the results, the study provides valuable insights into the mechanical behavior of ASA/PET blends, contributing to the development of materials suitable for large-scale additive manufacturing applications.

Keywords: polymer, chemical compatibilizers, additive manufacturing, mechanical properties.

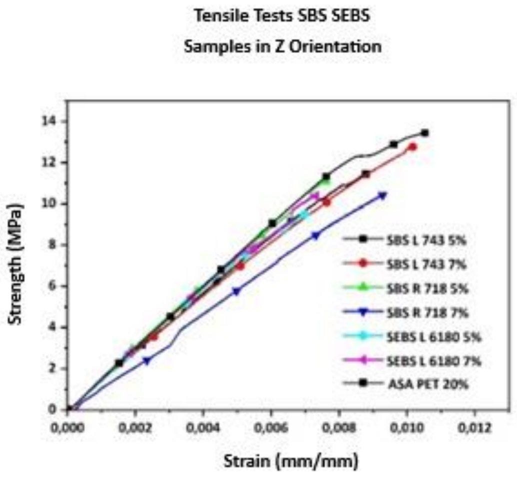

Figure 1: Tensile test results of SBS/SEBS blends in Z orientation: strength vs strain curves

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Development of infrared polymer optical filters based on sulfur and cross-linking agents

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Abstract:
In the past decades most of the studies have been dedicated to the visible-near infrared spectral regions using appropriate materials having a high transmittance in these spectral bands. However, there is a growing interest for midwave infrared (MWIR) applications, e.g. for infrared imaging, thermo-vision systems or directional infrared counter measures (DIRCM). Accordingly, the development of transparent organic polymer materials for the mid-infrared range is rapidly expanding. Indeed, they could provide an alternative to existing inorganic materials such as ZnSe, Ge and others[1].
Most polymers have a limited transmittance in the MWIR spectral range, such as PMMA or polycarbonate. For this reason, this work focuses on sulfur-based polymers which have shown interesting optical properties for mid-IR applications[2].
Sulfur (S8) is a highly reactive molecule since it undergoes a ring-opening polymerization (ROP) under heat. However, the obtained polymer is not stable and depolymerizes easily. To counteract this, copolymers have been synthetized by the interaction between radical sulfur chains and alkene crosslinkers[3]. This study deals with the development of bulk poly(sulfur-random-divinylbenzene) (poly(S-r-DVB)) optical filters (Figure 1) by the inverse vulcanization process and the addition of another crosslinker within the previous synthesis, 1,3,5-benzenetrithiol (BTT)[4]. The samples obtained were analyzed to determine their physico-chemical properties (determination of the glass transition temperature (Tg) by DSC, of the thermal stability by TGA, of the transparency by IR transmission (Figure 2), etc.). The refractive index (n) was also measured. The challenge is to have a high IR transparency and good thermal properties, therefore a high Tg. Preliminary tests were carried out on an optical bench with a black body and a scene to test the infrared transparency of the samples.

Figure 1: Optical filter of Poly(S-r-DVB) – thickness 1.6 +/- 0.02 mm

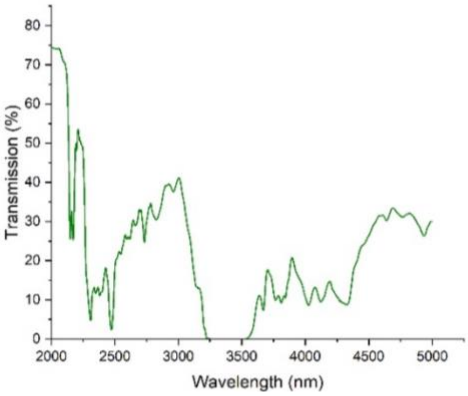

Figure 2: IR transmission spectra of poly(S-r-DVB)

Keywords: MWIR, optical filters, sulfur-based polymers, divinylbenzene, 1,3,5-benzenetrithiol, inverse vulcanization process.

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Validation of the Karrenberg/Wortberg Melting Model for Polyamide in Polymer Injection Molding

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Abstract:
Accurate simulation of the plasticizing process in injection molding is essential for a comprehensive understanding of the process and the development of optimized procedures. Modeling the melting mechanism plays a crucial role in improving plasticizing simulations accuracy. Originated in single-screw extrusion modeling, the Tadmor model is state-of-the-art for many polymer processing applications. However, the Karrenberg/Wortberg melting model, a recently developed approach, promises an improvement even in injection molding.

Previous studies have validated the Karrenberg/Wortberg model for high-density polyethylene using a high-speed-extruder. In this study, we assess its capability for an injection molding process, in detail, for a standard three-zone screw for polyamide. Therefore, the Karrenberg/Wortberg melting model is implemented in CFD-simulations and the results are compared to experimental data.

Both in ANSYS Fluent and in real experiments, a parametric design study is carried out, varying back pressure, circumferential screw velocity, and metering volume, as well as measuring the pressure and the melting profiles. The latter is obtained using ultrasonic sensors, while pressure data is acquired via in-barrel pressure sensors. Additional process parameters are recorded via the injection molding machine's user interface.

The simulation model is validated by real melting performance, pressure build-up, and key process parameters such as drive power, torque, melt temperature, mass flow rate, and plasticizing time. Based on quality and model-stability of the results, an integration of the Karrenberg/Wortberg model into other simulation software tools will be discussed.

Keywords: polymer processing, modeling, melting, injection molding, simulation

Structure-property relationships in coil coatings: Assessing the capability of molecular dynamics simulation for the prediction of glass transition temperature

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Abstract:
Polymeric coatings for metals have an important economic function due to their protective capabilities, useful in numerous contexts. Coil coating, the continuous pre-painting of metal strips with organic coatings, provides a highly efficient process with almost 100% yield which saves manufacturers from the expensive and time consuming painting of products after metal forming. The coatings must have good formability (the capacity of the paint layer to undergo deformation as the substrate it covers is "formed" during manufacturing processes) withstanding related strains without developing defects such as cracking and delamination. A key element in the formability of coatings is their glass transition temperature (T_g) - the temperature at which their behavior changes from glassy/brittle to rubbery/viscous. Molecular dynamics (MD) simulation is a computational material modelling technique which models atomic motion using Newtonian equations integrated numerically. Simulated atomic "force fields" calculate the potential energy of structures thereby modelling intermolecular and intramolecular interactions and predicting material behavior and properties. MD offers the potential to model coating structures and predict important properties such as T_g allowing optimisation of coating formulations for specific requirements. This study examines the capability of MD simulations to predict structure property relationships in coil coating formulations focusing on T_g. Free films of polyester coating formulations based on a standard industrial Resin P, crosslinked by hexa(methoxymethyl)melamine (HMMM) were produced and T_g values tested experimentally by differential scanning calorimetry (DSC). The molecular dynamics simulation code GROMACS and cross-linking code HTPolynet [1] were employed to model thermoset systems representing the same formulations. Simulated results for T_g, though currently incomplete, replicate the structure-property trends indicted by the experimental results but are artificially high. This agrees with the findings of a 2011 study [2] on the same resin formulations. These findings are due to the reduced timescales inherent to MD simulation which does not allow polymer chains sufficient time for normal rotation. Resolving this discrepancy between simulated and experimental results with the Williams Landel Ferry (WLF) model [3] and statistical analysis was investigated.

Keywords: polymer coating, molecular dynamics, simulation, material modelling, structure-property relationship, Glass transition,

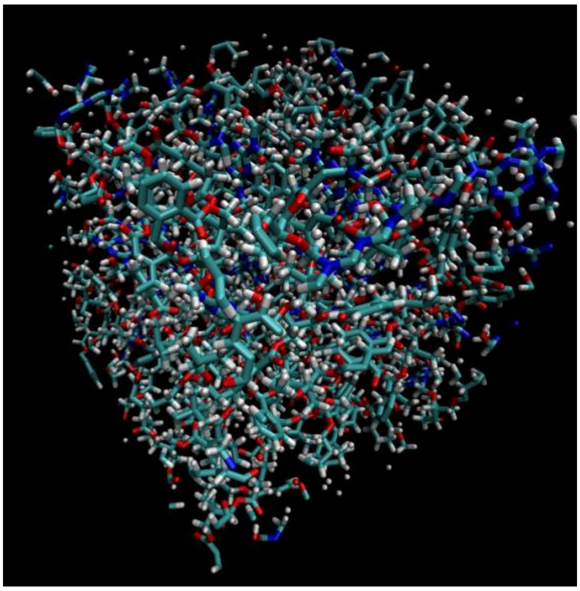

Figure 1: Figure illustrating one of the simulated thermoset systems representing the coil coating formultions based on Resin P, crosslinked by hexa(methoxymethyl)melamine (HMMM)

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Poly(3-octylthiophene-2,5-diyl) – based composite material as high-capacity layer in potentiometric sensor – synthesis and application

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PL-30059 Krakow, Poland

Abstract:
Recent trends in potentiometric sensing refer to introducing new functional materials into sensors with polymeric PVC membrane in order to enhance their analytical and performance parameters. In this work I am presenting the new functional material consisting of three significantly different materials: conducting polymer (poly(3-octylthiophene-2,5-diyl POT), carbon nanotubes (CNTs) and iridium dioxide (IrO_2) and its practical application as solid-contact layer in potassium-selective electrodes.

Potentiometric sensor is defined as electrochemical sensor that transforms the effect of the electrochemical interaction between ion and membrane into a signal. The construction of modern potentiometric sensors is characterized by the presence of three layers: electronic conductor at the bottom, ion-sensing membrane at the top, and solid-contact layer in between.

Triple composie material was used as solid-contact layer. Each of three materials contributes individually to the properties of composite material. The role of each material, including polymer POT, will be discussed in the scope of presentation. Designed composite material is characterized with high value of electrical capacitance parameter and low value of resistance. The new functional material was implemented into potassium-selective electrodes in order to improve their electrical and analytical parameters. This is the first presented so far potentiometric sensor with solid-contact layer composed of three significantly different materials.

The superhydrophobic layer of triple composite material improved long-term stability and repeatability. Potentiometric sensors presented in the scope of this work enable potassium determination in the wide range of potassium ions (from 10^{-6} to 10^{-1} M of K^+ ions). The possibility of practical application was successfully confirmed by the analysis of potassium in vegetable juices.

Keywords: ion sensing, composite material, conducting polymer, polymeric PVC membrane, potassium determination, high capacitancy material

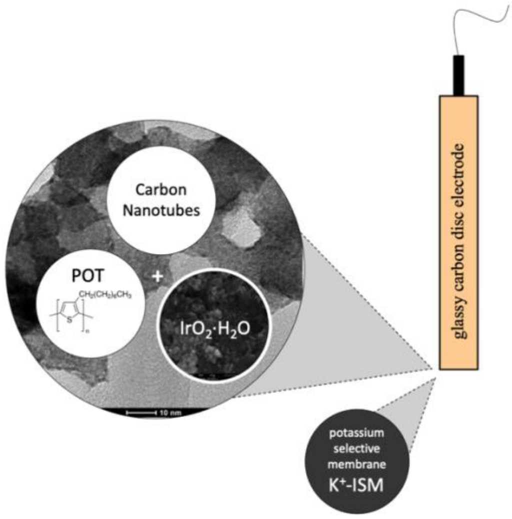

Figure 1: Potassium-selective sensor with triple composite POT-CNTs-IrO_2 layer.

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Analysis of Consumption Data and Migration calculations for ensuring Safety in Recycled Polystyrene Food Packaging

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Abstract:

Recycling of polymers for food contact applications is a critical area of research, driven by the need to ensure safety and sustainability. The European Food Safety Authority (EFSA) has stringent regulations governing the use of recycled materials in food contact applications. Currently, polyethylene terephthalate (PET) is the only polymer widely permitted for recycling back into food contact materials, with limited information available for other polymers.

This study specifically addresses polystyrene packaging, examining the consumption patterns of various food types to determine the quantities consumed. By combining different food categories (typically stored under similar conditions) and employing rigorous statistical methods, we derived comprehensive consumption data for possible food categories packaged in polystyrene.

Migration calculations for polystyrene were conducted under diverse storage conditions, simulating real-world scenarios of food storage in plastic packaging. European regulatory limits on daily and per-bodyweight consumption of non-intentionally added substances (NIAS) were utilized to determine permissible levels of NIAS in polystyrene packaging. These limits, along with the concentrations of substances found in polystyrene packaging waste, were applied to calculate the necessary cleaning efficiency of the recycling (decontamination) process. These calculations are crucial for evaluating challenge tests, which are mandatory for the registration of novel technologies in food contact polymer recycling (Figure 1).

This study provides a robust framework for assessing the safety of recycled polystyrene packaging, ensuring compliance with regulatory standards and facilitating the development of effective decontamination processes for food contact applications. This will contribute to the advancement of safe and sustainable practices in polymer recycling.

Keywords: recycling, packaging, food-contact packaging, food consumption, EFSA, migration, NIAS, decontamination, cleaning efficiency, challenge test.

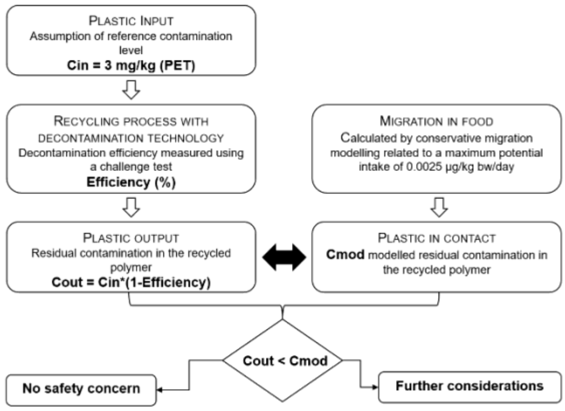

Figure 1: This figure illustrates the procedure for evaluating the safety of a material for food contact applications for novel technology recycling.

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Real-time X-rays investigation on the structural evolution of polyethylene during tenter-frame biaxial stretching

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Abstract:

Typical packaging materials have a multi-layered structure in which polyethylene (PE) is glued with different materials, which are extremely difficult and costly to recycle.[1] The adoption of mono-material packaging containers entirely based on PE is being explored to improve the circularity of plastic packaging. Biaxially oriented polyethylene films (BOPEs) are promising materials due to their superior mechanical properties and optical characteristics. Tenter-frame biaxial stretching is a semi-solid state process in which a cast PE sheet is stretched in two perpendicular directions.[2] It has attracted great attention since the resulting BOPEs show significantly improved tensile modulus, strength, impact resistance, and puncture resistance compared to conventional blown films.[3] However, due to the fast crystallization rate of PE crystals and the fast segmental dynamics of chains in the amorphous and melt states, the tight control of the properties upon processing still remains a challenge.

In this project, we developed an apparatus able to apply biaxially orientation of PE while exposing the sample with X-rays (**Figure 1a**). Thanks to it, we performed an in-situ X-ray investigation during PE biaxial stretching and successive crystallization. In particular, we were able to follow the evolution of the degree of crystallinity and orientation during biaxial stretching of different PE industrial grades. These results helped us to assess the structural configuration before, during and after the stretching at the unit-cell length scale (**Figure 1b-c**) and will be used to understand BOPE processing, a fundamental step towards single material packaging applications.

Keywords: tenter-frame biaxial stretching, biaxially oriented polyethylene films, polymer crystallization, in-situ X-rays scattering, crystal structure, packaging applications.

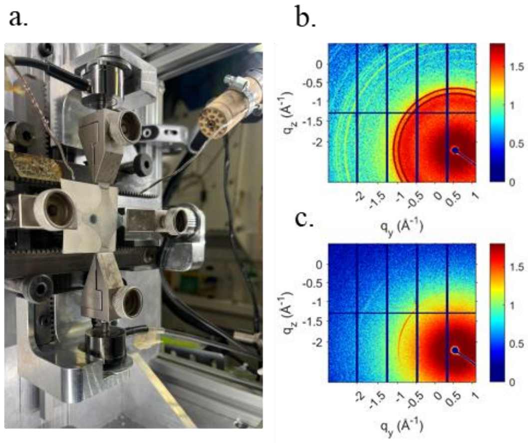

Figure 1: Home-built device for biaxial stretching of PE (a); wide angle X-rays scattering patterns of a PE sample before (b) and after tenter-frame biaxial stretching (c).

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Modeling the Drying Kinetics of Polymer Volatile Systems Using Thermogravimetric Analysis Data

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Abstract:
Thermogravimetric analysis (TGA) is a well-established technique for investigating the drying kinetics of moist polymers by monitoring mass loss under controlled temperature conditions. In this study, simplified lumped parameter models originally developed for food drying, such as the modified Page and Verma models, were applied to polymer drying processes with good agreement [1,2]. These empirical models can describe the transition from Fickian to anomalous non-Fickian diffusion observed at different temperature regimes. We used a model system based on polyamide 6 (PA6) with water as its volatile component. Its drying kinetics were comprehensively characterized and served as the foundation for developing and validating predictive drying models. The temperature dependence of the drying process was effectively captured through Arrhenius-type behavior and fitted using nonlinear regression techniques, enabling the development of predictive models with adjusted R^2 values consistently exceeding 0.98 (see Figure 1). Such models allow to interpolate the drying behavior across various process conditions and to optimize the drying procedures for minimizing polymer degradation while drying to the desired moisture content. Furthermore, the predictive capability of these models paves the way for designing industrial drying processes with reduced need on extensive experiments. In conclusion, looking at the similarities in moisture transport mechanisms between food and polymer systems offers a robust framework for understanding and controlling volatile removal in polymer processing.

Keywords: thermogravimetrical analysis, polymer drying, drying kinetics, modeling, sorption, desorption, volatile removal, polymer processing

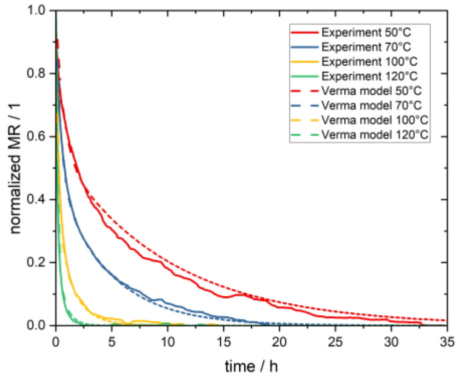

Figure 1: Comparison of drying kinetics described by the Verma model with experimental TGA results under various isothermal conditions. The model predictions (dashed lines) are superimposed on the experimental curves (solid lines), showing excellent agreement over the temperature range of 50 to 120°C. This validates the model's capability to capture the complex drying behavior of the polymer–water system.

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Composites Session I. C: Synthesis, Processing and Characterization

Hybrid toughening techniques for enhancing interlaminar fracture toughness and mechanical performance of thermoplastic composites

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Abstract:
Enhancing the interlaminar fracture toughness of composites is critical for improving load-bearing capacity, delamination resistance, and structural integrity over extended service life. This study investigates hybrid toughening effects on CF Elium®-based thermoplastic composites using polydopamine (PDA), multi-walled carbon nanotubes (MWCNTs) sizing, and polyphenylene sulfide (PPS) veil interlayers. Mechanical performance was evaluated through 3-point bending, interlaminar shear strength, and Mode I fracture toughness tests. Hybrid toughening mechanisms significantly enhanced fibre-matrix adhesion, improving flexural and interlaminar shear strength. Mode I fracture toughness increased by 218%, attributed to PDA bridging, PPS pull-out and breakage, and fibre bridging. These findings demonstrate the synergistic effect of combining PDA-MWCNTs sizing and PPS interlayers, offering a novel strategy for composite toughening. The study primarily aims to assess the impact of these hybrid approaches on mechanical properties, focusing on fracture toughness, while identifying the mechanisms contributing to the observed improvements. Advanced characterization techniques, including X-ray Photoelectron Spectroscopy (XPS), Scanning Electron Microscopy (SEM), and Fourier Transform Infrared Spectroscopy (FTIR), provided molecular and microstructural insights into the toughening mechanisms. This research stands out for its novel combination of PDA-MWCNTs and PPS toughening methods, which have not been extensively explored in CF Elium®-based composites. The mechanical analysis and advanced microstructural characterization contribute to a deeper understanding of the material behavior. Overall, this study outlines the potential of hybrid toughening to develop composites with superior fracture toughness and mechanical performance, paving the way for more durable and reliable structural materials.

Keywords: Interlaminar Fracture Toughness
Hybrid Toughening, Fibre-Matrix Adhesion
Mechanical Performance

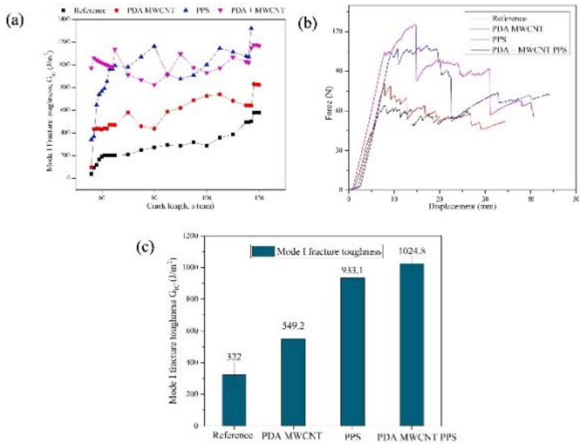

Figure 1: Figure illustrating the Mode I fracture toughness results with the (a) R-curve showing crack growth resistance, (b) force-displacement curve illustrating mechanical response, and (c) Mode I fracture toughness values comparing reference composites with PDA-MWCNTs treated, PPS interleaved, and PPS+PDA-MWCNTs hybrid composites.

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Experiments and analysis of fatigue delamination in UD Layered composites

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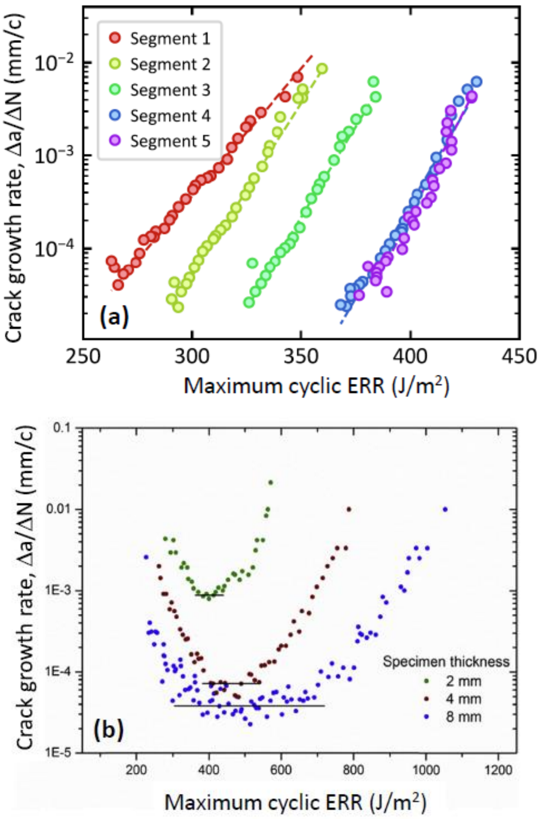
Abstract:
Fatigue delamination, accompanied by large scale bridging (LSB) in CFRP, is an important toughening mechanism due to significant shielding on the crack tip. In delamination with LSB, the resistance to fracture is expressed as, $J_{total} = J_{tip} + J_{I,b}$, where J_{tip}, is the local energy release rate (ERR) around the crack tip and $J_{I,b}$ is the ERR attributed to LSB. Ample experimental evidence shows that J_{total} is dependent on load type (Figure1a,b), specimen geometry (Figure 1b), materials, interface and ply orientation rendering delamiation modeling challenging. Conventionally, crack propagation, $\frac{\Delta a}{\Delta N}$, is correlated with J_{total}; $\frac{\Delta a}{\Delta N} = f(J_{total})$. Such formulation is empirical and cannot be generalized to different experimental configurations because crack growth is not controlled by J_{total}, a load-history and geometry dependent parameter. In this presentation, experimental results and modeling of fatigue delamination in CFRP are discussed. The experimental work consists of displacement-controlled and load-controlled fatigue tests of DCB specimens of UD laminates (Figure 1). Selected specimens are equipped with fiber Bragg grating sensors to monitor crack growth and strains over the delamination zone. Using these strains, parametric finite elements and optimization, in an iterative scheme, bridging tractions, $J_{I,b}$ and thus, $J_{tip} = J_{total} - J_{I,b}$ in selected ranges of crack propagation, is calculated. Considering that fatigue crack growth is controlled by the local ERR, the data are correlated with J_{tip} using a Paris-Erdogan relation, $\frac{\Delta a}{\Delta N} = A(J_{tip})^n$. Analysis results in n = 7.2 (displacement-controlled) and n = 5.63 (load-controlled). When the same data are correlated with J_{total}, the corresponding exponents are several times higher. In addition, the specimen thickness effect on delamination growth is eliminated when J_{tip} is used to correlate the data instead of J_{total}. Further analysis shows that a thickness effect is due to different specimen's arm curvature that can be added as a kinematic parameter in delamination [3].



Keywords: composites, fatigue delamination, large scale bridging, traction-separation, energy release rate, scale effects, energy release rate.

Figure 1: Data on fatigue crack growth in DCB specimens plotted against total maximum ERR: (a) displacement-controlled in a single specimen [1], (b) load-controlled [2]. Notice the important effects of specimen thickness [2,3] (Fig. 1b).

References:

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Preliminary Design of SOFC:
Material Enhancement, Structural Design, and Manufacturing Process

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Abstract:
This study serves as a strategic foundation for the development of high-performance composite hydrogen tanks, focusing on the structural integrity of composite overwrapped pressure vessels (COPVs). Numerical and experimental investigations were conducted to predict burst pressure, monitor structural weakening, and assess fatigue life. Advanced uncertainty quantification (UQ) and global sensitivity analysis (GSA) techniques were applied using Latin Hypercube Sampling and Sparse Polynomial Chaos Expansion to optimize the design and reduce computational costs.

Additionally, this invetigation combines numerical and experimental approaches to predict the mechanical properties of wound carbon-fiber composites. A multiscale finite element modeling framework was employed, progressing from micro-scale modeling, which accounted for void effects in the epoxy resin, to meso-scale and macro-scale analyses. The mechanical properties were computed using Abaqus software, with a three-point bending test validating the simulation results.

Failure analyses driven by internal pressure employed the Hashin failure criterion to evaluate damage progression in cylindrical and dome sections. Fiber tensile strength and ply thickness emerged as critical design factors affecting burst pressure, stiffness, and failure mechanisms, emphasizing their pivotal role in optimizing hydrogen tank designs for enhanced durability and performance in demanding operational environments.

Keywords: Pressure vessels; Uncertainty; Simulation methods; Manufacturing process; Epoxy resin; Multi-scale modelling; Micromechanics.

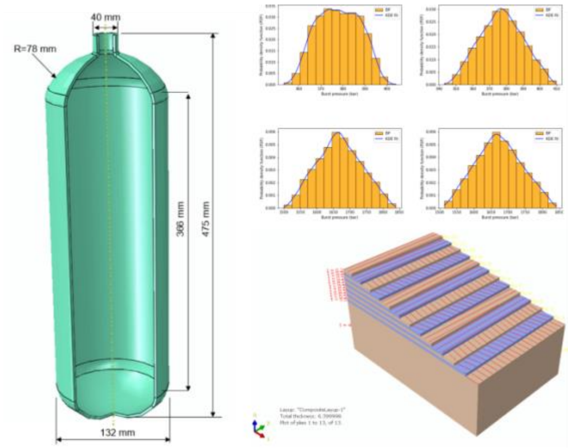

Figure 1: Figure illustrating the Geometry of the tank and the associated 12-ply stacking sequence and the probability density function (PDF) of the burst pressure (BP) with histogram and kernel density estimate (KDE) fit.

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Folding of flax/polypropylene composites based on comingled fabric : Feasibility study

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Abstract:

Plant fibers are increasingly being incorporated into composites, as they reduce the material's environmental impact. As part of an eco-design approach, we studied the processing of a flax/polypropylene (PP) composite. Flax fiber present a real interest for bio-based composites. The plant fibers are lighter and available in larger quantity than synthetic fibers (such as carbon or glass fibers). This natural fiber has lower impacts on the ground and water than kenaf or jute fiber.Composite material enables to reach the requirement specifications, thanks to the combination of the properties of its components (matrix and reinforcement).. The flax fibers could enable to get a composite with a higher or similar strength and flexibility than the composites reinforced with natural (jute, kenaf) or synthetic (glass and carbon) fibers.The thermoforming processes gather methods that shape the composite by adding thermal and mechanical stresses [1]. The range of these methods is not fully explored at the present time. The main developed processes are compression molding [2], thermo-stamping [3], and vacuum casting [4]. However, all these methods have the same drawback : they require a specific tooling for each product. It regroups a superior mold and an inferior mold which take time to design and manufacture, impacting the cost of the product. Tooling is therefore not adaptable to different part geometries. Current thermoforming processes work well for the mass production of a piece, but not for small batches and are therefore not very adaptable. The folding seems to be a lever to the limitations of the previous techniques and thus meets the requirements of Industry 5.0. In this study, the feasibility of folding composite samples at an angle of 90 degrees is evaluated. Process conditions were experimented with to achieve external folding without detrimental damage to mechanical behavior. Chosen parameters are surface composite and tool temperatures, process speed and fabric fold orientation. The influence of the parameters on fold quality (visual and mechanical) is analyzed by experimental design and strength tests. The aim of this paper is to demonstrate the possibility of hot-folding flax/PP composite and to evaluate the quality of the parts produced, according on the parameters implemented.

The ability of companies to adapt to demand is also a key factor in the ecological transition.

Semi-finished products will play a role in tomorrow's street furniture, as well as in the construction of vehicle parts for boats, cars, etc.

Keywords: Fibers, thermoplastic resin, weaving, mechanical testing, forming

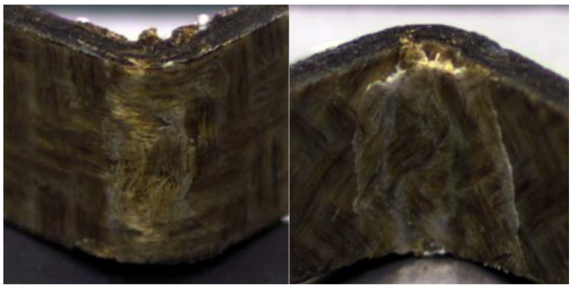

Figure 1: Macroscopic view of an outer and inner fold respectively

References:

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Human Robot Collaborative Draping of Carbon Fibre Composite Parts: Results of Three Case Studies

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Abstract:
Draping is a process where carbon or glass fibre fabric is placed in a 3D mould. This process requires high precision in terms of placement accuracy and quality. About 30% of all fibre-reinforced composites parts are made through draping and the vast majorit is draped manually.
To increase the degree of automation and to use the synergies of humans and robots in this task, developments have been made to perform this task through human-robot collaboration. This will benefit from the higher precision of the robot and the high dexterity of the human operator, when draping areas with high curvature.
The developments were evaluated on three use cases coming from the aerospace, automotive and boat-building sector. A comparison is made between conventional (manual) draping and human-robot collaborative draping in terms of efficiency of the overall process. The analysis includes different modes of human-robot collaboration, ranging from co-existence in the same workspace to physical human-robot collaboration when jointly handling a piece of carbon fibre fabric. Also, different ways of user interaction with the robot through gestures and voice are analysed and the need for feedback to the user is highlighted.
Results indicate that human-robot collaboration has benefits for the draping of composite parts. Interaction modes need to be chosen carefully, to allow a natural interaction leading to a real improvement of efficiency. Safety certifications seem to be the most restricting aspect at the moment, as the lack of sufficiently intelligent safety devices does not allow efficient collaboration with large industrial robots.

Keywords: draping of composite parts, human-robot collaboration, human-robot interaction, productivity

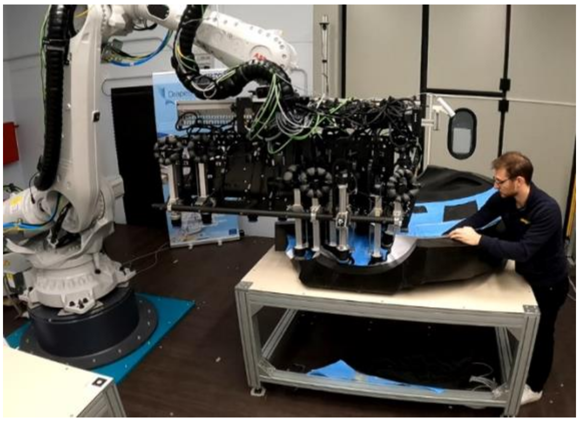

Figure 1: Human-robot collaboration during the draping of an automotive part. The focus of the research is on collaboration with large industrial robots and how to obtain an efficient and high-quality draping process.

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Segmentation Aware Attention Mechanism for Defect Classification of both Virgin and Recycled Carbon Fiber Fabric

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Abstract:
Carbon fiber components are widely being adapted in the aerospace industry to reduce CO2 emissions and fuel consumption [1, 2]. The automation of end-of-line quality control is thus an important step towards the automated documentation and mitigation of defects during the production process. This work focuses on carbon fiber defect segmentation and classification after the layup process. For this purpose, a modular vision-based sensor is utilized to perform a multi-modal image acquisition of fiber orientation [3] and defect detection. Several commonly identified defects such as gaps, missing stitch, fuzzball, foreign objects, wrinkles and overlaps were considered as target labels. The machine learning (ML) model, based on the segmentation aware attention mechanism architecture, was designed to overcome the challenges of present parametric-based manual approaches (Figure 1). The classification performance was measured and validated in the K-fold cross validation scheme. Benchmarking analysis of the proposed ML model was performed against several standard ML models [4-7] over the same train-test data split. Results demonstrated that the proposed ML model can detect and segment various defect types with up to 95% accuracy (ACC), overcoming the performance of the standard models by up to 35% ACC.

Keywords: carbon fiber defect classification, carbon fiber defect segmentation, segmentation-based attention mechanism, multi-task multi-head neural network, carbon fiber orientation.

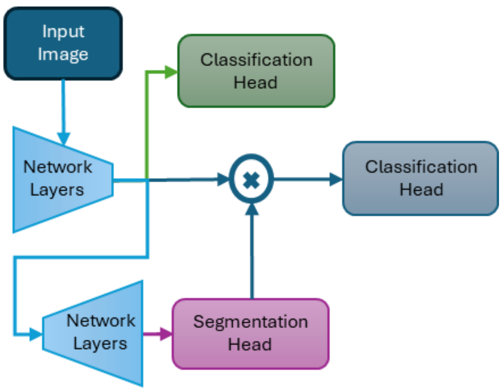

Figure 1: Figure illustrates an overview of the proposed deep learning model.

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Challenges on Multilyer Composites Desintegration and Materials Recovering for Waste Printed Circuit Boards

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Abstract:

Printed circuit boards (PCBs) are one of the most common types of multilayer composites used in many electrical and electronic equipment devices. The most important layers are Conductive Layer, Dielectric Layer, Solder Mask Layer, Silkscreen Layer. In most cases, PCBs with multiple conductive and interconnected layers are formed.

The dielectric layer can be formed from such materials as FR-4 (composite material composed of woven fiberglass cloth with an epoxy resin binder that is flame resistant), CEM materials, polyimides, Teflon, etc. The choice of these materials depends on the nature of the PCB operation. Copper is usually used for the conductive layer, for specialized PCB – also aluminum, silver, gold.

Due to technological development the nature of materials used for PCB layers is constantly changing. For example flexible PCBs are increasingly being used instead of rigid PCBs. And this affects the process of recovering valuable materials at the end of their life time due to the variety and different properties of these materials.

Generally, the process of recovering materials from used PCBs consists the main stages - mechanical crushing and separation, hydrometallurgical extraction and selective concentration of different valuable metals. At the industrial level, mechanical processes are mainly used, while hydrometallurgical extraction presents many challenges, so the right answers are still being sought at the laboratory level. Attention should also be drawn to the fact that when FR-4 is used for the dielectric layer, so after mechanical crushing it is also appropriate to recover the epoxy resins by dissolution them with solvents, which is impossible to apply to other types of dielectric layers.

This paper shares the laboratory experience of recovering valuable materials from computer PCBs and push-button cell phone PCBs. Many current challenges are started from the sorting of used PCBs and continued on further hydrometallurgical extraction of metals, when it comes to the efficiency of leaching of rare and precious metals from the dielectric layer.

Keywords: printed circuit boards, dielectric layer, conductive layer, mechanical treatment, disolution, hydrometallurgical extraction.

Figure 1: Figures illustrating the FR-4 residues after disolutions of resins and hydrometalurgical extraction of metals. Gold residue is visible in the grooves of the processors plastic pieces.

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Defects analysis and microstructural characterization of 3D-printed sintered parts of ceramic matrix composites (cordierite-graphene)

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Abstract:
The design and manufacture of aerospace parts still face significant challenges, particularly due to the inherent brittleness and hardness of ceramics, which make them difficult, or even impossible, to machine for improved surface finish or intricate geometric shapes. The advancement of 3D printing technologies provides a promising, precise, and efficient approach for producing parts with these characteristics. Aerospace materials must possess exceptional performance, strength, durability, and heat resistance [1]. Traditional technical ceramics such as cordierite exhibit high chemical and thermal stability, very low thermal expansion coefficient, high thermal shock resistance, low dielectric constant and high resistivity [2-3]. These properties make cordierite an excellent candidate for aerospace applications.

In this study, the effect of reduced graphene oxide (rGO) on the microstructure and properties of cordierite-based composites was investigated. Composites with different rGO concentrations were fabricated by 3D printing, followed by sintering. Elemental characterization of raw materials was performed using x-ray photoelectron spectroscopy (XPS), energy-dispersive X-ray spectroscopy (EDS), Raman spectroscopy and Fourier-transform infrared (FTIR) spectroscopy. Crystalline phases were analyzed using X-ray diffraction (XRD) and optical microscopy. Defects analysis of the 3D-printed parts was conducted in optical microscopy and measurement were performed using ImageJ software (Figure 1). Microstructural analysis was carried out using optical microscopy, SEM-EDX, XRD and Raman spectroscopy (Figure 2).

In conclusion, the addition of rGO in cordierite composites offers new opportunities for designing advanced aerospace materials, where thermal and mechanical properties are critical. The defects observed in 3D-printed parts impact material strength but also provide opportunities to optimize manufacturing processes.

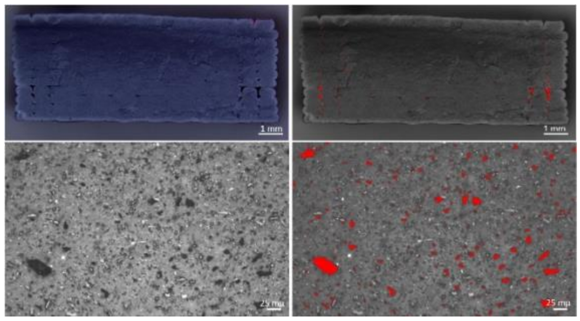

Figure 1: Macro and micro porosity (optical microscopy image)

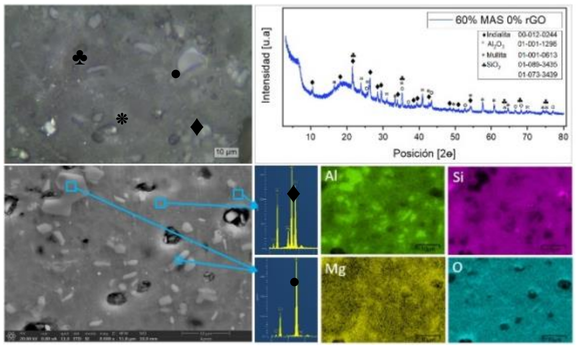

Figure 2: Microstructural characterization of cordierite (SEM-EDS and XRD).

Keywords: 3D printing, Additive manufacturing, ceramic matrix composite, CMC, cordierite, graphene oxide reduced, rGO, nanocomposite.

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Predictive Modeling of Porosity Characteristics in High-Pressure Hydrogen Tanks using Augmented Fuzzy Cognitive AI

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Abstract:

High-pressure Type IV hydrogen vessels are commonly used in industrial applications and hydrogen vehicles. These vessels are constructed from composite materials like carbon fibers, providing lightweight properties and strength. However, internal defects such as porosity can compromise the structural integrity of the tanks and negatively impact their mechanical performance [1] [2]. While some porosity is acceptable, excessive porosity can lead to mechanical failures, making quality control essential [3][4]. This study aims to develop predictive models to assess two key characteristics of porosity in each composite winding layer of these vessels: the number of porosities and the porosity rate.

Initially, the focus was on predicting the porosity rate, which is important for classifying winding layers into two categories: low porosity (below 3%) and medium or high porosity (above 3%). However, after analyzing the dataset and examining the distribution of the output values, it became clear that predicting the porosity rate alone was insufficient. The quality of the data and the measured parameters did not support the development of reliable predictive models for porosity rates. As a result, the approach was broadened to include the prediction of the logarithm base 10 (log10) of the number of porosities, which was addressed through modeling.

The number of pores was modeled as a regression problem using log10 transformations. The study employs Generalized Reasoned Artificial Intelligence (GRAI) Xtractis [5], which aids in discovering both robust and interpretable predictive models. Out of 58 potential predictors, 15 were chosen to construct the models. The experimental results show strong performance, with a Root Mean Square Error (RMSE) of 7.94% and a correlation coefficient of 0.824 on an external test set, confirming the predictive accuracy of the models.

A key advantage of the Xtractis approach is its interpretability, which enhances our understanding of the relationships between variables and ensures transparency in the models. This contrasts with other nonlinear methods, such as Boosted Trees, which are often viewed as "black boxes." The clarity of Xtractis models offers valuable insights into the underlying data, creating new opportunities for improving quality control and reducing the risk of failures in hydrogen storage tanks.

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Determinaton of the Aging State of Resin Systems in Wind Turbine Blades at the End of Lifetime with IR-Spectroscopy

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Abstract:
The growth of renewable energies is leading to an increase of wind turbines. The global cumulative installed wind power capacity generated from wind turbines has risen from 24 GW in 2001 up to 1021 GW in 2023. At the same time, wind turbines have become constantly larger and more powerful. Due to regulatory requirements (e.g. service life of 20-25 years) and technical progress, more and more wind turbines are being dismantled. The recycling of turbine blades is therefore both a major challenge and an opportunity.

The current recycling processes are mechanical shredding, chemical processing, pyrolysis, solvolysis and oxidation. These processes are used, for example, to recover fibre materials at great effort or to produce cheap fuels, e.g. for the cement industry. For a secondary use of the material-mechanical structure of a rotor blade, it is important to have precise knowledge of the material behaviour. However, the available information and data on the exact manufacture or material of the rotor blades is generally not sufficient.

The research project focusses on the development of a characterisation method for the aging of wind turbine blades. First, the resin system used in the blades is to be analysed. Therefore, different parts of the blades were analysed using infrared spectroscopy. The results were compared to known and extensively characterised resin systems (Figure 1). These measurements are a source for a database of the resin systems used and their ageing condition. The analysis of the recordings shows that different resin systems were used in the analysed blades. Minor fluctuations in the spectra are an indication of the ageing condition of the material. In future research, these measurements will be linked to structural-mechanical analyses in order to determine the correlation between material systems, ageing and the properties of the wind turbine blades.

Keywords: wind turbines, recycling, IR-spetroscopy, aging effects, composites, epoxy resin systems.

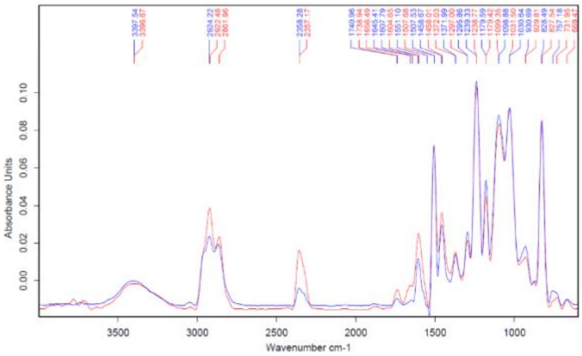

Figure 1: Selection of IR-spectral-measurements of different resin systems for determing the aging state of wind turbine blade material.

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Optimizing Recycling: Fragmentation and Sorting of GFRP Components in Battery Housings - Impact on Recyclate Properties

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Abstract:
Europe aims to achieve climate neutrality by 2050 through the "Green Deal," with plastic recycling and the use of recycled plastics playing a key role (Single-Use Plastics Directive, DIN-Spec 91446). Lightweight construction, heavily reliant on plastics, is critical for reducing CO2 emissions in the mobility and energy sectors. Incorporating recycled plastics into lightweight structures significantly reduces CO2 by lowering the use of primary raw materials.
The increasing diversity of materials makes recycling routes more complex and challenging. Studies, such as Conversio [1], highlight the current limitations of mechanical recycling for thermoplastics, with a recyclability cap of around 15%. Similar findings in the automotive sector indicate a maximum recycled content of 10-20% [2]. Since mechanical recycling offers limited potential for improvement, solvent-based polymer recycling, which enables polymer purification and tailored properties, is essential for increasing recycled content in the future [3].

This research investigates how combining solvent-based recycling methods with mechanical recycling routes can address challenges in increasing the recycled content in circular battery housings consisting of glass fiber reinforced polymers for mobile applications. The sustainable use of recycled plastics in lightweight structures not only reduces primary raw material consumption but also contributes significantly to overall CO2 savings through lightweight applications. The mechanical properties of various recycled content levels will be evaluated and compared to those of virgin materials, ensuring that performance requirements are met. Our findings provide important insights into the development of sustainable recycling solutions that are in line with the goals of the circular economy. Increased recycling rates in the production of e-mobility battery casings will play an important role in saving emissions and energy, especially with the growing demand for electrically powered cars. This work advances practical methods for the recycling and development of components for the mobility of the future and contributes to a more sustainable and resource-efficient industry.

Keywords: metallized polymer foam, delamination, pretreatment methods, recycling, circulyr economy

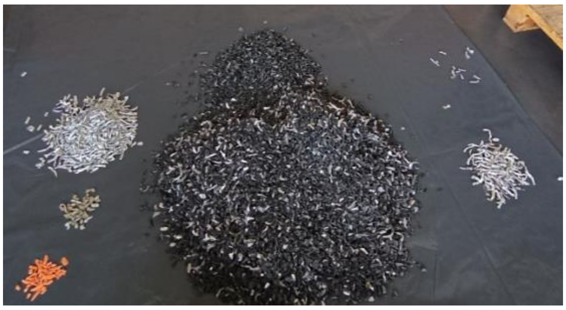

Figure 1: The image shows a shredded battery box during initial sorting to assess the components of the battery boxes and at the same time to analyze which residual materials and composites are still present after shredding the battery boxes and how they can be further processed

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

Extrusion-based 3D printing of multifunctional bioceramics for biomedical applications

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Abstract:
Large bone defects ensuing from diseases, infections, tumor resection, or even trauma are still dificcult to repair and currently represent one of the most demanding health challenges in the elderly population [1]. Calcium phosphate-based (CaP) bioceramics have been reported as the gold standard solutions for bone repair and regeneration, in the form of scaffolds, granules or injectable self-setting pastes [2]. However, the commonly applied solutions in the clinical practice are still insufficient to fulfill the needs. Optimizing the composition of these bioceramics to obtain multifunctional biomaterials, able to be fabricated by the current innovative additive manufacturing (AM) technologies, has been highlighted as potential solutions. Robocasting, also called direct ink writing (DIW), uses extrudable aqueous-based ceramic inks at room temperature and has been highly explored for these purposes. However, the addition of thermal-sensitive biomolecules to the printable inks to make them multifunctional, such as drugs or other biomolecules, hinders the commonly used sintering post processing step in ceramics (> 1000 ºC) needed to achieve the required mechanical performance. This demands the research for alternative formulations.
In this regard, several approaches have been developed using extrusion-based 3D-printing: (i) sintering-free CaP-based scaffolds incorporating drugs to treat local infections [3]; (ii) CaP-based magnetic scaffolds able to heat when exposed to an alternate magnetic field, killing cancer cells by hyperthermia effect [4]; and (iii) self-setting scaffolds incorporating growth factors to improve the bioactivity of CaP. For all formulations, the inks were optimized for the printing process and characterized by rheological measurements. The developed scaffolds were characterized in terms ofmacro and microstructure, shape fidelity, mechanical properties, crystalline phases, drug release profiles, magnetic performance, and biological behaviour.

Keywords: calcium phosphates, bioceramics, multifunctional biomaterials, magnetic materials, hyperthermia, sintering-free bioceramic composites, self-setting materials, 3D printing, extrusion-printing, inks, rheology, mechanical properties, bone regeneration, bone repair.

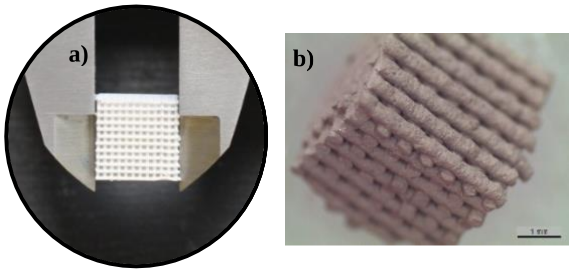

Figure 1: Figure illustrating CaP-based multifunctional materials: **a)** cement-based scaffolds and **b)** magnetic scaffolds.

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Akowledgments

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A bone substitute for dental use functionalized with hydrotalcite ZnAl and gallic acid prevents osteoclast formation in vitro

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Abstract:

Physiologic bone homeostasis is critically maintained by the balance between osteoclast and osteoblast activity, which degrade and build bone matrix, respectively. Osteoclasts are macrophage-derived large multinucleated cells whose excessive activity is one of the prominent features of bone diseases in the jaw, such as periodontitis.

Aiming to achieve a product useful in the rebalance of bone cell turnover, we have prepared and tested a functionalized biomaterial that releases a bioactive molecule, preventing the bone demolition mediated by osteoclasts. The RIGENERA® biomaterial, purchased by btk-Biotec in 1-cm blocks, has been coated by Prolabin & Tefarm with hydrotalcite ZnAl intercalated with gallic acid (RIG_GA), an osteoprotective bioactive molecule already known to be capable of inhibiting osteoclast formation [1,2]. By the in vitro cell model of RAW 264.7 macrophages differentiated into osteoclasts by receptor activator of nuclear factor kappa-B ligand (RANKL), we have investigated whether the releasing medium, obtained by incubating one block of RIG_GA in 2 ml of culture medium for 24 hours, would possess the ability of contrasting the osteoclast formation. For RIG_GA releasing medium, we found a potent anti-osteoclastogenic effect compared to the non-functionalized control, as revealed by the dose-dependent, strong decrease of both osteoclast number and osteoclast marker gene expression, which suggests the actual release of gallic acid from the RIGENERA® block.

In conclusion, we have demonstrated that the properties of inducing rapid formation of vital bone, already possessed by RIGENERA®, can be enhanced by the additional antiosteoclastogenic effect of gallic acid in a novel formulation of functionalized biomaterial for the treatment of an inflamed environment such as that of the socket of an extracted or lost tooth.

Keywords: bone resorption, bone substitutes, functionalized biomaterials, hydrotalcite, osteoclastogenesis, dental applications.

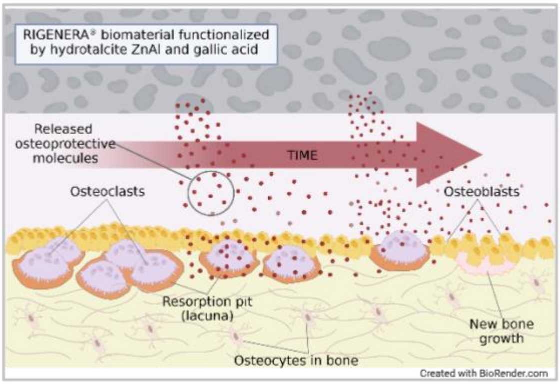

Figure 1: The functionalization of RIGENERA® biomaterial with hydrotalcite ZnAl and gallic acid aims to achieve the local release of therapeutic agents contrasting the bone demolition mediated by osteoclasts. The slow local release of these molecules is expected to enhance the RIGENERA® property of inducing rapid formation of vital bone and, presumably, to shorten the time in which the alveolar bone of an extracted or lost tooth is regenerated.

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Chitosan derived from *Hermetia illucens* as a novel biomaterial for the production of nanofibrous scaffolds for wound healing

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Abstract:
Chitosan (CS), a natural polysaccharide, is widely recognized in wound healing for its biocompatibility, biodegradability, hemostatic, and antimicrobial properties. In response to the growing demand for sustainable, affordable biomaterials, the aim of this work was to develop a wound healing nanofibrous scaffold, utilizing unbleached *Hermetia* illucens-derived CS (HL CS_{UBL}) and polyvinyl alcohol (PVA). The obtained nanofibers were compared with analogous fibers made from commercial CS (CM CS) of similar molecular weight.

Solutions containing 3% (w/w) CS and varying PVA concentrations (7-10% (w/w)) were prepared and combined at two different ratios (50:50; 60:40, respectively) to identify the optimal formulation for electrospinning. The viscosity of the solutions was evaluated to ensure appropriate processing conditions. Two citric acid concentrations (2.5% and 7% (w/w)) were tested to obtain a crosslinked matrix. The most promising CS/PVA mixtures were electrospun and different voltage levels, flow rates and collector distances were evaluated to minimize bead formation. The resulting nanofibers were subjected to a thermal treatment at 125ºC for 1h to promote crosslinking among the three molecules (CS, PVA and citric acid). Afterwards, the nanofibers were characterized in terms of diameter and mechanical properties. Fiber stability was assessed by soaking in water for 24 h, followed by morphology evaluation using Scanning Electron Microscopy.

All studied solutions showed a non-Newtonian behavior, characterized by a decrease in viscosity on increasing shear rate, confirming shear-thinning properties. In the case of HL CS_{UBL}, the highest PVA concentration (10% w/v) and 50:50 ratio resulted in more uniform fiber structures with minimal bead formation. The addition of citric acid (7% w/v) led to an effective crosslinking, resulting in nanofibers with enhanced stability and hydrophobicity. Optimal electrospinning conditions—22 kV and a 20 cm collector distance—produced homogenous HL CS_{UBL} fibers insoluble in aqueous media with an average diameter of 382 ± 59 nm. Nanofiber morphology was stable after 24 h hydration in water, with a diameter of 395 ± 98 nm, showing no significant difference from pre-hydration values ($p = 0.4028$). HL CS_{UBL} nanofibers displayed similar characteristics to CM CS-derived ones, showing a consistent structural quality. Dynamic mechanical analysis (DMA) showed that the HL CS_{UBL} electrospun nanofibers exhibited a typical viscoelastic behavior and the ability to provide elastic support during dynamic movements, Considering the promising properties, the nanofibers were further characterized for: i) hydrophilicity and water retention capability to absorb a medium mimicking wound exudate; ii) rheological properties upon hydration; iii) bioadhesion towards a model substrate mimicking wound bed; iv) in vitro cytocompatibility; and v) the capability to support fibroblast adhesion and proliferation, indicating their potential to promote tissue regeneration in wound healing applications.

The use of CS derived from *Hermetia illucens*, in combination with PVA and citric acid, enabled to obtain electrospun stable, homogeneous nanofibers with favourable mechanical properties. These nanofibers maintained their structural integrity after hydration, demonstrating their potential as scaffolds for wound healing applications. By providing an effective platform for tissue regeneration and reducing the risk of infection at the injury site, these novel nanofibers represent a promising advancement in the development of biocompatible wound care materials.

Keywords: chitosan, *Hermetia illucens*, electrospinning, wound healing, nanofiber

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Rheology-driven designing of high-performance bioinks for effective implementation of 3D-bioprinting in tissue engineering

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Abstract:
In recent years, the advent of extrusion-based 3D bioprinting (EBB) has revolutionized the field of regenerative medicine by enabling the precise fabrication of cell-laden complex scaffolds. EBB requires a bioink that fulfill biological requirements while simultaneously satisfy the stringent rheological properties needed by the printing process[1]. In specific, the ideal bioink should exhibit gel-like behaviour before dispensing, shear-thinning properties and an appropriate yield point to enable extrusion through the nozzle. Moreover, it should demonstrate a fast recovery ability to quickly regain its initial properties immediately after extrusion. Therefore, rheology surely represents an essential tool for the development of bioinks with adequate printability. Nevertheless, to date, the potential of rheology in this field has not yet been fully exploited. The aim of this research work was to leverage this tool to evaluate the rheology-to-printability relationship and, in this way, optimise high-printing performance biomaterial inks and bioinks. For this purpose, biomaterial inks were formulated using gelatin methacryloyl (GelMA) at four different polymer concentrations (5, 10, 15, and 20%w/v) and synthesized via two different procedures, a single-phase ($GelMA_{SP}$) and a double-phase synthesis ($GelMA_{DP}$), which allow the formation of derivatives with different rheological properties[2]. In order to improve the printability of the inks, the use of a rheological modifier, laponite (Lap), at 3 concentrations (0.5, 1.5 and 3.0%w/v), was also evaluated. Oscillatory temperature ramp analysis was performed to determine the polymer and laponite concentrations required to obtain samples with a solid-like behaviour at temperature values within a range compatible with cell survival. Samples were then subjected to further rheological tests to evaluate their shear thinning behaviour, yield stress and elastic recovery ability. In particular, oscillatory time sweep tests were performed to assess their time-dependent elastic recovery ability. These tests were also successfully used to investigate the effect of temperature on the recovery ability of the inks and to identify the temperature at which the fastest and most complete elastic recovery occurs. In was demonstrated that operating at temperatures below the T_{gel} enhanced the recovery properties of the inks. Considering all of this, it was possible, through rheological analyses, to develop and optimize an ideal biomaterial inks (named SP20-3 and made of 20%w/v $GelMA_{SP}$ and 3%w/v Lap) with optimal rheological and printability properties (Fig. 1A). SP20-3 ink was then converted in the corresponding bioink by inclusion of HaCat cells. The rheological tests highlighted a reduction in gel strength and its ability to recover due to the presence of cells, indicating the need to perform the recovery phase at a temperature lower than that of extrusion to ensure higher shape fidelity (Fig. 1B). Finally, printing trials were conducted and the uniformity factor (U), pore factor (Pr), and integrity factor (I) of the printed scaffolds were calculated to quantitatively assess printability. The results (Fig. 1C, D) demonstrate high printability for both the ink and the bioink, validating the effectiveness of rheological tests as a tool for optimizing bioink formulations.

Keywords: extrusion-based bioprinting, rheology, bioinks, gelatin, laponite.

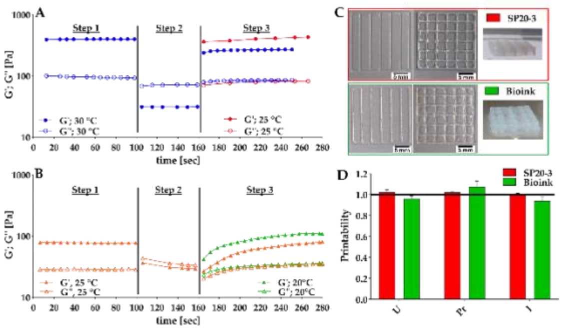

Figure 1: Oscillatory time sweep tests of SP20-3 ink (A) and Bioink (B). Printing test (C) and printability evaluation (D) of SP20-3 ink and Bioink.

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Fabrication of Hydrogel Composite for Tissue Engineering Applications; incorporating Magnetite nanoparticles

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Abstract:
Hydrogels are a class of materials that are useful as scaffolds in tissue engineering. Hydrogel scaffolds are particularly noted for their biocompatibility, customizable mechanical properties, versatility in fabrication, and their capacity to encapsulate cells and bioactive factors (An et al., 2024). Several self-healing scaffolds are developed as extracellular matrices (ECM) for soft tissues that lack regenerative capabilities (Fang et al., 2024). Here we report the fabrication of self-healing hydrogel composite with gelatine (Gel) and sodium alginate (SA) as the primary raw materials (Figure 1c). Gel-SA hydrogels were synthesized at varying ratios (2:1, and 3:1), crosslinked with calcium chloride (Ca^{2+}) and subjected to different crosslinking durations to identify the optimal hydrogel matrix. The selected hydrogel concentration was used to obtain hydrogel composites by incorporating magnetite (Fe_3O_4) nanoparticles. These nanoparticles induce thermal and structural stability, and magnetic response property to the composite material. A novel approach to self-healing, avoiding the use of toxic crosslinkers, is employed to ensure a consistent and uniform degree of healing. The thermo-reversible gelation of gelatine and ionic crosslinking of alginate chains with calcium ions (Ca^{2+}) are utilised to achieve self-healing. The mechanical performance of prepared hydrogels was characterised by healing, tensile and rheology tests. This work demonstrates the influence of polymer concentration, crosslinking time and Fe_3O_4 nanomaterial incorporation on the mechanical properties of the Gel-SA hydrogel composites. The resulting hydrogel can be tuned to mimic mechanical properties approaching that of soft tissues.

Keywords: Tissue engineering, soft tissue ECM, biomaterials, hydrogel composites, self-healing, Nanoparticles, mechanical properties.

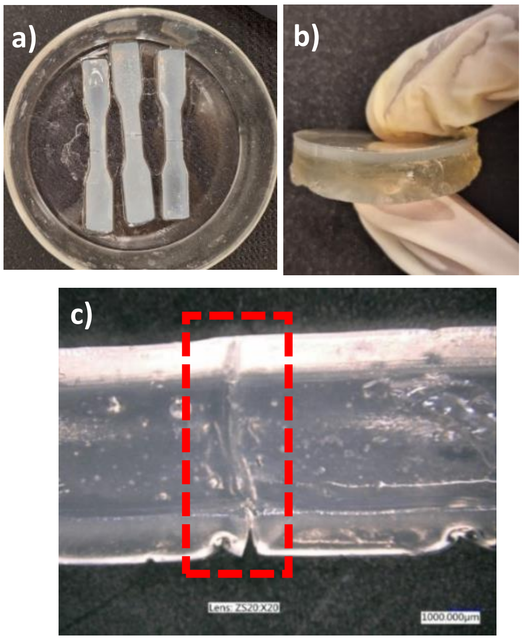

Figure 1: a) Dog bone shaped samples prepared for tensile tests, b) Cylindrical samples for rheology testing and c) Microscopic image of self-healed dog bone shaped sample that was cut perpendicular to the length.

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Sandalwood-Reinforced Composites for Personalised 3D-printed Arm Fracture Fixation Braces Using Finite Element Analysis

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Abstract:

Personalised 3D-printed orthoses have gained significant attention in biomedical engineering, offering patient-specific devices that facilitate precise alignment and efficient recovery. However, traditional materials used in orthotic fabrication often lack biocompatibility, antimicrobial properties, and sustainability. To address these limitations, this study explores the potential of using sandalwood-reinforced polylactic acid (PLA) filaments, leveraging sandalwood's natural antibacterial, anti-inflammatory, and bioactive properties to enhance patient comfort and healing efficiency. For arm fracture treatment, in particular, a 3D scanning process was conducted to capture the patient's limb geometry, followed by reverse engineering-based modelling to design a customised arm brace. Extruded filaments made of sandalwood powder-reinforced PLA composites were used here to fabricate an FDM 3D-printed arm brace (as illustrated in Figure 1). The mechanical performance of the brace was evaluated using finite element analysis (FEA), for which topology optimization was incorporated to assess the effects of different thicknesses (1 mm, 2 mm and 3 mm), topological shapes (circular, rectangular and hexagonal), and densities (10%, 20%, 30% of the volume). Simulation results demonstrated that an optimization of the topology led to a significant reduction of the brace's weight while maintaining sufficient mechanical strength and support. The optimised design rendered a balance between strength and stiffness, thereby enhancing patient comfort by minimizing unnecessary bulk and rigidity. This study highlights the potential of biocompatible and sustainable 3D-printed orthoses, paving the way for the next generation of lightweight, antimicrobial, and patient-specific orthopaedic supports.

Keywords: Sustainable 3D printing filaments, Natural Filler-Reinforced Composites, FDM 3D Printing, Finite Element Analysis, Structure Topology Optimization, Biomedical Applications.

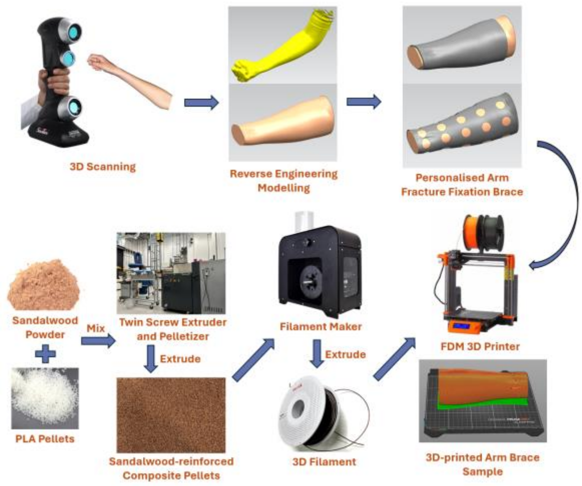

Figure 1: Schematic showing the experimental procedure employed to fabricate a customized arm fracture fixation brace by sandalwood-reinforced filament.

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PLGA based electrospun membrane for accelerated wound healing

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Abstract:
Electrospun membranes based on poly(lactic-co-glycolic acid) (PLGA) offer a promising platform for biomedical applications, particularly in wound healing. Their high surface area, porosity, and biocompatibility make them ideal for facilitating cell adhesion, proliferation, and tissue regeneration. In our study, we developed and characterized PLGA-based electrospun membranes incorporated with tetracopper silicate (cuprorivaite), a compound exhibiting intrinsic antibacterial properties. The addition of cuprorivaite aims to address the challenge of wound infections, a major impediment to efficient healing.

The sacrifice at the desired time-point of control and treated mice allowed for tissue collection and subsequent histological analysis to gain insights into tissue regeration process.

Preliminary results demonstrate that the PLGA-cuprorivaite composite membranes retain the mechanical integrity and biodegradability of PLGA while offering significant antibacterial activity.

Future research will focus on evaluating the effects of incorporating additional bioactive agents, such as growth factors, natural plant extracts, or nanomaterials, to further enhance the functionality of the membranes. These advancements aim to create a multifunctional wound dressing capable of addressing complex wound healing scenarios, such as chronic wounds or those in immunocompromised patients.

This work highlights the potential of PLGA-based electrospun membranes for transforming wound care by integrating antimicrobial and regenerative functionalities in a single, adaptable platform.

Keywords: electrospinning, PLGA, silica-based biomaterials, microscopy, wound healing, micropatterning, biomedical applications.

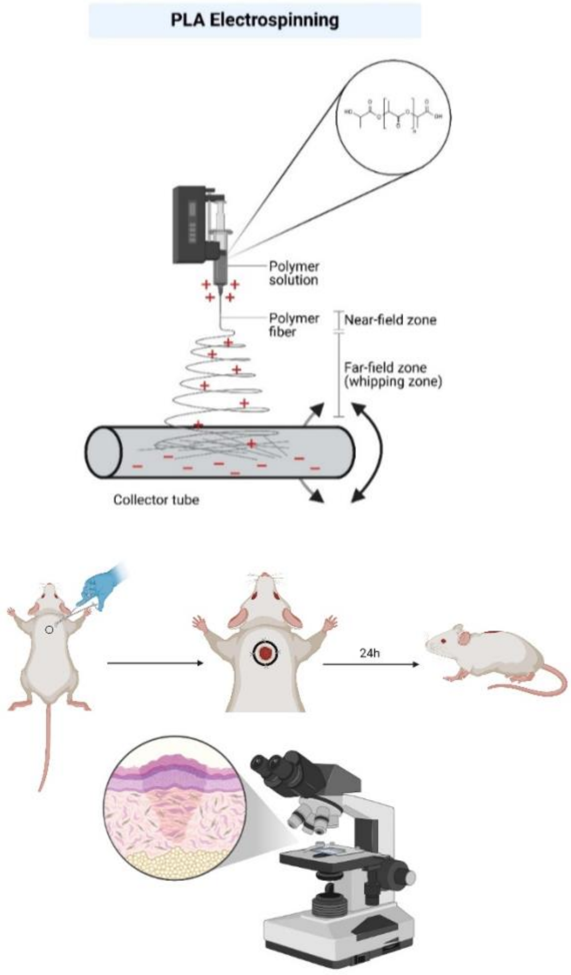

Figure 1: Synthesis of the membranes and experimental setting. Surgical implant of the membrane and histological analysis after sacrifice.

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ISOLATION AND CHARACTERIZATION OF POLYSACCHARIDES FROM COLOMBIAN AGROINDUSTRIAL BY-PRODUCTS AS BIOMATERIALS FOR 3D BIOPRINTING

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Abstract:
Colombia is a megadiverse country, rich in natural resourses such as animals, microorganisms and plants due to its geography, light, humidity, among others. This characterisitcs have created an important agroindustrial sector, which sustains the livehoods of an important part of the population, specially the most financially and socially vulnerable. Among these crops it is remarkable the presence of cocoa and corn, as cocoa is promoted as a replacement for illicit crops, showing a production close to 302,093 t of cocoa beans in 2021 [1]. Meanwhile, corn is an important crop in the basic basket, producing around 1,591,400 t in that same year [1], in addition to being fundamental in the ancestral diet.
besides these crops, the seaside populations depend on traditional practices of harvesting shrimps. While these products help to sustain and empower these communities, they generate an important amount of by-products, for instance the shell, head and tails of shrimp constitute nearly 60 % of the catch volume [2].
The lack of applications for these by-products result in their waste and the generation of novel pollution sources for the different ecosystems. For these reasons the need to obtain alternatives to use these by-products is important to reduce the ecological impact of these activities, while providing options to financially support these communities.
Among these alternatives, the isolation of their constituting biomolecules, specially polysaccharides (PS), and their uses in high-value applications such as 3D Bioprinting. The use of biopolymers in the development of 3D-printed scaffolds results in an green alternative that promotes novel applications in the biomedical science, such as the production of 3D cell lines for modelling organs or tumors, drug screening, wond dressings, among others.

To successfully incorporate these PS in a bioink, it is needed to understand the characteristics of the isolated biomolecules, and identify their biological and printing performance. For this reason, this work aims to isolate and evaluate the physicochemical, thermal, biological and rheological properties of pectin, cellulose, starch and chitosan, from cocoa, corn and shrimp by-products.

PS were isolated using an alcoholic extraction process, followed by sequential alkaline and/or acid treatments. The isolated PS were then rinsed, precipitated, and either dried or homogenized for further analysis. The methoxyl group content and degree of esterification were specifically determined for pectin. Characterization of the PS involved infrared spectroscopy, thermogravimetric analysis, scanning electron microscopy, rheological measurements, and particle size distribution analysis. Biological characterization included assessments of cytotoxicity in accordance to ISO 10993-5, along with evaluations for mycoplasma and endotoxin content. Finally, the printability of the PS was evaluated using a Bio X6 cellink bioprinter.

The PS studied, including starch, chitosan, vegetal nanocellulose, and pectins, exhibited the characteristic vibration bands and thermal behavior influenced by their chemical bonds and microstructure. Chitosan, starch and vegetable nanocellulse demonstrated a homogeneous particle size distribution and shear-thinning behavior, which are advantageous for extrusion processes in 3D Bioprinters. In contrast, pectins displayed a wide range of particle size and degree of esterification, which plays a critical role in their suitability for applications involving acid gelation or interactions with divalent cations. Moreover, all PS performed a cell viability above 70%, no Mycoplasma spp, nor endotorin presence confirming their biocompatibility and suitability for inclusion in bioink formulations intended for biomedical applications. Additionally, the absence of Mycoplasma and endotoxins in the samples verifies the effectiveness of the extraction and handling protocols, ensuring the microbiological quality and safety of the isolated PS. Finally, the parameters of filament collapse, printing preassure and shape fidelability ensured that the PS are suitable for 3D biobrinting. This results highlighted the promising potential of PS for applications in 3D bioprinting.

Keywords:

Polysaccharides, Colombian agroindustrial by-products, 3D bioprinting, biomaterials.

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Exploring the structure and composition of Black Soldier Fly pupal shells throughout chitin extraction

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Abstract:
Over recent decades, the pursuit of alternative protein sources has fueled the rise of an industry dedicated to farming insects for use in food and animal feed. Among the species explored, the Black Soldier Fly (*Hermetia illucens*) has gained significant attention, becoming one of the most commercially farmed insects on a large scale. Remarkably, this fly is capable of converting waste streams and agro-industrial residues into valuable resources such as proteins and fats. Companies in this field are also working to repurpose by-products like exuvial fragments, pupal casings, and dead adult flies, paving the way for a sustainable circular economy.[1] The exoskeletons of these insects offer a promising alternative source of chitin – a versatile biomaterial with unique properties enabling its applications in drug delivery, water purification, agriculture, and beyond.[2] Research on chitin sourced from Black Soldier Fly (BSF) remains relatively nascent compared to studies on crustacean-derived chitin. Therefore, gaining a deeper understanding of this biopolymer organization and interaction with other compounds in the considered biological matrices could facilitate the development of more efficient and sustainable extraction methods.

In this regard, the structure and composition at the micro and macro scale of the BSF pupal shells was investigated (Figure 1). A series of physico-chemical analyses were conducted at each stage of the chitin extraction process, ensuring that the native structure of the shells was preserved throughout. Imaging techniques were used as core techniques to monitor the extraction impact on the matrices and process efficiency. X-ray micro computed tomography (µ-CT) revealed a bilayer nature for the pristine pupal shells, where an inorganic layer recovers homogeneously the organic matrix; being converted progressively to a mono organic layer through extraction. X-Ray photoelectron spectroscopy (XPS), Energy-dispersive X-ray spectroscopy (EDS) and ToF-SIMS analysis confirmed the presence of a calcium-based epicuticular layer in the initial raw material. Scanning electron microscopy (SEM) was used to probe the surface and cross-section of each sample, highlighting the singular pattern of mineralization in this matrix. Associated with wide-angle scattering using a synchrotron radiation (SR-WAXS), infrared spectroscopy (FTIR) and thermal analyses (TGA), this study provides scientific knowledge for biomimetic applications (singular mineralization), as well as a new approach to monitor chitin extraction efficiency based on morphological evolution of the BSF pupal shells.

Keywords: insect industry, by-products, circular economy, structure, biomineralisation, chitin.

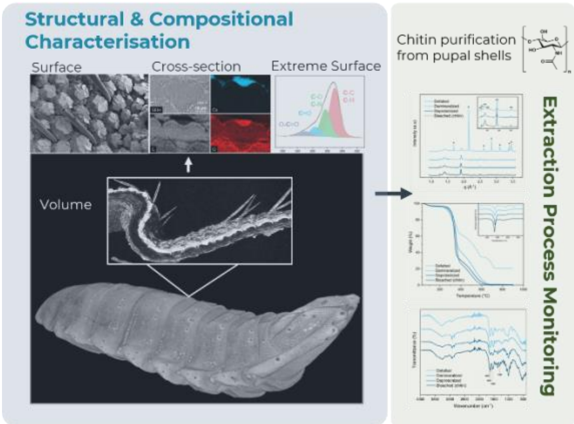

Figure 1: General physico-chemical characterization of the BSF pupal shells, emphasizing the power of imaging techniques to monitor chitin extraction efficiency.

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Polymers / Composites / 3Bs Materials 2025 Plenary Session II. A

The Reinforcement of Polymer Nanocomposites with Carbon-Based Nanofillers

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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. A range of different carbon-based nanofillers are now available as shown in Figure 1. The fillers considered in this study 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 of 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, and is independent of its mechanical properties. The failure of the nanocomposites by crack propagation is analysed regarding the fracture toughness of the epoxy nanocomposites and tear strength of the elastomer nanocomposites. The addition of nanoparticles is 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 may also occur, such as cavitation..

Keywords: Carbon nanomaterials; elastomers; epoxy resins; Young's modulus; fracture toughness; modelling.

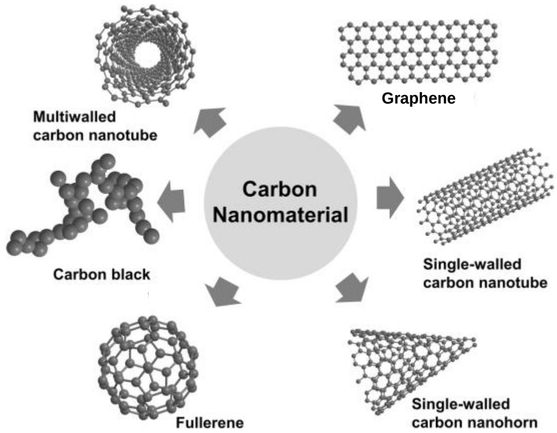

Figure 1: Examples of the different types of carbon-based nanomaterials [1].

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Development of Functional Biopackaging From Pomegranate Wastes

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Abstract:
The generation and disposal of synthetic polymers are largely unsustainable. A valid alternative to the development of biodegradable polymers, or green polymers, which could create new environmental impact, consist in the use of natural polymers extracted from vegetable resources.
Cellulose extracted by cell walls, undoubtedly represents a natural polymer whose unique features allow to use as efficient replacement of conventional plastic in many different applications. Moreover, each year, tons of wastes containing cellulose are generated by the agri-food industry. This is the case of pomegranate juice industry, generating a large quantity of discarded peels, even rich of added value compounds, such as ellagitannins, as well as of hydrolyzable and not hydrolysable fibres, such cellulose precisely.
The present works aims to join the polymers technologist’s competence with the cellulose recycling by waste residues of pomegranate, long investigated in our food chemistry laboratory.[1]
A procedure for the mildest and simplest cellulose extraction and purification from pomegranate peels was optimised. In parallel, biocompatible films were developed using gellan gum and glycerol as plasticizer and adding, in different percentage, commercial cellulose. This cellulose was then substituted with the home extracted and purified one, always achieving the objective of the least environmental impact.[2]
Extraction of cellulose was based on the use of mild and diluted solutions of alkali, applied for few hours at mild temperature followed by precipitate filtration and washing using little volumes of mild and diluted solutions of acidified water. Only if necessary, extracted cellulose was bleached, using mild and diluted solutions of hypochlorite or hydrogen peroxide, and/or sonicated or ultraturraxed.
The differently purified celluloses were, finally, characterized by FT-IR spectroscopy and SEM microscopy analysis, to verify the purity and the surface morphology.
Films were prepared following a simple methodology based on the solvent casting using different percentage of polymer, plasticizer and cellulose (**Figure 1**) and the mechanical properties of the obtained thin films were studied. An active ellagitannic pomegranate peels extract was also added to the film forming solution, with the aim to develop a functional biopackaging, exerting antioxidant, anti-radical, antimicrobial and light protecting properties.[3] Preliminary results show that mechanical properties of films are improved by cellulose adding.
Studies on permeability to water and oxygen and protection exerted toward food autoxidation, by comparison with commercial food protective films, are in progress.

Keywords: biopackaging; cellulose extraction; food waste recycling, pomegranate peels

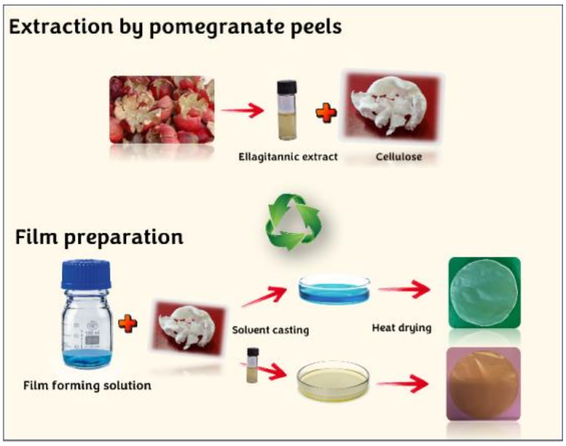

Figure 1: Ellagitannins and cellulose extraction by pomegranate peels and film preparation adopted technologies

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Synthesis of Fully Bio-based Copolymers with Tailor-Made Properties for Sustainable Food Packaging Applications

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Abstract:
The use of biopolymers as packaging materials to replace petrochemical polymers is becoming an emerging trend due to their natural and renewable origin and biodegradability. However, most biopolymers still show low flexibility, high melting temperature, and poor barrier properties in terms of water and aroma vapors and oxygen gas, which habitually reduce their application in food packaging. Therefore, the use of biopolymers in the form of monolayers is currently restricted to low-performance applications, such as plastic bags, lid films, or food-contact disposables. One potential strategy to increase the use of biopolymers in food packaging is currently focused on the development of copolymers with controlled molar ratios of different monomers. In the case of condensation biopolymers, such as biopolyesters and biopolyamides, the presence of ester and amide groups separated by alkane segments of different length, in combination with the chain symmetry, determines the final properties of the biopolymers. Whereas the polar ester and amide groups contribute to the mechanical strength, thermal resistance, and chemical stability, the long-chain aliphatic methylene groups provide mechanical flexibility and water resistance. Therefore playing with the methylene-to-ester ($CH_2/COOH$) and amide ($CH_2/CONH$) ratios biopolyesters and biopolyamides with specific properties can be successfully designed.
In the present study, different fully bio-based polyesters and polyamides with varying $CH_2/COOH$ and $CH_2/CONH$ ratios were synthetized by polycondenstion from biomass derived monomers reactions and analyzed. To this end, the biopolymers were thermo-compressed into films and fully characterized to ascertain the effect of the comonomer content on their crystallinity, optical, thermal, mechanical, and barrier properties. Finally, the application of the newly developed bio-based copolyesters and copolyamides films was validated by packaging meat in thermo-sealed bags and the food shelf life was assessed for a period of up to 14 days of cold storage. The resultant copolymers represent a Circular Bioeconomy solution, where their monomers derived from biomass and their packaging can be organically recycled in a compost or subjected to mechanical and chemical processes of recycling.

Keywords: polymerization, biopolymers, copolyesters, Bioeconomy, Circular Economy, sustainable packaging, food preservation.

Figure 1: Ciruclar Bioeconomy concept of the fully bio-based copolymers: (1) Monomers obtained from natural and renewable resources, including the valorization of agro-food waste; (2) High-performance material with tailor-made properties able to produce a packaging that reduces food waste; (3) Packaging that is compostable and/or fully recyclable after use; (4) The compost or recycled material yields raw materials that enter the cycle again.

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Novel eco-friendly composites with mineral particles derived from ocean shells and eggshells on a matrix of biobased poly(ethylene terephthalate)

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Abstract:
Nowadays, biobased polymers play a significant role in the global market. Alarming information on environmental pollution prompts the scientific society and industry to look for sustainable solutions aimed at reducing the negative impact of manufactured products on the environment [1]. Therefore, the project was aim to create a functional, ecological polymer composite based on bio-based PET (NP002 Nature Plast Mondeville ,France) reinforced with natural waste particles (eggs and molluscs shells) with antibacterial properties (as a results of addition of titanium oxide nanoparticles). In order to achieve the result, it was necessary to use chemical modifications to the fillers in order to increase fibre/matrix adhesion, which had a positive effect on the strength properties.

Figure 1: Optical microscope images of shells

The shells of mollusc and eggs were initially soaked for 2 weeks in a solution of water and dish liquid and then thoroughly rinsed. They were then digested in a 10% NaOH solution for 45 min and rinsed again. In the next stage, they were boiled for 30 min [2]. The dried shells were then ground in a disc mill (FRITSCH, PULVERISETTE 13). Composite pellets were produced using a compounding line with a Steer Omega 20H (Bangalore, India) co-rotating twin-screw laboratory extruder. The process was carried out at 270°C, and the screw speed was set to 90 rpm. The compatibilizer was added in an amount of 3%. Tests were carried out with the three compounds - Scona TPPL 5112PA; Scona TPKD 8304 PCC; Scona TPKD 8304 PCC.

The results of the research indicated that the choice of compatibilizer and the size of the waste shell particles is important in terms of improving strength and, above all, stiffness. Small shell particles and the formation of crystallisation nuclei show the best mechanical properties.

The proposed research were contribute to the creation of new ecological materials, which will not only affect the development of the market for the production of everyday products (electronic accessories, toys, etc.) but also develop such fields of science as materials and environmental engineering. The issue of producing composites with enhanced antibacterial properties will probably be undertaken for a long time in order to protect the life and health of society.

Keywords: biobased composite, poly(ethylene terephthalate), mechanical properties, surface treatment, waste particles, circular economy

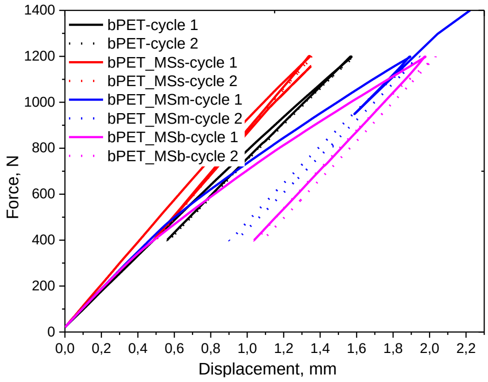

Figure 2: . Comparison of the dissipation of mechanical energy values for cycle 1 and 20

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Acknowledgment

This research was funded by the National Center for Research and Development (NCBiR), grant number mERA.NET3/2021/79/EcoMat/2022, “Durable bio-based polymer composites reinforced with natural waste fillers with antibacterial properties”

Polymers / Composites 2025
Session II. B

Electrostatic Spraying for Additive Manufacturing

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Abstract: The food industry is seeing an increase in the use of additive manufacturing technology for customised food printing. 3D food printing allows personalising food to consumers on individual needs. It can be customized to various parameters such as shape, size, ingredients, texture, colour, nutrients, application, etc. Currently, the technology is used for military and space missions. People are often busy with work and cannot taste their favourite foods due to lack of time; hence, technology plays a vital role in producing such food products. The research activities of 3D food printing are divided into four sub-activities: 1) prototype/technology development, 2) modelling and topology, 3) development of novel materials, and 4) characterization. This work investigates the potential use of electrostatic forces for 3D food printing to achieve precise and accurate printing. The advances in the custom food market are the main reason behind the growth of the 3D Food Printing Market.

Keywords: Customised food, additive manufacturing, edible materials, chargeability.

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Influence of Supplementary Cementitious Materials on the Strength of Sustainable Cementitious Concrete Composites

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Abstract:
Concrete is a composite material resulting from the design of a cement-based mixture with the role of binder, aggregates of different types and sizes, water and additives in order to obtain a good workability at the installation as well as to increase the durability. Concrete mix design for use in the construction industry, have a very high life rate, being made in various exposure environments. In recent decades, the focus has been on partially replacing conventional cement concrete components with alternatives that can reduce: the CO2 footprint and the amount of non-renewable or hardly renewable materials used. Research has been conducted to replace an amount of clinker with supplementary cementitious materials (SCMs) to replace more than 30% of the cement according to the mixture. SCMs contribute positively to the properties of concrete through hydration reactions especially with Portland cement. Pozzolans are siliceous or alumino-siliceous constituents found in powder form and which, in the presence of water Some pozzolans have very high reactivity (fly ash, silica fume, glass powder, ground granulated blast-furnace slag (GGBS)) while others have a common reactivity, namely raw or calcined natural pozzolans such as: metakaolin, volcanic ash, calcined marls, clays, etc. Replacing Portland cement with powdery recycled material leads to an ecological cement and implicitly an ecological concrete. One of the composites analyzed in our research is illustrated in Figure 1. A) and B) regarding the influence of SCMs in hardened composites in particular on the evolution of compressive strength over time.

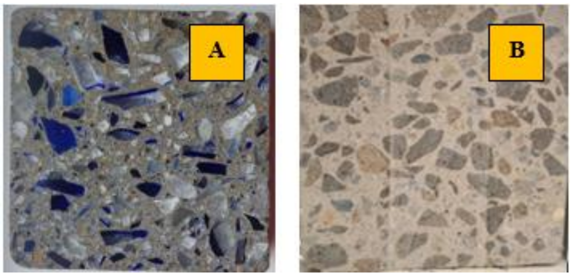

Figura 1,A: Innovative C60/70 concrete with SCMs such as fume silica (SF), waste glass powder (WGP), Natural river aggregate and alternative aggregates from recycled glass waste (WGA).

Figura 1,B: cementitious composite type road concrete with waste glass powder (WGP) as (SCMs), natural river aggregates, aggregates from recycled concrete waste (WCAA) and career aggregates.

SCMs materials influence the composite over time and depending on the amount substituted from the amount of cement in the mixture. All these are useful and feasible solutions for decarbonization and sustainability in the construction sector.

Keywords: cementitious composites, Additional cementitious materials (SCMs), ecological concrete, durability, Compressive strength.

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Incorporation of carbons into PP/PBE blend for obtaining 3D-printable conductive polymer composites

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Abstract:
Additive manufacturing by means of fused filament fabrication (FFF) is a technology popular for its rapid prototyping of designs and the ability to implement customized functional parts, in a cost-effective manner. Due to the ubiquitous nature of small electronic devices in the form of smart appliances, small portable devices, sensors, actuators and circuits, FFF stands out as a way to implement free-form batteries, which could better fit the geometry of the device. This application becomes increasingly useful when considering the need of batteries in isolated instances such as on a aircraft carrier or space station where they can be used to replace defunct batteries without the need of resupply. In this study, we produced the filament for 3D-printing through a solvent-free extrusion process. This method enables on-demand fabrication of batteries in an eco- and user-friendly way, and their printability in zero-gravity environment. We focus on understanding the polymer blend used as matrix for 3D-printing and the influence of different conductive carbon additives on the morphology and electrical properties of the printed material. Two different thermoplastic polymers have been selected PP and PBE. PP has a higher electrical conductivity in combination with the fillers, but lower printability, while PBE is used to add flexibility. We characterized the morphology of this blend at different polymer ratios by scanning electron microscopy (SEM), atomic force microscopy (AFM), differential scanning calorimetry (DSC) and Raman spectroscopy. Conductivity of the composite material was obtained through electrochemical impedance spectroscopy (EIS). The combination of these techniques provided us with a deeper understanding on the relation between the formulation and electrical properties of a 3D-printed conductive composite. This presentation will highlight our findings and shows how the control the mechanical and electrical properties of conductive polymer blends consolidates the bases for future applications of 3D-printed conductive free-form parts.

Keywords: conductive polymer composites, thermoplastic polymer blend, fused filament fabrication, 3D-printable batteries, solvent-free extrusion.

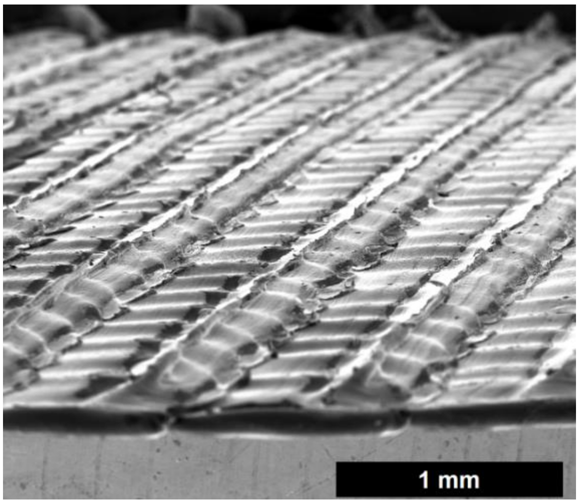

Figure 1: SEM image of a conductive polymer composite disk obtained through fused filament fabrication, giving us a macroscopic look at the structure of interest for future energy storage applications

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Improving Process Stability in Mechanical Recycling of Thermoplastic Composites with a Lab-Scale Dosing System

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Abstract:
Thermoplastic composites (TC) offer significant advantages over thermoset composites, particularly in their ability to be remelted multiple times, which enables thermoplastic composites to be mechanically recycled, thereby promising a more sustainable solution for lightweight design with endless-fibre reinforcement. The mechanical recycling process involves three key stages: pretreatment, in which the TC-parts are cut to flakes; regranulation, in which these flakes are pelletized into recyclates; and remanufacturing, in which the recycled pellets are reprocessed into new fibre-reinforced TC-parts.

During regranulation, flakes of different size and shape are fed into the (twin-screw) extruder for either the dilution of fibre content or the adjustment of material properties by using additives. However, inconsistent bulk density of the flakes within the screw intake zone may induce variations in the fibre mass content of the final pellets, preferably if the used gravimetric flake dosing itself conveys differently depending on flake size.

To test and improve process stability, we developed a lab-scale dosing test system that measures flake size distribution and transient output weight. This system comprises four main components: the gravimetric dosing unit that transports the flakes onto a conveyor belt; a line scan camera that measures the size and shape of the flakes; the conveyor belt; and a differential scale placed at the end of the conveyor belt that records the weight of the flakes.

This setup was tested using shredded thermoplastic composite flakes, both unfiltered and size-filtered, to verify both the accuracy and the reproducibility of the dosing unit. First experiments validated our hypothesis, demonstrating a strong correlation between flake size and the measured throughput rate of the dosing system.

Finally, our results may allow a feedback loop system that can adjust the flake feed rate to the extruder in real time, leading to a better process consistency.

Keywords: Thermoplastic composites, Mechanical recycling, Flake size distribution, Gravimetric dosing system

Novel composites reinforced with different types of fibers (basalt, quartz, aramid and polymide) on a biobased polyethylene terephthalate matrix

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Abstract:
The aim of this study is to asses the effect of the addition of different types of fibers on the physico-mechanical properties of bioPET composites. BioPET is a type of thermoplastic polymer that is made from renewable resources and offers similar mechanical properties, processability and recyclability as its petroleum-based counterpart, but with a reduced carbon footprint [1]. One type of fiber used to reinforce polymers is basalt fiber, which is derived from natural volcanic rocks with excellent mechanical properties, high thermal stability and resistance to chemical and environmental degradation [2]. Basalt fibers also exhibit higher tensile strength and better heat resistance than glass fibers and compared to carbon fibers, are more cost-effective, making them a more economical choice for many industrial applications [3,4].
Samples were produced by injection molding on the matrix of biobased PET (NP 002) by Nature Plast (France) with the addition of 5, 10 and 15% by weight of fibers:
1) basalt - BCS 13-3.2- KV02M with a diameter of 13 µm, length 3.2 mm from Basaltex (Belgium)
2) aramid - with a length of 1 mm from Alfa Chemistry (USA)
3) quartz - BN104-3 with a length of 3 mm from Bannor (China)
4) polymide - BN2D-1 with a length of 1 mm from Bannor (China).
To increase adhesion and miscibility, 3% of Scona TPKD 8304 PCC compatibilizer (SEBS functionalized with glycidyl methacrylate) was also added to the composites.
The composites were subjected to mechanical tests - tensile, bending and impact tests, as well as low-cycle dynamic tests. SEM images were also taken to evaluate the surface structure and adhesion between the fibers and the polymer matrix. The results showed that regardless of the type and amount of fibers, there was a significant increase in the tensile strength (11.5 - 86.7%) and Young's modulus of the composites (11.3-165.5%). The composites with the addition of quartz and basalt fibers had the highest tensile strength. The addition of 15% quartz fibers, increased the tensile strength by 86.7% and Young's modulus by 165.5% compared to neat bioPET. The three-point bending test also showed that the best composites were those with the addition of 15% quartz and basalt fibers, where the increase in flexural strength was 50.2% and 46.1%, respectively, and bending modulus by 113.7% and 76.2%. High results were also obtained for the composite with the addition of aramid fibers.

Keywords: bioPET, biocomposites, basalt fibers, quartz fibers, aramid fibers, polymide fibers, physico-mechanical tests

Table 1. Tensile and impact test results of the produced composites

Sample	Tensile strength [MPa]	Young's modulus [MPa]	Impact strength [kJ/m^2]
bPET	52.1 $^{\pm 0.3}$	2871$^{\pm 231}$	-
bPET+15b	76.6 $^{\pm 4.1}$	5541 $^{\pm 43}$	26,6
bPET+15q	97.3 $^{\pm 0.1}$	7622 $^{\pm 36}$	23,9
bPET+15a	70.5 $^{\pm 2.8}$	5558 $^{\pm 162}$	16,4
bPET+15p	62.6 $^{\pm 1.5}$	3197 $^{\pm 245}$	18,4

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Acknowledgment

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The effect of the reinforcement of ceramic tile waste powders on the microstructure and mechanical properties of composites based on epoxy vitrimer

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Abstract:
One of the priorities of developing new composite materials is to reduce the con-sumption of natural resources and recycle post-production and post-consumer material wastes. The main additives for resins used in the construction industry are mineral pow-ders. A Limestone and quartz powder fillers are used to reduce the consumption of resins, thus decreasing costs and improving or giving them specific properties. Considering the protection of all resources understood as re-sponsible production, consumption, reuse, and recovery of all products, ceramic tile waste (CTW) can be used as a filler for the resin matrix [1].
The most commonly used resin is epoxy, which, since it is a duroplastic, cannot be reused as in the case of thermoplastics. Hence, the typical epoxy resin can be replace by epoxy vitrimers (EVs) [2]. This study reports an innovative pathway for successfully synthesizing com-posite based on ceramic tile waste and epoxy vitrimer. The effect of the reinforsement of ceramic tile waste powders on the microstruc-ture and mechanical properties of CTW/ EV composites was shown. Ceramic tile waste was ground in a planetary ball mill and then dried and sieved. The phase composition and particle size distribution were evaluated. The particle size was no more than 125 um. The matrix was a vitrimer resin obtained on the basis of epoxy resin. The weight fraction of CTW ranged from 10% to 90%. The silane coupling agent was used to improve the adhesion between CTW powder and resign.
It was found that bondings between resin and powder particles are the crucial factor affecting the mechanical strength. The SEM observations proved uniform dispersion powder reinforcement in matrix. Moreover the mechanical properties of CTW/EV compo-sites were improved by using an adhesion promoter. By obtaining a low resin viscosity it was possible to add up to 90% CTW.

Keywords: ceramic tile waste (CTW), epoxy vitrimers (EVs), silane, mechanical properies, microstructure

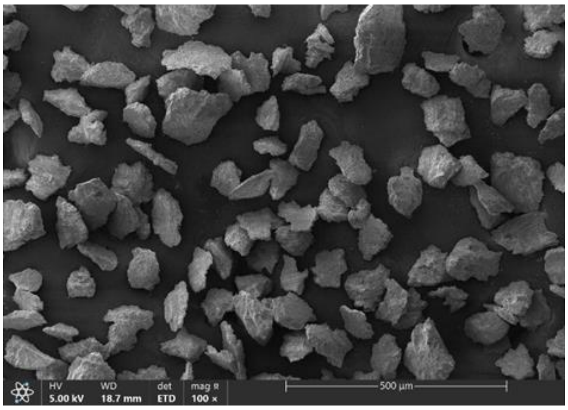

Figure 1: Figure illustrating the milled and sieved ceramic tile waste powder

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Polymers / Composites/ 3Bs Materials
Session II. C:
Biobased Materials/ Biopolymers/ Biocomposites/ Bio interfaces / Biomaterials applications

Electroactive micropatterned materials for advanced biointerfaces

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Abstract:
Electroactive and micro/nanopatterned biomaterials, which can electrically and topographically stimulate cell-cell interactions, cell development, migration, and differentiation, are of significant interest in regenerative medicine. To this aim, various strategies can be employed to enhance the capabilities of these biomaterials. In this talk, the potential for fabricating nanomodulated and electroactive interfaces that synergically promote neuronal development in vitro will be presented [1]. This is achieved by combining soft-lithography techniques with conductive polymers like poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS), renowned for its unique properties, including mixed ion-electronic conduction, high water processability, biocompatibility, and low impedance [2]. These interfaces can be easily transferred onto biodegradable substrates, ensuring rapid biodegradability once implanted in vivo [3]. Additionally, we will demonstrate the fabrication of flexible, conductive micropillar arrays with tunable electrochemical properties [4]. These arrays can both support axonal development of neurons and record neural signals in vivo when integrated into multi-electrode arrays [5]. Lastly, a novel conductive and biodegradable micropatterned blend based on 3D Mxene multiflakes will be presented (**Figure 1**), showing promise for promoting muscle cell differentiation.

Keywords: Multifunctional materials, conductive polymers, contact guidance, micropatterns, nanomodulated surfaces, electrical stimulation, neuronal differentiation, MEAs, Mxene composites.

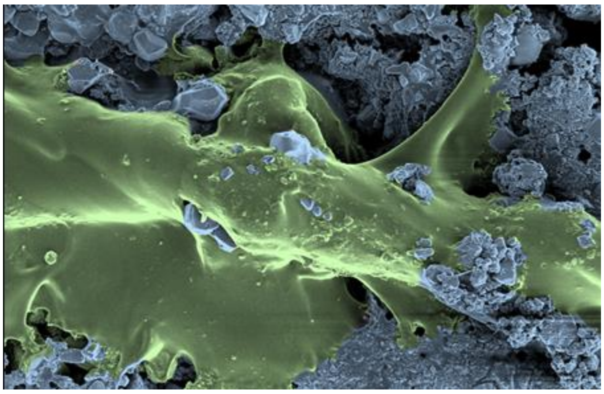

Figure 1: A C2C12 cell on a micropatterned MXene/PLA composite substrate.

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Brewers spent grain as main by-product for development of novel, high-performance bio-based polymers, polymer blends, and co-polymers

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Abstract:
The European Project POLYMEER aims to address the sustainable management of brewer's spent grain (BSG), a major by-product of the brewing industry. Globally, approximately 40 million tons of BSG are produced annually, with 8 million tons coming from Europe. Currently, BSG is predominantly used as animal feed (70%) or discarded in landfills (20%), with a small percentage converted into biogas (10%). However, the increasing decline of farmers accepting BSG as feed[1] highlights the need for better, higher-value disposal options

Bioplastics currently represent only 1.5% of global plastic production[2], and existing growth rates are insufficient to meet future market demands. BSG, offers significant potential as a bioplastic feedstock but faces challenges due to its poor mechanical properties and scalability. POLYMEER aims to overcome these challenges by developing high-performance bio-based polymers, copolymers, and polymer blends for applications where traditional fossil-based plastics are still dominant, such as in agriculture, packaging, and textiles, utilizing green, waste-minimized processes.

All materials will be designed to be recyclable and/or biodegradable in specific environments. POLYMEER will also assess the life cycle sustainability, cost-effectiveness, and scalability of these solutions. Ultimately, the project aims to establish a sustainable bio-based value chain for bioplastic products, offering an innovative alternative to conventional plastics while contributing to environmental sustainability.

To achieve these goals POLYMEER project, supported by CBE-JU, will involve the collaboration of 14 partners from 8 EU countries (IT, BE, ES, HR, NL, PT, DE, DK) including academic institutions, research centers and companies.

Keywords: bio-based products, polymer chemistry, polymers and plastics, brewers spent grain, polymerisation, PLA, vitrimers, agricultural plastics, textiles for automotive, tertiary packaging, biodegradable

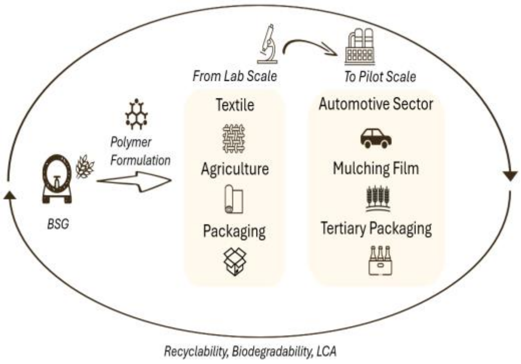

Figure 1: Figure illustrating the methodology that will be followed during the project (2024-2028): the brewer's spent grain will be converted into bio-based building blocks, creating materials with tailored properties for automotive textiles, mulching films for agriculture and tertiary packaging for brewery, up-scaling the experimental phase from laboratory scale to pilot scale.

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Acknowledgment

The project is supported by the Circular Bio-based Europe Joint Undertaking and its members. Funded by the European Union. Viewes and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CBE JU. Neither the European Union nor the CBE JU can be held responsible for them.

Increasing the resistance of PLA-starch composites

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Abstract:
The use of bioplastics like poly(lactic acid) (PLA) is still limited, mainly due to its high costs. A promising solution involves adding native potato starch as a filler for PLA. This approach not only lowers the cost but also reduces the material’s carbon footprint, as starch extraction emits less CO_2 than PLA synthesis. Despite the demand for sustainable materials, an application of PLA and PLA-starch composites is mostly restricted to packaging due to limited resistance, particularly under environmental stresses like temperature and humidity. To expand the application areas of PLA and ists composites, it is crucial to improve the resistance against hydrolytic and physical aging [1–3].

For this purpose, composites of PLA with 50 wt. % potato starch were produced using a twin-screw extruder and neat PLA was used as reference. Various additives such as hydrolysis protection systems, coupling agents and impact modifiers were added to both materials. Test specimens were produced from all batches by injection molding and then exposed to various environmental conditions (standard climate, elevated temperature, elevated humidity, water) for 168 hours. In order to evaluate the effect of the additives on the stabilization of the composites, mechanical characterizations were carried out by means of tensile tests and impact bending tests. In addition, the test specimens were analyzed using Fourier Transformation IR Spectroscopy (FTIR) and scanning electron microscopy (SEM).

The results show that the hydrolytic degradation of PLA can be prevented by the addition of carbodiimides (hydrolysis protection) during the investigated test period. Likewise, depending on the additive, significant changes in the mechanical properties of the blends can be seen through the addition of coupling agents and impact modifiers. The studies show that the currently insufficient resistance of PLA and PLA-starch composites can be significantly improved, which will considerably expand their range of applications.

Keywords:
poly(lactic acid), starch, stabilization, degradation

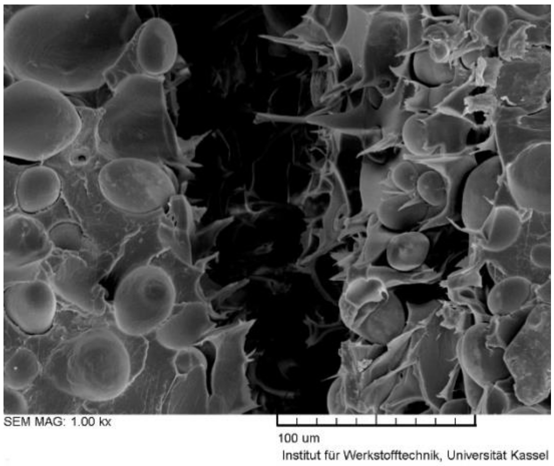

Figure 1: SEM image of a PLA-starch composite stored for 168 hours in water

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Chemical Resistance of Regenerated Cellulose Fiber-Reinforced Bio-Polyamide 5.10

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Abstract:

Polyamides are known for their good chemical resistance. As matrix material for glass fiber reinforced composites (GFC), they are often used in applications of the automotive sector, such as fuel caps or housings [1]. In order to be able to make a prediction about the suitability of natural fiber-reinforced composites (NFC) for this application, the chemical resistance of a bio-based polyamide with natural fiber-reinforcement was investigated in this study.

Effects of chemical storage on the crystallinity, molecular structure, viscosity as well as on the quasi-static behavior of regenerated cellulose fiber-reinforced (RCF) bio-based polyamide (PA) 5.10 were examined. Composites with 20 wt.% of RCF were produced using a twin-screw extruder and non- and RCF-reinforced test specimens according to DIN EN ISO 527-1 type 1A were prepared on an injection molding machine. Thereafter, these test specimens were stored in various fluids/ chemicals (destilled water, salt water, soap water, acid rain, rubbing alcohol, engine oil, ethanol, sodium hydroxide solution, 2-propanol) for up to 168 hours. Once chemical storage was completed, tensile and notched impact tests, SEM images (Figure 1) as well as DSC, FTIR, moisture and viscosity measurements have been performed. Strong hydrolytic and thermo-oxidative influences were detected subsequent to the chemical storage, which accelerate the degradation of the PA5.10 with increasing storage time. In addition, a strong correlation between the accelerated moisture absorption of the PA5.10 and decreased mechanical properties has been demonstrated. The RCF-composites are severely damaged by the chemicals, which is mainly due to the moisture absorption of the incorporated RCF. In addition, fiber-matrix-debonding, which result due to swelling processes of the RCF, have been detected in REM images. The loss of fiber-matrix-adhesion reduces the tensile strength and Young´s modulus of the stored specimens significantly [2].

Keywords:
bio-polyamide, regenerated cellulose fibers, chemical storage, degradation

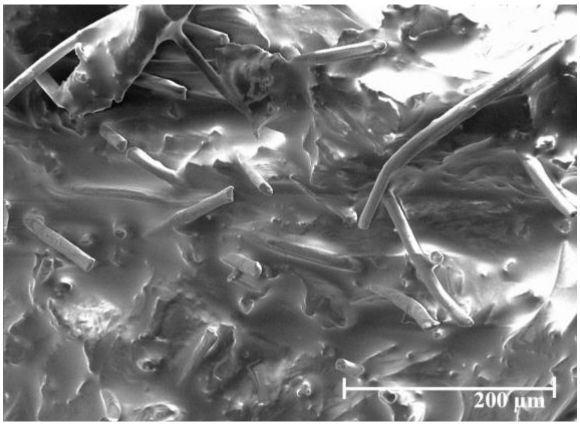

Figure 1: SEM image of a RCF-reinforced specimen stored for 168 hours in engine oil at 500x

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Development of Clays/Chitosan Nanocomposites for Microneedles Preparation

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Abstract:
Clay-polymer nanocomposites (CPNCs) are advanced materials that combine polymers and nanoclays, resulting in improved physical, chemical, and structural properties compared to pure materials. CPNC are being successfully integrated in many biomedical fields, making them suitable for applications in drug delivery, tissue engineering, and wound healing [1]. This research focuses on developing CPNC-based microneedles (MNs) for the treatment of pathological scars. Three different CPNCs were prepared *via* solution blending technique, based on nanoclay hydrophilic bentonite (BEN), halloysite nanoclay (HAL) or sepiolite (SEP) (Sigma Aldrich, ES) with chitosan (CS, low molecular weight 50-190 kDa, Sigma Aldrich, I). To prepare CPNCs, a 4% CS solution was dissolved in 0.5 M acetic acid and adjusted to pH 4.5. Each clay was dispersed in water and homogenized, then mixed with CS in specified ratios reported in Table 1. The dispersions were stirred for 48 hours and sonicated twice. CPNCs were characterized using rheology, X-ray diffraction (XRPD), elemental analysis, SEM/TEM imaging, FT-IR spectroscopy, DSC/TGA, and ζ potential measurements.
MN patches made from CPNCs were produced using a micromolding solvent-casting technique. A polydimethylsiloxane (PDMS) mold with a 10x10 array of 800 µm-deep, pyramid-shaped cavities was used. First, 200 µl of CPNC dispersion was applied to the mold and centrifuged to fill the cavities. An additional 100 µl of CPNC dispersion was added to form the backing layer; the mold was dried for 6 hours before peeling out the MN. The MNs were analyzed using optical and SEM microscopy, and their mechanical strength was tested with a texture analyzer. Preliminary tests for skin insertion were conducted using a Parafilm® model membrane, where MNs were applied with 40 N force for 30 seconds, and insertion success was confirmed through microscopy.

BEN/CS (w/w ratio)	HAL/CS (w/w ratio)	SEP/CS (w/w ratio)
0.25:1	0.25:1	0.25:1
0.5:1	0.5:1	0.5:1
1:1	1:1	1:1
2:1	2:1	2:1
5:1	5:1	5:1

Table 1. Quali-quantitative composition of the CPNC.

Rheological measurements allowed to calculate the normalized rheological synergism parameter (Δη/η%): negative values support successful interaction. XRPD confirmed the intercalation of CS within BEN layers, with shifts in basal spacing demonstrating the structural integration. FTIR analysis identified electrostatic interactions, shown by shifts in NH^+ bending. Elemental analysis linked nitrogen concentration to CS content, suggesting ideal CS loading ratios of 0.25/1 and 0.5/1. These ratios were also confirmed by morphological studies using SEM and TEM, showing optimal layering and surface coverage. MNs with a pyramidal structure were fabricated and displayed sufficient mechanical strength, exceeding the required 0.05 N/needle force for skin penetration.

Keywords: nanocomposite, chitosan, clay, bentonite, alloysite, sepiolite, microneedles, pathological scar.

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Composite scaffold based on Poly(lactic acid) and Chitosan/Hydrolyzed Collagen for the treatment of peripheral nerve injuriy

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Abstract:
Peripheral nerve injury (PNI) is one of the most debilitating pathologies that severely impairs patients' life[1]. Innovative treatments for peripheral nerve repair are based on nerve guide conduit, namely engineered tubular structures designed with necessary mechanical and biochemical cues for neural regeneration[2]. Given these premises, the aim of the present work was to develop an innovative nerve guide conduit based on a composite tubular scaffold composed by a thin sheath of poly(lactic acid) filled with a Chitosan-Hydrolyzed Collagen porous scaffold.

As for the outer sheath, Poly(D,L-lactic acid), PLA) was dissolved at 10% w/v in acetone under magnetic stirring and then poured into a silicon mold. Glycerol (GLY) was added as plasticizing agents at 1%, 3% and 5% w/v. The solutions were left overnight under flow hood and PLA, PLAGLY1, PLAGLY3 and PLAGLY5 films were obtained by solvent casting. Morphological analysis via Scanning Electron Microscope (SEM) was performed and ImageJ was used for pore dimensional analysis; mechanical analysis was performed with Texture Analyzer.

As for the filling matrix, Hydrolyzed Collagen (HC) aqueous solutions were prepared at different concentrations (2, 3, 4, 6 % w/w); medium MW chitosan (Cs) was added to HC solution at different concentrations (2, 3, 4, 6 % w/w) and then glacial acetic acid was added. Six different solutions were obtained, fixing the total polymer concentration at 6% w/w (Cs2HC4, Cs4HC2, Cs4HC2) and at 8% (Cs2HC6, Cs4HC4, C63HC2). Viscosity of the CsHC solutions was measured by means of a rotational rheometer. CsHC solutions were poured into 24-well plate and subjected to freeze-drying. Porous scaffolds were then characterized by morphological, mechanical, hydration and viscoelastic properties.

As for final scaffold preparation PLA solution was poured into cylinder glass molds. After solvent casting, tubular empty scaffolds were obtained and filled with CsHC solution. PLA/CsHC systems were then freeze-dried. PLA/CsHC scaffolds were characterized by means of morphological, mechanical properties and biocompatibility properties.

Homogeneous films with an interesting porous surface were obtained in the case of PLAGLY1, with pores mean diameter of 10-15 μm (Figure 1). Mechanical characterization showed that GLY addition increased film plasticity only at 1% w/v concentration. PLAGLY1 was selected for further study.The CsHC solutions rheological analysis revealed that viscosity increases with Cs concentration and decreases with HC concentration. CsHC porous scaffolds were characterized by a 3D porous interconnected structures (Figure 1), with decreased pore size observed with increasing HC concentration. Moreover, it was observed that an increase in total polymer concentration can decrease swelling behavior and enhance scaffold mechanical properties. Finally, as for the composite tubular scaffold PLAGLY1/Cs2HC4, both outer film and inner polymeric matrix were maintained (Figure 1), displaying enhanced mechanical properties and good biocompatibility towards Schwann cells.

Keywords: peripheral nerve regeneration, nerve guide conduit, chitosan, hydrolyzed collagen, PLA.

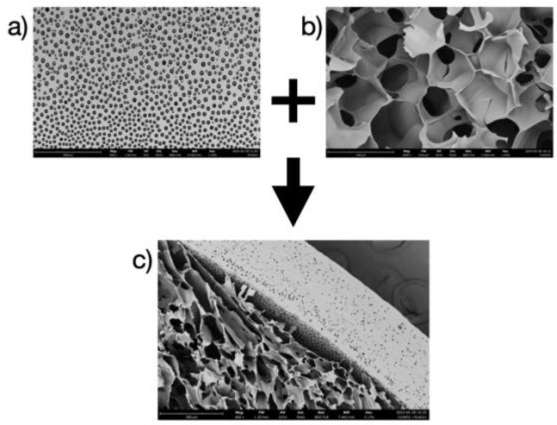

Figure 1: SEM images of a) PLAGLY1 film, b) CsHC porous scaffold, c) PLAGLY1/CsHC composite tubular scaffold.

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Enhanced Targeting of Pancreatic Cancer Using N6L-Functionalized Lipid Nanocarriers Encapsulating Paclitaxel

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Abstract:
Pancreatic cancer remains one of the most aggressive malignancies, characterized by poor survival rates and limited therapeutic options [1]. Despite advances in chemotherapy, treatments show limited efficacy due to systemic toxicity, poor tumor specificity, and the emergence of drug resistance. Nanostructured lipid carriers (NLCs) have emerged as a promising strategy, offering improved drug delivery, controlled release and enhanced therapeutic efficacy, while enabling active targeting [2]. These particles possess a solid matrix which allows them to encapsulate and protect bioactive compounds. The unique properties of NLCs facilitate their bioavailability and stability, which is particularly advantageous in cases where molecules exhibit low absorption or rapid degradation. The present study explores the development of NLCs by solvent diffusion method with natural lipid compounds, such as cholesterol and oleic acid, for pancreatic cancer treatment [3].
NLCs were loaded with Paclitaxel (PTX), a chemotherapeutic and hydrophobic agent, and coated via electrostatic interaction with N6L, a synthetic hydrophilic ligand that specifically targets nucleolin, which is overexpressed on pancreatic cancer cells [4]. The developed particles demonstrated stability under physiological conditions with diameters ranging from 150-170 nm. They were characterized in terms of morphology, zeta potential and suitability for storage under varying temperature, ionic strength, and pH condition. Additionally, the development of physically stable topical formulations was successfully achieved by freeze-drying with the addition of a cryoprotectant. The formulated NLC demonstrated promising anti-cancer efficacy *in vitro* against PANC-1 cells. The preliminary findings suggest that this dual-encapsulation system has potential to serve as an alternative treatment for pancreatic ductal adenocarcinoma (PDAC), addressing the limitations of conventional chemotherapy.

Keywords: nanostructured lipid carriers, pancreatic cancer, surface modification, tumor targeting, drug delivery, biocompatibility, biomedical applications.

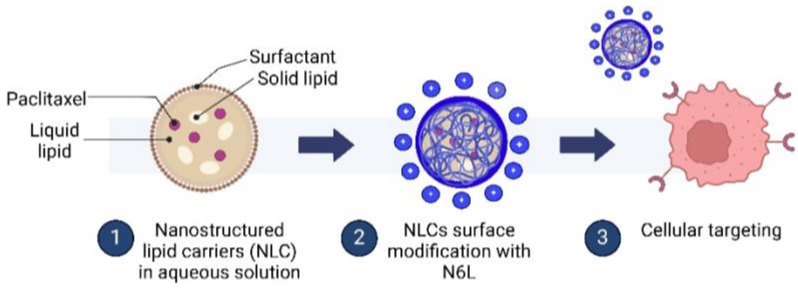

Figure 1: Schematic representation of the strategy for obtaining N6L-modified PTX-loaded NLCs for targeting pancreatic cancer cells.

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Development of Biomimetic Bi-Layered Hybrid Patches for Chronic Wound Management: Integrating Antimicrobial and Regenerative functions"

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Abstract:
Chronic wounds are a major healthcare challenge, affecting the quality of life of millions of people. This phenomenon escalates due to the aging of population and rising comorbidities. It is widely acknowledged that traditional wound care methods are often inadequate when it comes to dealing with the complexities of chronic wounds. Biomaterials, however, have emerged as a promising solution to this issue.

This study focuses on the development of biomimetic, bi-layered hybrid patches designed to treat chronic wounds. These patches combine sustained, targeted antimicrobial activity with regenerative capabilities, inspired by the natural composition of skin. Chitosan and gelatin were chosen for their antimicrobial properties and structural compatibility with connective tissues. The matrices were functionalized with bioactive hybrid particles to enhance their regenerative potential, then assembled into a bi-layered structure with precisely tailored chemical and structural properties, using various fabrication techniques, followed by cross-linking. Furthermore, the inner layer can be locally medicated with custom-designed antimicrobial agents to enhance its antimicrobial efficacy.

The developed patches exhibit excellent physiochemical properties, including exudate absorption, moisture permeability, biodegradability, and effective drug release kinetics. In vitro biological studies have proved their biocompatibility and antimicrobial function, while in vivo tests, using medicinal leeches as an animal model, have demonstrated their affinity for live tissue and efficacy in supporting endothelial cell proliferation by stimulating epidermal tissue healing processes.

Keywords: wound-healing; multilayered dressing; hydroxyapatite; drug release; personalized medicine.

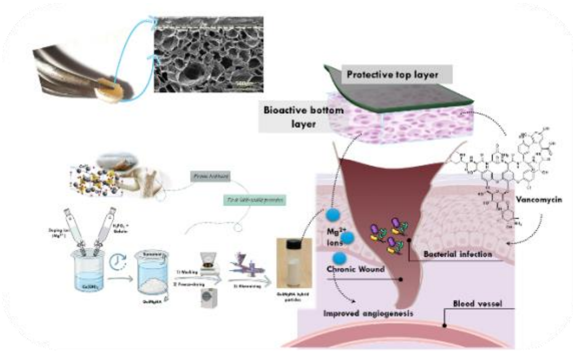

Figure 1: Schematic illustration of bilayered scaffold composed of gelatin-chitosan and biomineralized Mg-hydroxiapatite.

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Silencing AP-1 Signaling Accelerates Ischemic Wound Healing in the Elderly

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Abstract

The present study aimed to test the hypothesis that the ROS/MAPK/MMPs signaling axis plays an important role in pathobiological process of chronic wound in elderly by using siRNA approach in a novel ischemic wound model.

The delayed wound healing model was created in 12 month-old male Fischer 344 rats. Non-targeting control siRNA and SMARTpool AP-1-siRNA nanoparticle were administered to ischemic wound tissue by injecting into artery pedicle for both control and experimental group respectively. The closure of the wounds was monitored and the wound tissue was analyzed on days 7 &14 (n=12) by means of RPPA, IHC and western blot, etc.

Laser Doppler flowmetry, X-ray angiography and Indocyanine green scanning showed that the area beyond mid-line of the flap was hypo-perfused from day 0 to day 7. The ischemic wounds created on the distal region of the flap showed significantly impaired wound closure compared to the normal acute wounds. 3-nitrotyrosine, a marker of oxidative stress, is markedly increased in ischemic wounds. IL-1, HIF-1α and VEGF receptor 2 were significantly decreased in ischemic wound tissue. The MMP9 and Cleaved Caspase 3 protein were increased dramatically, correlated with more collagen degradation. These data of control group suggested severe oxidative stress with excessive collage breakdown and increased apoptosis leading to wound closure impairment. The fluorescently labeled siRNA was successfully delivered and detected in the wound tissue. AP1-siRNA treatment significantly improved ischemic wound healing and reversed the effects of oxidative stress on such wounds.

Blockage of ROS/MAPK/MMPs signaling axis with siRNA could be a translational therapeutic approach for chronic wounds in elderly.

Polymers / Composites 2025 Session III. A: Energy and Environmental Applications

Carbon dioxide Conversion to Fuels and Chemicals using Polymer-Photocatalyst composites

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Abstract:
Over the past century, atmospheric concentrations of greenhouse gases have increased due to extensive human activity[1]. Consequently, pursuing environmentally friendly processes that not only capture CO_2 but also convert it into valuable products is a critical challenge for the modern chemical industry. A promising green approach to transforming CO_2 into useful compounds involves photocatalytic reactions that, facilitated by suitable semiconductors, can operate under ambient conditions. However, existing photocatalytic systems often suffer from limitations such as low selectivity toward the desired products and limited conversion of reactants[2]. A potential solution involves confining the photocatalyst within a solid phase that selectively captures CO_2 while minimizing product adsorption. This reactive composite phase would include porous polymeric materials with a high affinity for CO_2 and a low affinity for the desired products. This research focuses on investigating a CO_2 photoreduction reaction using polymer-based composite photocatalysts. Experimental efforts have focused on evaluating the reductive capacity of semiconductor catalysts by monitoring variations in dissolved CO_2 concentration, pH, and potential reaction products, including acetic acid, formic acid, carbon monoxide, and methane.

Keywords: carbon dioxide conversion, heterogenous photocatalysis, solid phase, polymer composite, acetic acid, formic acid, methane.

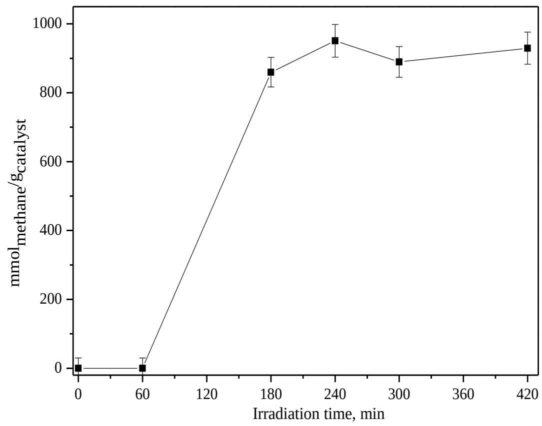

Figure 1: Methane production as a function of irradiation time using a polymer-photocatalyst composite consisting of ZnS dispersed into syndiotactic polystyrene aerogel.

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Lignins extracted from banana pseudosteam: oxidation and evaluation on the removal of heavy metals from effluents

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Abstract:
Brazil is the 4th global banana producer and the main residues after harvesting are the pseudosteam and the leaves. Pseudosteam is composed by cellulose, hemicelluloses, lignin and a sort of extractives and small molecules. In aim to bring more added value to the bananeculture, this paper aims the extraction of the lignin from this biomass, its oxidation and the study on the complexation with heavy metals. Banana pseudosteam was collected, milled, dried and extracted with NaOH solution in closed vessels at 130ºC-170ºC by 15-60 min. After cooling at room temperature, the extract was analyzed by UV-vis (200-800 nm) and HPLC for the quantification of biomass components. The dark material was precipitated with H_2SO_4 and the solid quantified and analyzed by FTIR using KBr pellets. Oxidized lignin was obtained by the reaction of the solid product with $KMnO_4$ and directly put in contact with Cu^{+2} ions to evaluate its chelating properties and oxidation kinetics. FTIR and UV-vis spectroscopy techniques were used for the quantification and construction adsorption curves. Non-oxidized lignins were used over silver nanoparticles (AgNP) to increase metal removal[1]. Absorbance ratios at 1420 cm^{-1} and 1100 cm^{-1} (A1420/A1100) were used as the parameter to evaluate C-O linkage intensity, related to the binding to metal ions.
Up to 15% of metal removal was obtained, evaluated by FTIR spectra (Figure 1). The activation energy (Ea) for the oxidation of different lignins varied from 3.4 to 43.8 kJ/mol, depending on the extraction and pre-treatment methods[2]. Ea for the alkaline extraction was 141.6 kJ/mol, showing the biomass recalcitrance and need of sever conditions to obtain components. In experiments with AgNP, 99-108 mg Cu^{+2}/g lignin nanoparticles was obtained (Figure 2), revealing possibilities for the utilization of such materials in the treatment of effluents.

Keywords: lignins from banana pseudosteam; oxidation of lignins; chelating properties of oxidized lignins; heavy metals removal from effluents; biorrefinery.

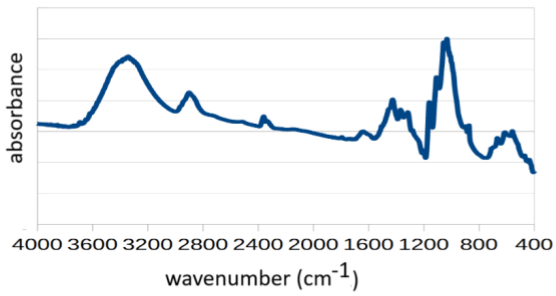

Figure 1: Example of FTIR spectrum of lignin + copper ions

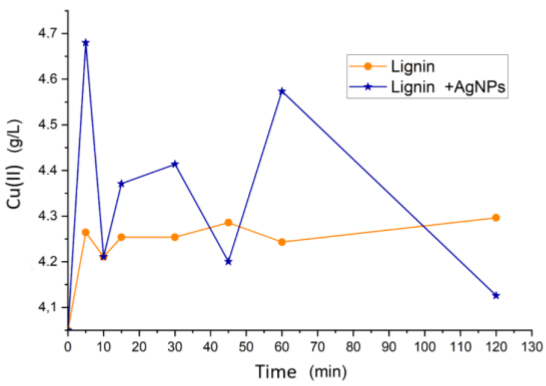

Figure 2: Examples of Cu^{+2} adsorption curves for lignin and lignin+silver nanoparticles.

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Functionalized SBA-15 for Enhanced Copper and Cobalt Sorption in Contaminated Environments

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Abstract:

A highly innovative approach to combating environmental pollution is the development of bio-perforated, mesoporous SBA-15 silica, distinguished by its extraordinary surface area of around 800 m²/g. Structurally, SBA-15 consists of amorphous silica with uniaxially ordered hexagonal channels, measuring approximately 5 nm in diameter and extending to micrometer lengths. These uniform channels provide remarkable capillary properties, optimizing the material for high sorption potential. The material is environmentally benign, showing no toxicity or irritation to living organisms, and offers versatile physicochemical properties that are easily modified through a range of chemical processes. This adaptability allows precise functionalization with various functional groups on both its inner and outer surfaces, thus expanding its application potential across multiple environmental remediation processes.

The functionalization of SBA-15 were engineered with variable content of targeted groups (1.25, 2.5, 5, 10, 20%) as propyl-phosphate or cyclam for chelating copper, or cobalt. A precise characterization of the structural properties and sorption potential, advanced techniques like Small-Angle X-ray Scattering (SAXS) and Positron Annihilation Lifetime Spectroscopy (PALS) have been employed. PALS, by measuring positron annihilation in the material, offers complementary information about pore sizes and distributions, crucial for understanding nanoscale porosity and diffusion pathways within the material. SAXS enables detailed analysis of pore size, providing insights into pore diameter and distribution that are critical for assessing metal sorption efficiency. Together, SAXS and PALS provide a comprehensive characterization of the mesoporous network in SBA-15. Atomic Absorption Spectroscopy (AAS) and UV-VIS spectroscopy further validate the metal uptake capacities in relation to the content of the functional groups. AAS quantifies the concentration of cobalt and copper absorbed within the material, allowing for precise determination of the sorption efficiency and saturation levels. UV-VIS spectroscopy complements this by analyzing the sorption kinetics and providing real-time data on the interaction between the material and the target metal ions. Time-dependent uptake curves from these spectroscopic analyses yield valuable insights into the rate and extent of metal sorption.

Through the combined functionalization of SBA-15 and its comprehensive evaluation via SAXS, PALS, AAS, and UV-VIS spectroscopy, this research aims to establish a new class of environmentally sustainable materials with unprecedented capacity for selective metal sorption. These innovations hold immense potential to impact environmental cleanup efforts significantly, contributing to safer ecosystems and better health outcomes.

Acknowledgment

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Electromagnetic shielding efficiency of composite laminates

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Abstract:
Electromagnetic interference (EMI) in aerospace vehicles occurs when electromagnetic waves radiating from a source equipment (eg. transmitter, radar, etc.) adversely affects a victim equipment (via wired network or transmitted waves) placed inside the vehicle. Conventionally thin metal sheets or wire meshes are added to the composite bodies of the vehicle to protect against EMI. We explore the possibility of eliminating the metal layer completely and using the carbon fibre reinforced composite (CFRP) panel itself as an EM shield. In order to assess the extent of shielding effectiveness a multilayer CFRP panel (or one modified such that either the matrix or the fibers are rendered much more conducting than epoxy or off-the-shelf carbon fibres) can offer, we have set up an analysis tool utilising the transfer matrix method (TMM), which considers 1-d wave propagation through multiple electromagnetically anisotropic layers. Each layer contains a conductivity modified or normal epoxy matrix, reinforced by unidirectional carbon fibres (see, Fig. 1). As functions of frequency in the X-band (i.e 8-12 GHz), the effective property of each such anisotropic layer is homogenised through Hashin-Shtrikman bounds, using measured complex permittivity of epoxy and longitudinal conductivity of carbon fibres. Assuming normal incidence on the panel with the electric field vector in a fixed vertical direction and accounting for transmission and reflection at each interface, scattering matrix of each layer is computed and combined to produce a global scattering matrix and hence the shielding effectiveness. As a demonstration of the efficacy of the technique, two examples are shown in Figs 2 and 3. In Fig. 2, experimental results for wave propagation through a multilayer consisting of 38 μm thick isotropic layers of Ag and 233 μm of MgF_2 is compared against experimental results reported in [1]. Similarly, propagation through a 1.6 mm thick metametarial layer with experimentally suggested frequency dependent anisotropic properties [2] is compared against experiments in Fig. 3. Finally some results on CFRP laminates will be presented.

Keywords: Electromagnetic interference, EMI shielding, transfer matrix method, CFRP

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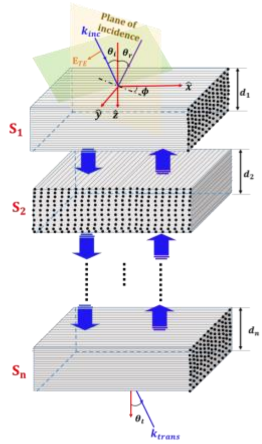

Figure 1: Wave propagation in multilayered material

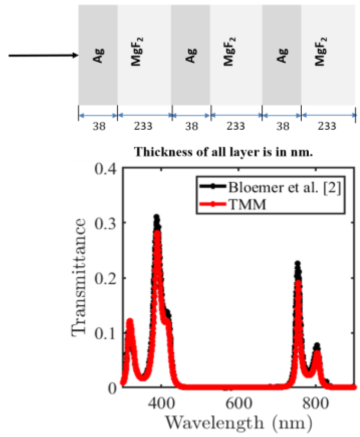

Figure 2: Comparison between experimental and theoretical transmittance of given layered configuration

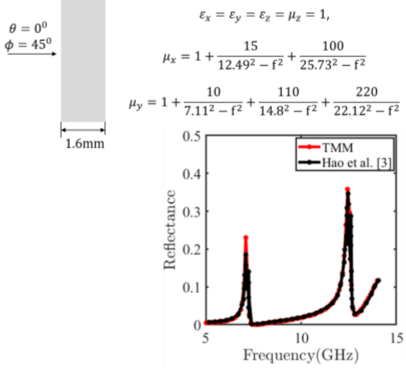

Figure 3: Comparison between experimental and theoretical reflectance.

A Sustainable Approach to Phenol Production: Photocatalytic Benzene Hydroxylation Using Visible-Light-Active Photocatalyst/Polymer Aerogel Composites

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Abstract:
Phenol, a crucial chemical precursor for plastics and medicines, is conventionally manufactured from benzene through the energy-demanding cumene process[1]. This method requires high temperatures and pressures, generating harmful cumene hydroperoxide[2,3]. To overcome the drawbacks of the cumene process, heterogeneous photocatalysis, utilizing light-activated semiconductor materials, represents a promising alternative at room temperature. In this research, the photocatalytic hydroxylation of benzene to phenol, using hydrogen peroxide as the oxidizing agent, is investigated with a light-responsive polymer composites consisting of visible-light-active photocatalysts embedded within a monolithic syndiotactic polystyrene aerogel (photocatalyst/sPS). The photocatalytic reactions are conducted immersing either photocatalyst powder or photocatalyst/sPS aerogel in an aqueous solution containing benzene and H_2O_2. Experimental results indicate that no phenol formation is observed with the powder photocatalyst under visible light, whereas it is facilitated with the photocatalyst/sPS (Figure 1). This behavior can be attributed to the differing polarities of benzene (non-polar), phenol (polar), and the sPS aerogel (non-polar). The non-polar benzene preferentially interacts with the non-polar polymer, hindering the adsorption of polar-phenol onto the catalyst surface. This reduces the photocatalyst ability into the overoxidation reactions of phenol.

Keywords: visible light, heterogenous photocatalysis, benzene oxidation, phenol production, syndiotactic polystyrene, polymer composite

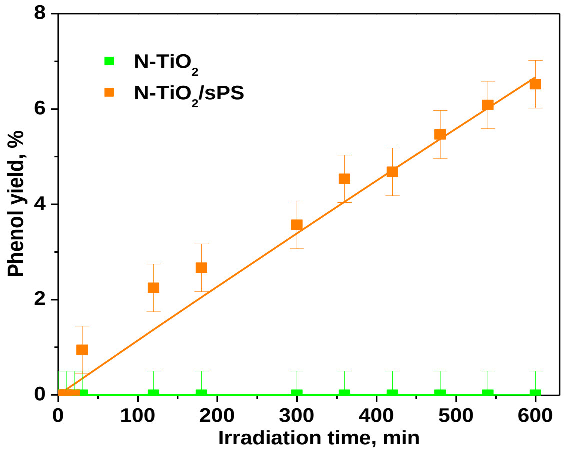

Figure 1: Phenol yield as a function of irradiation time using visible light active photocatalyst (N-doped TiO_2) dispersed into syndiotactic polystyrene aerogel.

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Prediction of Proof Test Outcomes for Type 4 High Pressure Hydrogen Vessels with Composite Layers Using Machine Learning Models

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Abstract:
This study focuses on analyzing the performance of classification models in predicting the result of the Proof Test for Type 4 High Pressure Hydrogen Vessels (HPV). These vessels, used in hydrogen-powered vehicles, are designed to withstand extremely high pressures [1], and their durability and safety are of utmost importance. The Proof test is a critical step in assessing the resistance of these vessels by simulating extreme pressure conditions to verify their integrity [2]. The objective of this study is to predict the outcome of this test based on multiple parameters measured during the trials, providing a faster and more reliable prediction method.

The methodology employed relies on a dataset containing measurements extracted from multiple composite winding layers of each Type IV high-pressure hydrogen vessel. We opted for a more compact approach where each parameter is represented by its average across all layers of each sample. This approach reduces the dataset size while making it more compact. Additionally, to handle missing values, we used an interpolation method that replaces the missing values with the average of corresponding values from other samples, provided they have the same outcome.

The results obtained, using machine learning algorithms and performance enhancement techniques, are particularly promising. The RandomForest classifier model [3] achieved an exceptional test accuracy of 0.96. The confusion matrix demonstrates remarkable performance in predicting "failures," with a minimal number of false negatives, which is crucial for ensuring the safety of hydrogen vessels. The ROC-AUC score of 0.8686 and the overall accuracy of 0.94 highlight the model's effectiveness, particularly in reducing false positives and its ability to distinguish failed vessels. These results have significant practical value in the industry, as they provide a rapid and reliable method for predicting the Proof Test outcome, thus reducing costs and improving hydrogen vessel safety.

In conclusion, this study shows that the approach combining intelligent data management, effective interpolation of missing values, and the use of the RandomForest classifier offers promising performance for predicting the Proof Test result for Type 4 HPV hydrogen vessels. The results obtained may pave the way for the automation of vessel validation processes, thus contributing to better risk management in the hydrogen industry. The Proof Test methodology is relevant to the certification and acceptance of critical composite structures. It can also be applied to manufacturing process development to achieve zero-reject rates for very large composite structures.

Keywords: Composite structures, hydrogen vessels, Type 4 HPV, Proof Test, machine learning, RandomForest classifier, classification, safety, vessel validation, industry automation, zero-reject, performance enhancement

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Posters Sessions

Recycling of mixed plastic waste: the effect of melt blending temperature on the structure and mechanical properties

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Abstract:

Realistic solutions are urgently needed to address the ever-growing plastic waste amounts. Mechanical recycling provides a solution towards circular economy through preparing waste into new raw materials. However, the complete separation of mixed plastic waste into single polymers is challenging, resulting in formation of polymer blends having polymers with different melting temperatures. In this work, to characterize the realistic composition of mixed plastic waste streams, low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP) and polyethylene terephthalate (PET) waste were melt blended using two different temperatures; 210 °C and 270 °C, typical for processing of polyolefins and PET, respectively. No purification steps or compatibilizers were used. The effect of the melt blending temperature was evaluated in respect to structure and mechanical properties. Recycled polymer blend prepared at higher temperature exhibited a more uniform structure, however, around 10 % decrease in tensile properties, compared to samples prepare at lower temperature, which of the latter one is attributed to the thermo-mechanical degradation of polyolefins at 270 °C. However, unacceptable amount of large nonmelted PET particles were detected in samples prepared at 210 °C (Figure 1A, label 1). Because of the waste origin, both samples also revealed large inorganic particles (Figure 1, label 2). The large particles were identified as discontinuous points in the material, creating cracks (Figure 1, label 3) under tension due to poor adhesion with the surrounding material thus limiting the mechanical performance. Large solid PET particles in the material limit also the potential applications of the polymer blend, for example being unsuitable for film-like products. Therefore, this work suggests that the melt blending temperature for the mixed plastic waste blend should be selected based on the polymer with highest melting temperature.

Keywords: mixed plastic waste, mechanical recycling, melt blending, mechanical property

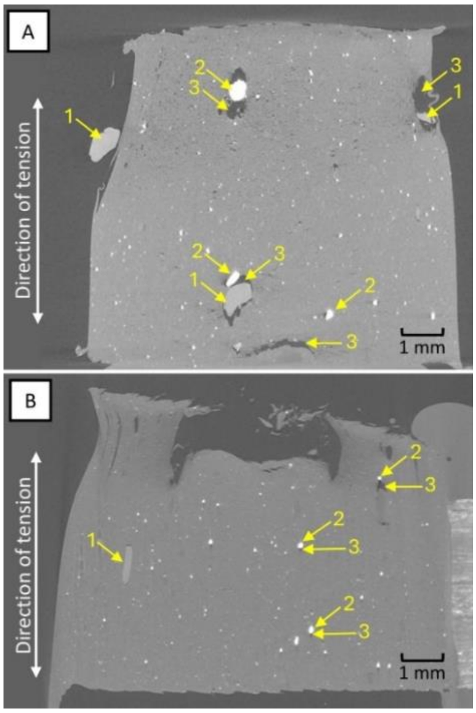

Figure 1: X-ray computed tomography images of recycled LDPE/HDPE/PP/PET blend tensile specimens' cross-sections melt blended at a) 210 °C and b) 270 °C. Labels: 1) nonmelted PET, 2) inorganic particle, 3) crack.

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Synthesis of new polymeric materials for use as coatings of a "homemade" SPME fiber for the analysis of toxic and hazardous compounds

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Abstract:
Nowadays, there is a lot of research on non-telecommunications applications of fiber optics. The article shows an application of the optical fiber processing technique and the photopolymerization method to obtain polymer layers on tapered optical fibers. Exploitation of the light guiding properties of an optical fiber can be used to prepare an SPME (Solid Phase MicroExtraction) fiber by coating its portions with a layer of polymeric material. The base of the homemade SPME fiber is a manufactured optical fiber tapered at its one end. The process of tapering the optical fiber involves stretching the fiber over a flame from a moving torch, in which a propane-butane-oxygen gas mixture is burned. The tapered optical fiber is cut into two equal parts. The fiber ends in a glass tip and it is coated with a photopolymerizing mixture – the main component is the monomer tricyclo (5.2.1.0) decanedimethanol diacrylate (TCDMA). Illumination of the specific light beam of this part of optical fiber induces polymerization and forms a polymer layer covering the tapered part of the optical fiber. This element is integrated with a special interchangeable housing and can be used as a "homemade" SPME fiber. The SPME fiber is exposed in the environment of the analyte under study, and adsorption of the analyte occurs on the sorbent. The fiber is then transferred to a chromatograph, where the analytes are desorbed and identified. The authors would like to start by testing the sorption properties of the manufactured fiber after exposing it to selected simulated volatile chemical warfare agents.

Keywords: photopolymerization, optical fibres, SPME fiber, polymeric materials

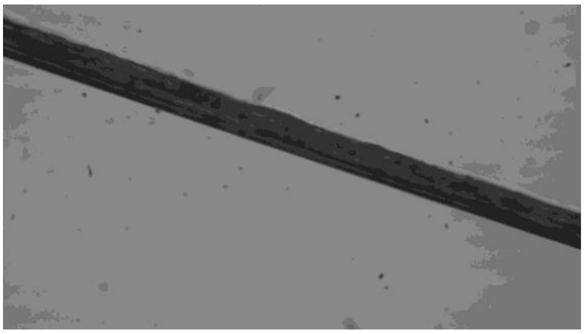

Figure 1: Optical microscope photo showing fiber optics coated with TCDMA polymer

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Polymethylacrylate with High Molecular Weight Obtained via Radical Polymerization with Iron Hydrometallation Initiation

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Abstract:
In this study, we present a novel Fe-H initiated radical polymerization method for methyl acrylate (MA), using commercially available iron(III) acetylacetonate as a catalyst and tetramethyldisiloxane as a reducing agent, under mild conditions at 40 °C. The polymerization of MA achieved monomer conversion rates of up to 65%, yielding high molecular weights (up to 400 Kg/mol) with narrow dispersity. For comparison, a traditional radical MA polymerization was carried out based on an azo initiator such as azobisisobutyronitrile (AIBN), producing a polymer with low molecular weight (40 Kg/mol). A comprehensive characterization was conducted in order to gain informations on thermal, viscoelastic and mechanical properties of these materials. The Fe-H initiated MA polymers exhibit enhanced thermal and mechanical properties compared to those obtained with a traditional initiator like AIBN. These improvements include greater thermal stability, increased tensile strength, remarkable elasticity (Figure 1) and reciclability. Rheological and dynamic mechanical thermal analysis further confirmed the formation of robust polymer networks with strong viscoelastic behaviour, primarily driven by the high molecular weight and entanglement density. All these findings show that this methodology offers a sustainable and efficient alternative to traditional radical polymerization techniques, employing non-toxic, inexpensive and commercially available catalysts. The ability to control molecular weight and structure of the investigated polyacrylates makes this approach highly scalable and suitable for various industrial applications.

Keywords: polymethylacrylate, radical polymerization, thermal properties, viscoelastic properties, mechanical properties.

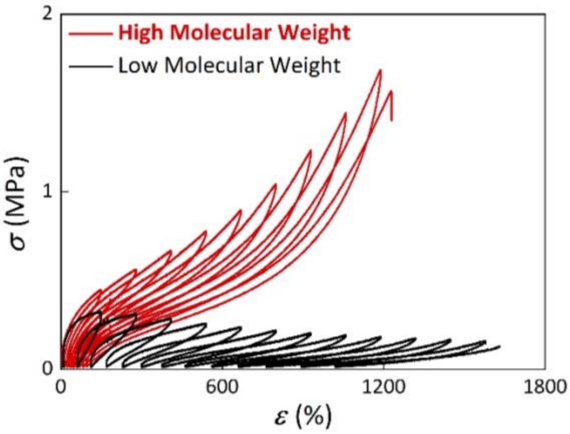

Figure 1: Stress–strain curves in the hysteresis test of polymethylacrylates obtained from Fe-H initiated polymerization (red line) and traditional radical polymerization with AIBN (black line).

Synthesis of Bio-based and Biodegradable polymers from monomers from renewable Biowastes via Biocatalysis and Green Chemistry

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Abstract:
Plastic materials are ubiquitous in our society but significantly contribute to Greenhouse Gas (GHG) emissions and have a strong environmental impact. Polymers-5B is an EU project that started in June 2024 and aims to develop novel alternative polymers synthesised from bio-based monomers (diacids, diols, diamines, hydroxyacids, amino acids, aromatic and phenolic compounds, fatty acids, oils, and others).

These bio-based monomers are sourced from underexploited second-generation (2G) feedstocks such as agri/food waste (Tomato and Olive wastes) and biomass (wood pulp and lignin derivatives). They obey the food first and cascading principle and are also commercially available in the EU (Figure 1).

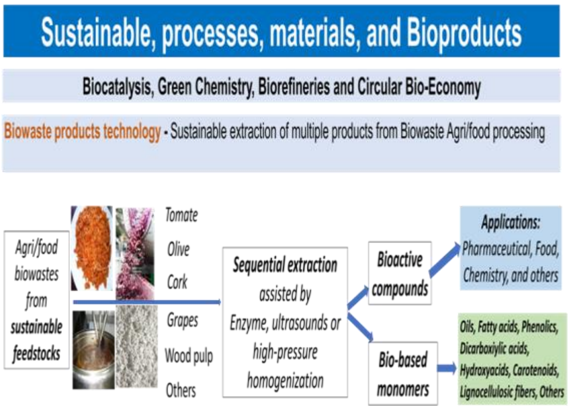

Figure 1: Extraction of bio-based monomers and bioactive compounds from biowastes generated from the industrial process of renewable feedstocks.

The project will resort 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) [1-3]. If possible, these new 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.

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

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

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Bio-based Thermosetting Resins from modified Epoxidized Soybean Oil

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Abstract:
The plastic market size is constantly increasing, especially the one of thermosetting resins, due to their widespread usage in coating, adhesive, composites and electronic packaging fields. Thermosets are polymers with permanent three-dimensional cross-linked structures mainly derived from non-renewable, petroleum-based materials.[1] Driven by environmental issues, more sustainable feedstocks, such as vegetable oils, have found application in thermosetting resins production. Vegetable oils offer a great opportunity to tap into a pool of complex molecules in terms of carbon skeleton, double-bonds and functionalities availability allowing to obtain different networks in relation to their structure.[2] In particular, the acrylated epoxidized soybean oil (AESO) has been widely studied for bio-based resins production. However, acrylic acid (AA), used in the acrylation process of epoxidized oils, is a volatile fossil-based compound and can cause serious health diseases.[3] In this work, sorbic acid (SA) was proposed as a greener alternative to AA in thermosetting resins preparation to overcome the problems linked to its volatility and toxicity. SA is a C6 carboxylic acid containing two conjugated carbon-carbon double bonds, which can react with radical initiators to produce crosslinked structures. SA can be directly extracted from non-edible berries of Sorbus aucuparia or synthesized starting from bioethanol (after oxidation to acetaldehyde, trimerization to 2,4-hexadienal, and final oxidation to sorbic acid). Here, sorbated epoxidized soybean oil (SESO) was synthetized for the first time and used for thermosetting resins production by a curing process in the presence of a thermal radical initiator. Various resins were prepared using comonomers such as myrcene, styrene and pentaerythritol tetraacrylate and comonomer's effect on mechanical and thermal properties of resins was studied. Moreover, a comparison between SESO-based and AESO-based resins was performed.

Keywords: Acrylic resins, sorbic acid, epoxidized soybean oil, vegetable oil-based resin, acrylic acid substitution.

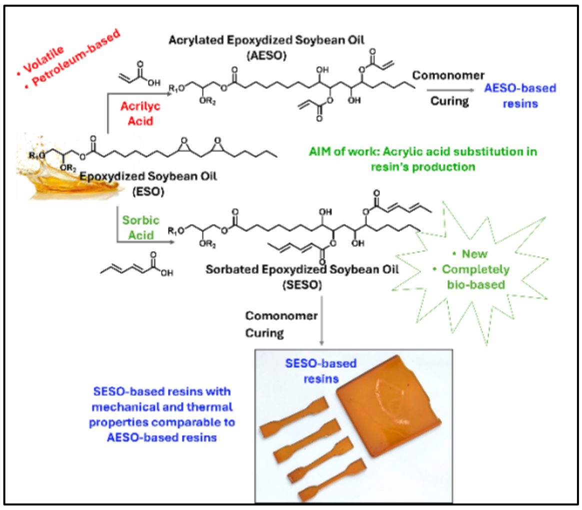

Figure 1: General illustration of the work

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Is the adsorption of styrene on clay enhanced by polymer?

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Abstract:
Styrene is one of the fundamental industrial chemicals belonging to the volatile organic compounds, which are often used in the production of e.g. polystyrene, polyester resins and glass fibres. Still, it is especially harmful even at very low concentrations (breathing causes respiratory problems, nose and throat damage, and lung damage and can also cause neurological effects such as fatigue, concentration problems, and even hearing loss) [1]. It is, therefore, necessary to implement an effective technology for removing styrene from the air, e.g., using a highly efficient ventilation system that supports a set of filters filled with an adsorbent, e.g., clay mineral. In particular, the one mentioned can be created as a polymer-clay composite and be supplied as a consumable material to manufactured products in small quantities (~ 1–2% wt.), which is their quality and thus closes the production cycle and improves the operating economy. The theoretical study of the hybrid styrene-montmorillonite (S-Mt and styrene-modified montmorillonite by poly(2-methyl-2-oxazoline) polymer, S-P-Mt, showed the effect of the presence of polymer at the surface of the Mt to the affinity of the clay mineral for styrene pollutant. The calculations using the DFT method implemented in the VASP program [2] investigated the influence of the pristine smectite (Mt) and the polymer-modified smectite on the styrene adsorption efficiency, favouring modified clay by polymer (Figure 1). The presence of the additional functional groups in the interlayer space of clay plays a significant role in the enhanced adsorption effectivity of styrene due to the presence of the additional interactions which act in the interlayer space of clay. Such a new hybrid material can potentially be an adsorbent in green technologies.

Keywords: green technologies, adsorption, styrene, smectite, poly(2-methyl-2-oxazoline, DFT method, modelling

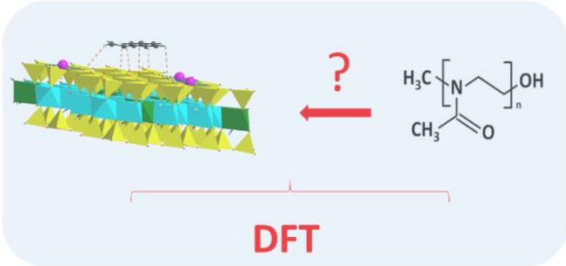

Figure 1 illustrates the fundamental question solved theoretically: What is the importance of clay surface modification by PMeOx polymer to enhance the adsorption effectivity of styrene from the environment to improve our everyday life?

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Numerical Simulation of Mechanical Properties of Hybrid Composites

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Abstract:
Hybrid composites that incorporate synthetic fibers, such as glass, aramid and carbon, offer a balance of high strength, reduced weight and cost-effectiveness, making them highly applicable across various industries [1, 2]. This research focuses on numerical investigation of the tensile properties of these hybrid composites, with particular emphasis on the effects of stacking sequences on mechanical performance. Two configurations of hybrid laminates were simulated and analyzed, with different sequences of aramid and carbon fiber reinforcements arranged symmetrically in woven mat forms. This study uses a detailed finite element model to predict the tensile response of each configuration, allowing optimization of stacking arrangements for maximal tensile strength and durability. By comparing the numerical simulation results with experimental data found in the scientific literature [3], the research establishes a robust framework for analyzing and predicting the performance of synthetic fiber-based composites in applications requiring specific strength and durability. In this research, FEM code ABAQUS was used for the numerical simulation of tensile test. Few models of tension specimens with different stacking sequence layer arrangements of different fibers were created. Using the developed models, the tension test was numerically simulated. As the simulation result, the stress-strain curves were determined. The validation of numerical simulation was achieved by comparing modeling results with experimental test results [3]. The comparison revealed a good coincidence between simulation and experimental results.

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Keywords: mechanical properties, numerical simulation, finite element method, hybrid composite, aramid, carbon

Enabling nanocomposite synthesis from nanoparticle-based bimetallic reactive systems

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Abstract:
Aluminides (e.g. Pt/Al, Ru/Al, Ni/Al) have a tendency to release stored energy on external stimulus in the form of heat, light and sound. When such metal combinations are synthesized as a multilayer stack system, the bimetallic multilayers form stable/metastable composites, intermetallics and alloys on ignition. This method can thus be used to form phases and consequently crystal structures which are interesting to study. The aim is to a correlate calorimetry (heat release) and nanocomposite film morphology. Such methods of formation of reactive aluminides have traditionally been used for applications in brazing, sealing, preparation of coatings and micro-joining. Different from current state-of-the-art, this study elaborates on ignition-dependent nanocomposite phase formations for a given Pt/Al nanoparticle based reactive system.

Nanoparticles are produced by a plasma process. Sparking (Schwyn, 1988) between two metal electrodes (Pt or Al) produces < 5-nm positively charged nanoparticles through cathode erosion which are selectively deposited on an electrically biased (-ve) patterned substrate inside a cylindrical reactor (Figure 1a$_1$). A carrier gas flow (typically N_2) through the spark, controls the size of nanoparticles produced (Figure 1a$_2$). Additionally, the spark power and carrier gas flow can define the porosity of the aluminide system produced as a multilayer stack. On ignition, the bimetallic stack undergoes a self sustaining reaction and releasing energy. This energy is used to form the Pt/Al nanocomposites, intermetallics and alloys (Figure 1b$_1$). When using thermal energy as ignition stimulus, the ignition temperature is a control mechanism to form various phases of alloys and composites. Through Differential Calorimetry studies, heat release is recorded. X-ray Diffraction studies are used to check for nanocomposites and intermetallic compound formation. Their phases are studied through electron diffraction (SAED) study (Figure 1b$_2$) and High resolution TEM images (Figure 1b$_{3,4}$).

It is concluded that the nanocomposite formation and intermetallic phases are a function of nanoparticle sizes, spark power, carrier gas flow rate and ignition temperature. Nevertheless, several knowledge gaps still exist on bimetallic nanoparticle interaction, effect of nanograins and the heat release mechanism.

Keywords: spark discharge, nanopatterning, energy storage, nanofoils, functional material, micropatterning, nanocomposites, synthesis methods, energy materials.

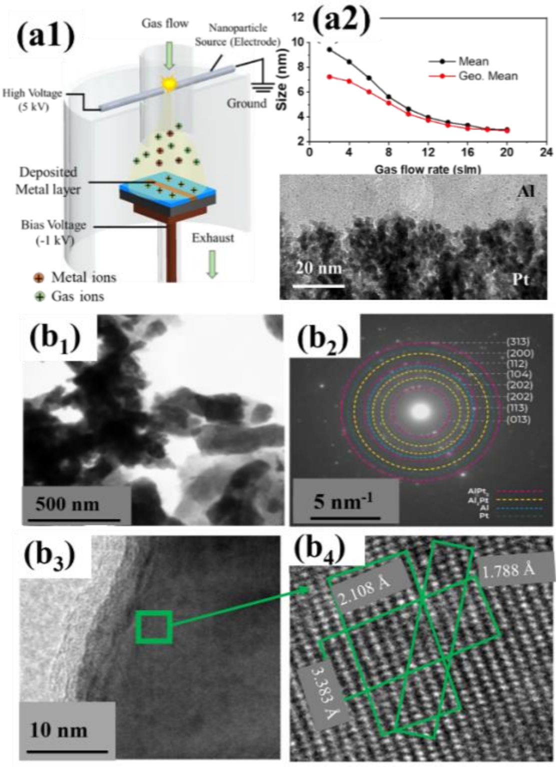

Figure 1 (a$_1$) Schematic diagram of the reactor for nanoparticle generation with biased substrate (blue) (a$_2$) Nanoparticle size depends on carrier gas flow rate and TEM image of cross section of Al,Pt nanoparticles deposited in multilayers. (b$_1$) Post ignition Pt-Al nanocomposites and intermetallics on TEM grid (b$_2$) SAED studies to ascertain the intermetallic phases and crystal planes (b$_3$) A small region to check high resolution TEM images and mark the Pt Al alloys nanocomposites and intermetallics formed. In (b$_4$) the green rectangles highlight the $PtAl_2$ and Pt_2Al planes when compared to (*hkl*) values from literature.

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Hybrid Metal Oxide Heterostructures for Thermoelectric and Photovoltaic Applications

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Abstract:
Nowadays, a major challenge is reducing the environmental and climate impact of industrial and domestic activities. This can be achieved by developing devices that efficiently generate energy from renewable sources. Nanostructured n-type zinc oxide (ZnO), and p-type copper (II) oxide (CuO), copper (I) oxide (Cu_2O) are known as promising materials for the fabrication of modern, environmentally friendly thermoelectric and photovoltaic electronic devices. Their advantages include low cost, non-toxicity, and energy bandgap values of 3.37 eV, 1.8 eV, and 2.1 eV, respectively, which, in combination in heterostructures, make these materials suitable for solar cells and other photovoltaic applications [1, 2]. The quite high (up to ~2000 $\mu V \cdot K^{-1}$ [3]) Seebeck coefficient for each of these metal oxides nanostructures has been reported previously. By this way, the thermoelectric properties of metal oxides also are promising for generating green energy from renewable sources (for example, solar heat, and temperature differences).

This study is devoted to the fabrication of p-n junction metal oxide-based heterostructures for low-grade waste heat harvesting and approaches combining thermoelectric, photovoltaic, and thermovoltaic technologies in multifunctional devices capable of self-powering using solar radiation and/or heat from renewable energy sources.

The zinc oxide-copper oxide heterostructures were fabricated layer-by-layer using thermal evaporation, physical vapour deposition, and thermal oxidation synthesis methods [3, 4]. The synthesized heterostructures' structure, morphology, and chemical composition were inspected using scanning electron microscopy, energy-dispersive X-ray spectroscopy, X-ray photoelectron spectroscopy, and X-ray diffraction techniques. The electrical, thermoelectric, photothermoelectric, and photovoltaic properties of fabricated metal oxide architecture will be discussed.

Keywords: zinc oxide, copper oxide, heterojunction, nanowires, heterostructures, thermoelectrics, photothermoelectrics, photovoltaics.

Acknowledgements:
This research was supported by the Latvian Council of Science, project No. lzp-2022/1-0239 "Multifunctional hybrid metal oxide nanowire arrays for simultaneous green power generation and CO_2 reduction".

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Eco-Friendly Biocomposites from Chestnut Waste: Production, Optimization, and Characterization

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Abstract:
Plastic pollution poses a significant global environmental challenge, driving the search for sustainable alternatives [1]. In Portugal, the chestnut industry generates substantial waste, including shells, burrs, and non-commercial chestnuts, with production exceeding thousands of tons annually [2]. This research focuses on the valorization of non-commercial chestnut waste from the chestnut industry in Portugal to develop sustainable and biodegradable biocomposites. The study aimed to enhance mechanical, thermal, and water-resistant properties using chestnut shells as both matrix and reinforcement. The mechanical properties were optimized using a Box-Behnken Design (BBD) model, identifying the ideal composition as 70% chestnut, 0% glycerol, and a processing temperature of 120 °C, resulting in a flexural strength of 9.00 MPa and an elastic modulus of 950 MPa. To improve water resistance, shellac was incorporated as a natural hydrophobic coating, enhancing durability against moisture exposure. Water absorption tests revealed that shellac-treated composites displayed superior water resistance, significantly outperforming those with glycerol or untreated samples. Thermal analysis indicated that glycerol functioned as a plasticizer, enhancing flexibility and reducing the glass transition temperature. The chestnut-based composite demonstrated a thermal conductivity of 0.79 W/m·K, qualifying it as a thermal insulator. A practical application of this study was the creation of a candle holder, underscoring the potential for chestnut waste to be converted into functional, eco-friendly products. This work emphasizes the value of repurposing chestnut waste to produce environmentally sustainable alternatives to conventional plastics, aligning with circular economy principles.

Keywords: chestnut waste valorization, biocomposites, mechanical properties, thermal conductivity, water resistance, sustainable applications.

Figure 1: A – All 17 composites produced for the optimization. B - Candle holder produced by hot compression from chestnut waste with a composition of 75% chestnut, 0% glycerol at 120 ºC.

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Acknowledgments:

This work received financial support from project Chestfilm - Valorização de resíduos sólidos do processamento da castanha: extração de biopolímeros e preparação de filmes biodegradáveis a PD21-00024, supported by national funds from Fundação “la Caixa”, em colaboração com o BPI e em parceria com a FCT 4a Edição do Programa Promove - Concurso 2022 - o Futuro do Interior.

Driving Sustainability in the Automotive Industry: Hybrid Yarns for Thermoplastic Biocomposites

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Abstract:
As a concept and practice, sustainability has boosted the research and development of new raw materials from renewable sources, and processes with a lower environmental impact for different industrial sectors, particularly those using composites such as Mobility and Transports, Construction, Sports, Furniture, or Defence industries. There is a common strategy that reveals the growing paradigm shift towards "more environmentally friendly" products.

Following this strategy, the Portuguese funded **Be@T** project includes an initiative (PI.I3.M8-M11) aiming at the development of textile-based biocomposites based in new solutions for continuous filament 3D printing, hybrid yarns, bioprepregs, biocoatings and bioSMCs with application in automotive components. These solutions are being studied for developing more ecological and sustainable textile-reinforced biocomposites, reducing the dependency on fossil fuels and gas emissions, as well as their impact through biodegradability and recyclability. While carbon, glass, and aramid fibers remain dominant, natural fibers like flax and hemp offer high performance and affordability with lower environmental impact Natural-based yarns are finding applications in automotive, construction, consumer goods, and sports equipment.

This work aims to study different approaches for combining natural and polymeric fiber materials in hybrid yarns. Using a wide range of technologies such as conventional spinning, core-spinning, wrap-spinning, commingling process, twisting yarns, amongst others. Every technique allows for a different structural organization of the fibers in the cross section of the yarn (Figure 1), therefore the processing parameters for the different types of yarns will be studied in detail. With this in mind, hybrid yarns are a solution that can be tailored to meed specific needs in terms of fiber distribution or reinforcement content. Fabric structures produced with hybrid yarns provide also numerous advantages in the production process, allowing for an easier impregnation of the reinforcement fibers, as well as more potential to obtain parts with complex 3D geometries.

Characterization methods will be employed to analyse the materials and solutions during the whole production process, including the raw fibers, yarns, textile structures and prepreg/composite parts, identifying the most effective conditions for obtaining homogeneous fiber distribution and the most promising hybrid yarns for using in the production of fabric structures.

This review outlines the benefits of natural-based hybrid yarns in thermoplastic composites, exploring production methods and current developments in the field.

Acknowledgements

This work was supported by the integrated project be@t – Textile Bioeconomy (TC-C12-i01, Sustainable Bioeconomy No. 02/C12-i01.01/2022), promoted by the Recovery and Resilience Plan (RRP), Next Generation EU, for the period 2021 – 2026.

Keywords: Hybrid yarns, natural fibers, biocomposites, automotive industry, thermoplastic, biopolymers

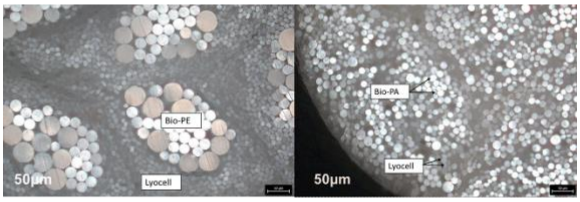

Figure1: Illustration of cross-sections of different hybrid yarns (core spun yarns and conventional spun yarns)

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Recovery of continuous carbon fibers from composites via plasma-enhanced solvolysis

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Abstract:

Conventional chemical recycling methods for composites, such as solvolysis, oxidation, and supercritical liquids, are typically slow and consume high amounts of chemicals and energy. This project aims to address these challenges by enhancing recycling rates through the integration of plasma inside liquids. Specifically, our study explores plasma enhanced solvolysis using nitric acid for chemical recovery of carbon fibers from carbon fiber-reinforced epoxy resin composites (CFRCs). The process operates at atmospheric pressure and without external heating, reducing energy consumption. It also seeks to minimize chemical usage and recover a significant amount of them. Moreover, conventional recycling methods can achieve satisfactory recovery of short fibers, but they struggle to recover long continuous fibers without significantly damaging them. On the contrary, the unique advantage of plasma-powered solvolysis is the ability to recover continuous fibers up to 200 meters long with few defects along their length, while retaining their original mechanical properties[1,2].

The decomposition of custom-made continuous fiber epoxy reinforced composites was studied. The efficiency of the process was examined in terms of a) process duration (Figure 1), b) resin decomposition rate, c) recovered material's properties and d) process wastes, while varying parameters such as solvent concentration and power input. Finally, electron microscopy (SEM) and energy-dispersive X-ray analysis (EDX) were used for the recovered fibers physicochemical characterization, while single-fiber mechanical tests took place, in order to evaluate the mechanical properties.

Overall, our findings suggest that plasma-powered solvolysis holds significant promise as a recycling technology for CFRCs, demonstrating potential for large-scale implementation.

Keywords: Plasma, plasma in liquids, recycling, CFRC, CF, composites, solvolysis, sustainability

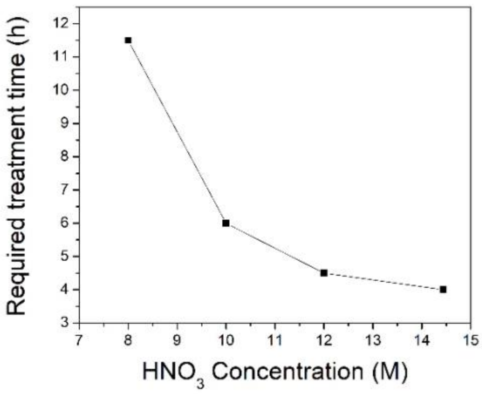

Figure 1: Results of the decomposition of custom-made CFRCs, illustrating the effect of HNO_3 concentration during plasma-enhanced solvolysis regarding the required process time.

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The research project is implemented in the framework of H.F.R.I call "Basic research Financing (Horizontal support of all Sciences)" under the National Recovery and Resilience Plan "Greece 2.0" funded by the European Union – NextGenerationEU (H.F.R.I. Project Number: 15231).

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Cattail fiber as an alternative material for insulation panels: properties and variation in different harvest season

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Abstract:

There has been a growing demand for natural cellulose fibers for different applications. The production of insulation boards from cattail biomass offers a viable substitute for conventional insulation materials, addressing both environmental concerns and economic challenges associated with traditional wood products.

Cattail (Typha spp.), a monocotyledonous plant, is widespread in swamplands, slow-moving shallow waters, marshes, ponds, dam borders, drainage ditches, and other freshwater or slightly brackish habitats (Morton, 1975; Rezig et al., 2016; Kamali Moghaddam, 2022).

With a long history as a lignocellulosic biomass, cattail has been utilized for floating insulation, medicinal applications, and as a protein source. However, one significant challenge in working with natural fibers lies in managing their variability (Biagiotti et al., 2004). This study investigates how seasonal variations in harvesting influence the quality and feasibility of insulation panel prototypes.

Fiber characterization plays a crucial role in this research. Factors such as fiber size distribution, chemical composition, and structural properties are critical for identifying cattail fibers that meet the performance requirements for rigid and flexible insulation boards currently on the market.

The physical and chemical properties of fibers extracted from plants harvested in winter, spring, summer, and autumn were analyzed, including crystallinity, moisture sorption behavior, particle size distribution (Fig. 1), and chemical composition and compared. Fibers from each season were incorporated into insulation panels, replacing wood fibers. The panels from the different were then evaluated for mechanical performance, thermal conductivity, and water resistance.

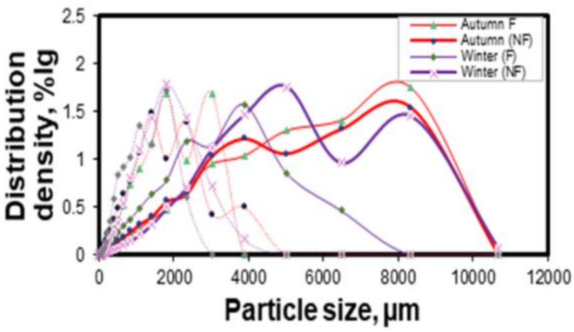

Fig.1

Keywords: Sustainable materials, lignocellulosic biomass, insulation panels, cattail, natural fiber characterization.

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Bacterial cellulose-based antioxidant biodegradable composite films for food-sustainable packaging

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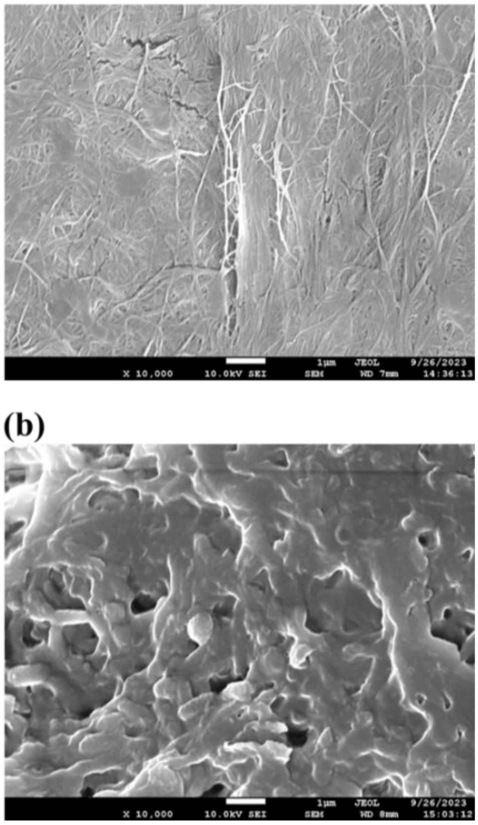
Abstract:
With the increasing public awareness regarding environmental protection, the use of green and sustainable packaging to replace disposable plastics has become a popular strategy for countries worldwide to achieve environmental protection and carbon reduction goals. The main food packaging materials currently in use are high- and low-density polyethylene, polyethylene terephthalate, polyvinyl chloride, polystyrene, and polypropylene, which account for approximately 90% of total plastic production. Although these petrochemical raw materials are cheaper to manufacture than natural resources, they are virtually non-biodegradable, rendering recycling difficult; moreover, plastic waste management issues can easily cause damage to ecosystems. Therefore, natural resource-based biodegradable polymers are emerging food packaging materials. Bacterial cellulose (BC) is an extracellular secondary metabolite produced via acetic acid bacteria fermentation. It is a linear polysaccharide comprising a β-1,4 glucan chain. Because of its unique properties such as biodegradability, good biocompatibility, high water retention, and high mechanical strength, it is widely used in food processing, health foods, textiles, conductive materials, skin care products, tissue engineering, and wound dressings to have broad application prospects. Besides, BC is also a bio-based, green, sustainable packaging material with potential market application. This study aims to develop a BC-based antioxidant biodegradable composite film, which was formed by incorporating the antioxidant lutein and orange pectin into BC, for the non-contact preservation of fresh-cut apples. Under 4°C and 25°C for 8 h storage, the preservation indicators weight loss, pH, total plate count, and color difference of fresh-cut apples were analyzed. The scanning electron microscopy images, water vapor transmission rate, and tensile strength of the resulting BC-based antioxidant biodegradable composite film were analyzed.

Keywords: bacterial cellulose, lutein, pectin, color difference, water vapor transmission rate, tensile strength, total plate count, sustainable materials, food preservation.

(a)



(b)

Figure 1: SEM images (× 10 k) of the BC and BC-based antioxidant biodegradable composite films.

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Bacterial Nanocellulose Based Materials for Oral Tablet Formulation in Colon Targeted Delivery of 5-Fluoruracil

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Abstract:
Colorectal cancer (CRC) is a major global health concern, with 5-fluorouracil (5-FU) being a key chemotherapeutic agent for its treatment. However, 5-FU's rapid elimination requires frequent intravenous administrations, leading to systemic toxicity and high costs [1].
Encapsulation in bacterial nanocellulose (BNC) offers a promising strategy for oral drug delivery or 5-FU due to its biocompatibility, stability, and resistance to gastric conditions [2]. BNC is a polysaccharide produced through bacterial fermentation, distinguished by its unique properties compared to other types of cellulose, (like vegetal cellulose), such as *in situ* nanostructure formation, chemical purity, and superior cristallynity index [3].
The objective of this research is to evaluate the properties or various BNC-based materials for colon-targeted delivery of 5-FU and assess their pharmaceutical attributes for oral tablet formulation.
The initial approach focused on analyzing how superficial modifications of BNC influence 5-FU encapsulation and its delivery profile to the colon. To accomplish this, polyanionic (TEMPO-oxidized BNC, BNCT) and polycationic (CHPTAC-aminated BNC, BNCA) derivates were synthesized through chemical modifications at the C6 position [4]. Morphological and physicochemical characterizations were performed to assess the changes introduced compared to pristine BNC.
The encapsulation capacity of 5-FU on BNC, BNCT, and BNCA was assessed through adsorption isotherms. The desorption profile were analyzed in simulated gastric (pH 1.6) and colonic (pH 7.4) fluids over a period of 72 hours. The materials with the most favorable 5-FU adsorption and desorption profiles were coated using two strategies: Eudragit S100 (EUD) for pH-dependent release, and polyhydroxyalkanoate copolymer (PHA) for enzymatic-triggered delivery. Coatings were evaluated at different EUD/PHA:BNC ratios. Finally, the pharmaceutical attributes for tablet formulation were assessed in the materials with the optimal coating strategy.
The results showed that BNCT and BNCA exhibit pH-dependent zeta potentials, suggesting their possible use for colon delivery. Adsorption isotherms revealed that BNCA achieved the highest encapsulation efficiency, followed by BNCT and BNC, with multilayer adsorption observed for all materials. BNCA also exhibited the strongest affinity for 5-FU across different temperatures (10 ºC, 25 ºC, and 40 ºC).
Spray-drying was employed for 5-FU encapsulation within BNC-based materials, resulting in nanostructured particles formed through the hornification process. Release profiles in simulated gastric and colonic fluids showed that the release behavior was influenced by the material-5-FU affinity, with the best release profiles observed for BNCA, followed by BNC and BNCT.
Coating evaluation revealed that the 0.5:1 PHA:BNC (PHA50) ratio was the most effective, enhancing gastric protection.
The pharmaceutical properties demonstrated that PHA coating improved mechanical properties, making them suitable materials for tablet development.
In conclusion, BNC and its derivates show strong potential as excipients for 5-FU oral delivery systems, offering high encapsulation efficiency, targeted release, and favorable compression properties for the development of colon-specific tablets.

Keywords: Colorectal cancer, Bacterial nanocellulose, 5-fluorouracil, TEMPO-oxidized Bacterial nanocellulose, CHPTAC-aminated Bacterial nanocellulose, Spray-drying encapsulation, Gastric coating, Compression attributes.

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APPLICATION OF MULTI-DETECTION GPC CHROMATOGRAPHY FOR DETAILED STRUCTURAL CHARACTERIZATION OF BIODEGRADABLE SYNTHETIC POLYMERS

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Abstract:
In the family of polyesters, PLA and PLGA, also known as polylactide and polylactide-co-glycolide have been the mostly used biodegradable polymers for drug delivery applications. For controlling the drug release from a drug delivery system that contains PLA/PLGA copolymers, understanding essential structural properties of polymers such as their molecular weight distribution, size and conformation is very important. [1]

The molecular weights of PLAs and PLGAs are routinely measured by gel permeation chromatography (GPC) with concentration detector (e.g. refractive index, RID) using external standards or by inherent viscosity. External standards typically used are polystyrene standards of different molecular weights. The molecular dimension of polystyrene in a given solvent is different from that of PLA/PLGA copolymers due to dissimilar polymer-solvent interactions. Thus, the molecular weight obtained by polystyrene standards may be acceptable only for a relative comparison. Molecular weights of PLA/PLGAs available from commercial sources are often calculated from measuring inherent viscosity. This again provides inaccurate information, as the size of the hydrodynamic coil that PLA/PLGA copolymers form in a given solvent also depends on the L:G ratio, and thus, it is difficult to rely on estimating molecular weights of PLA/PLGAs with different L:G ratios using one calibration curve obtained in a given solvent. More accurate molecular weights of PLA/PLGA copolymers can be obtained by using more advances multi angle light scattering (MALS) detector that does not rely on external standards for the molecular weight determination [2].

The chromatographic method for detailed structural characterization of the PLA/PLGA copolymers was developed using advanced instrumentation, including the DAWN HELEOS MALS, the Optilab T-rEX differential refractive index and the ViscoStar detector. The DAWN HELEOS MALS detector allows determination of absolute molecular weight, analysis of polymer branching and conformation [3]. The Optilab T-rEX differential refractive index detector ensures accurate concentration measurements, while the ViscoStar detector provides insights into the intrinsic viscosity and hydrodynamic properties of the polymers. Together, these instruments enable a comprehensive analysis of polymer size, shape and molecular weight distribution, exceeding the limitations of conventional GPC-RID. Additionally, the composition of PLGA copolymers is determined using 1H-NMR spectroscopy with the aim of investigating the correlation between the copolymers composition and their key structural properties, that consequently affect drug release profile and overall stability.

Keywords: biodegradable copolymers, multidetection chromatography, structural characterization, molecular conformation, absolute molecular weight

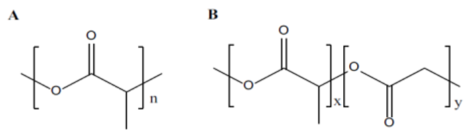

Figure 1: Chemical structure of A: PLA and B: PLGA

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Development and Characterization of Crocin-Loaded Hyaluronic Acid/κ-Carrageenan Hydrogels for Enhanced Topical Therapy in Chronic Wounds

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Abstract:
Chronic wounds often stall at the inflammation stage, failing to progress through proliferation, migration, and remodelling due to factors like immunodeficiencies and diabetes, among others[1]. These complications can lead to severe outcomes, including amputation, as current treatments often lack efficacy and fail to address the underlying biological complexities, highlighting the critical need for more effective therapies. Biopolymer-based hydrogels, particularly those made from κ-carrageenan, have garnered attention in the biomedical field for their drug delivery capabilities and regenerative medicine applications, notably in wound healing, due to their biocompatibility and high-water absorption capacity[2].

In this study, we developed a novel biocompatible hydrogel through the ionic crosslinking of κ-carrageenan and hyaluronic acid (HA). This hydrogel is designed to address the stalled healing process commonly associated with chronic wounds. It incorporates carnauba wax-based solid lipid nanoparticles (SLNs) containing ZnO nanoparticles and naturally occurring crocins from saffron, specifically formulated for topical administration to enhance wound healing. By harnessing the inherent characteristics of its constituents, our proposed hydrogel seeks to effectively promote the healing of chronic wounds: (i) HA (a critical element of the extracellular matrix) supports cellular signalling, wound repair, morphogenesis, and matrix organization, while also enhancing lubrication and moisture retention[3]; (ii) ZnO nanoparticles are extensively documented as antibacterial agents, primarily through the generation of reactive oxygen species (ROS) and bacterial membrane disruption by zinc ions[4]; (iii) Carnauba wax enhances this antibacterial activity, having been reported as an antimicrobial material[5]; (iv) Crocin provides anti-inflammatory properties that are beneficial for wound healing[6].

We characterized the rheology of these hydrogels, confirming the formation of strong, viscoelastic 3D structures with high mechanical stability, typical of hydrogel systems. Preliminary studies on the anti-inflammatory properties in both in vitro THP1 and ex-vivo pig skin showed promising outcomes. Tissue regeneration capability was also assessed in pig skin.

This innovative hydrogel formulation holds significant potential for advancing chronic wound management, offering a multifunctional approach to support and enhance the natural healing process.

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Development of Bacterial Cellulose-Based Cell Culture Platforms Incorporating Bifunctional Peptides for Enhanced Biological Properties and Biomedical Applications

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Abstract:
In vitro models have significant relevance in the biological context and in drug screening. Bacterial cellulose (BC) is a remarkable biopolymer, presenting a wide range of biomedical applications due to its biocompatibility, lack of immunogenicity and structural similarity to collagen fibers present in the extracellular matrix (ECM). BC has a high surface area and hydroxyl groups, which favor the interaction with biomolecules, such as peptides, growth factors and hormones, conferring bioactive properties. The present study was designed with the objective of developing a new cell culture platform based on BC and bifunctional peptides. The synthesis of the peptides (Collagen type 1, BMP-7 and E-PPL) was performed in solid phase (SPFS) using the Fmoc chemical protocol with Rink amide resin. Amino acid ore was performed with HOBt and DIC as reagents, using DMF as solvent and 20% 4-methylpiperidine in DMF for deprotection. After that, the amino acids were deprotected and cleaved, which was done in the acquisition of the peptides with ice-cold ether. After introduction, the peptides were extracted in TFA solution in water and acetonitrile and lyophilized. According thermal analysis revealed a reduction in the maximum degradation temperature of BC following functionalization with peptides, with the maximum degradation temperatures ranging from 289°C to 356°C, along with an increase in the residual mass at 600°C. ATR-FTIR spectra showed characteristic bands at 1650 and 1640 cm⁻¹ (amide I), 1560 and 1540 cm⁻¹ (amide II), and 1340, 1280, and 1200 cm⁻¹ (amide III), confirming the successful functionalization of the material. The next steps of the study will focus on evaluating the biological properties of the cellular platforms, specifically their ability to support cell adhesion, proliferation, and differentiation, as well as their potential antimicrobial activity.

Keywords: bacterial cellulose, peptides, cell adhesion, cell culture platform, 2D platform.

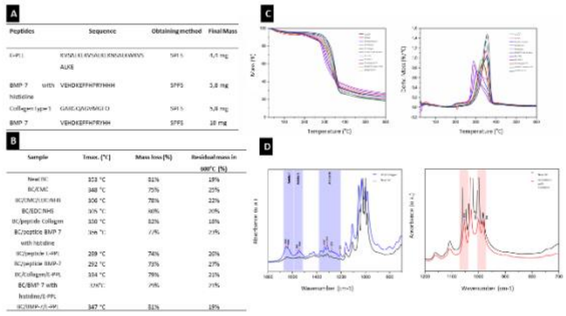

Figure 1: Characterization techniques of BC/peptides. A) Peptide sequences, synthesis method and corresponding masses after purificatiob; B) Maximum degradation temperatures, mass loss, and residual mass in the temperature range of 29°C to 600°C from TGA/DTG analysis; C) Thermograms from TGA/DTG; D) ATR-FTIR absorbance spectra.

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Intratumoral Therapy of Prostate Cancer with Docetaxel Nanomedicines in Nude Mice

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Abstract:

Prostate cancer (PCa) is the second most commonly diagnosed cancer in men, with an estimated 1.5 million (7.3% of cases) diagnoses worldwide in 2022 (WHO). Prevalence of PCa by age > 79 years is 59% among men >79 years. Despite the advances in recent decades, PCa chemotherapy presents important limitations yet [1]. Here, docetaxel (DTX) is a recommended treatment in patients with metastatic PCa, despite its therapeutic efficacy is limited by strong systemic toxicity. However, in localized PCa, intratumoral (IT) administration of DTX could be an alternative to consider that may help to overcome the disadvantages of conventional intravenous (IV) therapy. In this context, we recently have shown that mesoporous silica nanoparticles (MSNs) are promising nanocarriers for DTX delivery to prostate cancer cells, due to their biocompatibility, large surface area, tailorable pore size and easy functionalization with organic moieties [2]. Furthermore, the irruption of nanomedicines can provoke also significant evolution for IT chemotherapy. Thanks to their versatility and chemical characteristics, conjugation to nanomedicines could improve retention of cytotoxic molecules in the tumor site after IT administration and enhance their intracellular intake, among other effects [3].

We recently presented the first *in vivo* preclinical study of PCa therapy with nanomedicines of mesoporous silica nanoparticles and DTX by IT injection over a xenograft model bearing human prostate adenocarcinoma tumors developed over athymic nu/nu mice (Charles-River Laboratories, France), demonstrating that IT injection of DTX and DTX nanomedicines allow precise and selective therapy of non-metastatic PCa, and also show superior activity than the IV route [4]. In this contribution, we have carried out a complete study of the DTX biodistribution and the histopathology of tumor and main organs (liver, lung, kidney, bladder, spleen and heart) after IT and IV administration of DTX and DTX nanomedicines. The results indicate that DTX nanomedicine administered by IT route allowed higher drug retention within the tumor. Moreover, IT administration of DTX nanomedicine (2 mg/kg equivalent DTX) showed significant lower number of tumor cells than IV injection of free DTX (Figure 1). In conclusion, DTX nanomedicine in combination with IT dosing promotes strong anti-tumor efect and drug accumulation at the tumor site

Keywords: prostate cancer, intratumoral therapy, mesoporous silica nanoparticles, docetaxel.

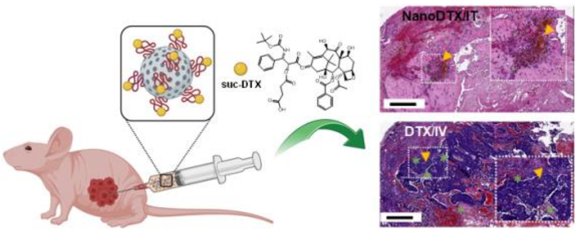

Figure 1: Antitumor effect of DTX nanomedicine administration (IT) and DTX (IV) in a xenograft mouse model bearing human PCa tumors (2 mg/kg DTX; tumor sections: H&E staining).

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Sonosensible liposomes development for transport and release of Gd-piclenol

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Abstract:
There's an extensive use of liposomes as drug carriers in literature with many different types of mechanisms used for the release of drugs from inside the core or the bilamellar membrane. In this work we focus on liposomes which release their content from the aqueous core using ultrasounds (US) to temporarily fenestrate the phospholipid membrane, the ultimate goal being the controlled release of Gd-piclenol, an innovative MRI contrast agent. Since everything, from the US setup, to the lipids choice, till the content inside the nanoparticle, influences the amount of release[1] we decided to do an extensive study with the help of chemometrics experimental design.
First, we got to understand and verify that the geometry of the US beam is not easy to predict and if we don't use the main focus of the beam it's really hard to have consistent results. Based on our previous works we found a spot in the beam that was stable enough to use to stimulate exactly the space we wanted and we confirmed with the DoE that has a comparable stability to the main focus. We also found out that, as expected, the higher the amplitude of the signal, the higher the percentage of release, same thing for the duty cycle but in a positive-quadratic way. Frequency of the US stimulation was also important with the best release at lower frequency than the transducer-rated 1 MHz. Pulse Repetition Period seems not to be an important variable in our setup. The goal intended is to not get a release related to thermal events, just a mechanical release.
This will be also useful to be in safe levels of heating for a future in vivo study.
In the immediate future we are going to study the impact of liposome dimension, liposome concentration, incapsulated solute concentration on the US sensitivity following the same steps.

Keywords: liposome nanocarriers, ultrasound therapy, drug release, chemotherapy, experimental design, MRI contrast agent

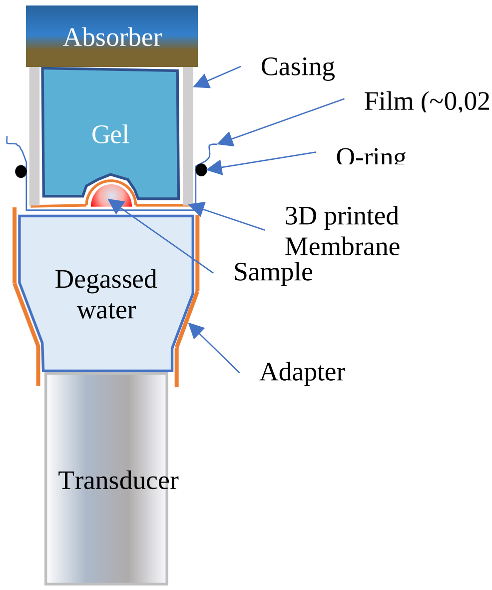

Figure 1: The US setup is especially designed to mimic the geometry of a subcutaneous tumor model. The US beam travels from the transducer, through the sample, the gel that simulates soft tissues and gets blocked by the absorber.

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The Influence of Nitrocarburization on the Functional Properties of Implants used in Thoracic Surgery

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Abstract:
Deformities of the anterior chest wall constitute approximately 90% of all congenital chest deformities and are considered the phenotypical consequence of anomalous chest wall growth. Most often, this type of deformity is stabilized using stabilizing plates manufactured with 316 LVM steel. While bending the implant to the anatomical curvature of the chest, mechanical damages on the surface of the plates, which may cause decreased biocompatibility in these areas and initiate inflammation in the place of the contact with the tissue. Therefore, this paper presents the results of physicochemical and biological studies (Figure 1) of plates with a nitrogen-carbon layer for pectus excavatum and carinatum treatment.

Based on the TEM analysis, clearly visible zones were revealed: nitrided and carburized, separated by the separation boundary from the substrate. On this basis, it was found that the thickness of the surface layer was about 1.5 µm. The presence of the nitrocarbon layer was also confirmed by the qualitative analysis of the chemical composition (SEM-EDS). The participation of unfavorable elemental ions in the layer, such as Cr and Ni, was eliminated, which was confirmed during the spectrometric analysis. On the other hand, based on the results obtained using (AFM) atomic force microscopy, it was found that the formation of the layer didn't significantly affect the increase of the Sa parameter in relation to the polished surface. However, higher values of the contact angle were obtained, which had an impact on the reduction of the surface wettability. The results of the potentiodynamic tests showed a favorable effect of the formed layer on the parameters defining the resistance to pitting corrosion. The results of the potentiostatic tests of the resistance to crevice corrosion also confirm the increased resistance to this type of corrosion in relation to the polished surface. The results of the studies using electrochemical impedance spectroscopy indicate that the electric charge density Q was observed to be 2.6 times lower for the plates with the layer compared to the samples without the layer. An increase of about 2.4 times in the surface hardness value was also observed in relation to the substrate hardness. A similar relationship was observed during the abrasion tests. In the last stage, biological studies were carried out using human skin fibroblast cells (NHDF – Normal Human Dermal Fibroblasts). It was found that the arrangement of cells on the surfaces indicates high biocompatibility of the starting material, as well as the material with the modified surface.

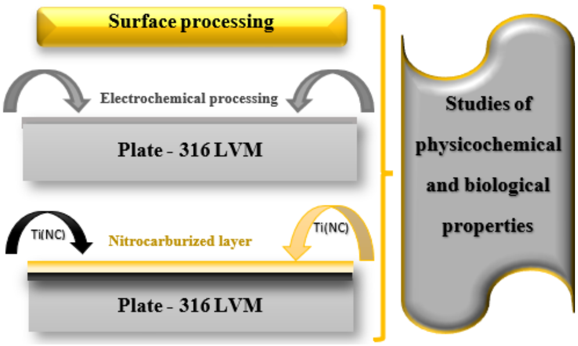

Figure 1: Diagram of research stages.

Keywords: 316 LVM steel, biomaterial, implant, surface modification, nitrocarburizing proces, biocompatibility, biomedical applications.

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The effect of PVD coatings on physicochemical properties of AZ31 magnesium alloy

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Abstract:
The issue of using magnesium alloys for the production of implants is constantly raised by scientists around the world. Magnesium alloys are considered promising materials for implants due to their biodegradable nature in the environment of tissues and physiological fluids. These biomaterials are characterized by lightness and density similar to bone density, high specific strength and very good biocompatibility. Despite many advantages they have in comparison with other metal biomaterials, their biggest disadvantage may be uncontrolled corrosion and rapid degradation in the physiological environment, and their decomposition products do not always have a positive effect on the human body. Approaches to overcome these limitations include the selection of appropriate alloying elements, proper surface treatment or surface modification using oxide coatings, understanding the characteristics and factors influencing mechanical and corrosion behavior, as well as methods to improve the mechanical properties and corrosion resistance of Mg alloys. It has been proven so far that the corrosion products of Mg alloys are non-toxic and can be excreted by human metabolism, but the hydrogen gas (H2) released during decomposition can excessively increase the pH value in the solution of physiological fluids. The released H2 accumulates in the gas pocket around the implant and causes premature implant failure, and can also be very dangerous to the patient's life. In addition, postoperative complications are mainly caused by infection in the operated area. Statistical data show that infections in hospital wards (mainly surgical) are at the forefront of postoperative complications. This phenomenon can be very dangerous for the operated patient himself, but also for all those staying in hospital wards. Aseptic issues are also one of the main areas of interest of scientists around the world. The simplest method of combating bacterial infections is to subject the patient to antibiotic therapy, but problems related to drug administration and its effective action have led to the search for new solutions related to the use of surface layers produced on implants as antibacterial solutions. The use of nanosilver in medical applications is known, but there is a lack of information on the use of ZnO. In this work, the magnesium alloy AZ31 was tested. A ZnO coating was deposited on AZ31 alloy by means of the nano PVD method. ZnO nanoparticles exhibit antibacterial properties, which can effectively inhibit bacterial reproduction, adhesion and biofilm formation [1, 2].
In the paper a preliminary investigation on produced layer properties and production technology of them is presented. Based on various research methods, like scratch test and potentiodynamic tests, it was found that there is a significant influence of the parameters of oxide layers deposition on their physicochemical properties (Figure 1).

Keywords: magnesium alloys, biodegradable materials, surface modification, biomedical applications, physicochemical properties

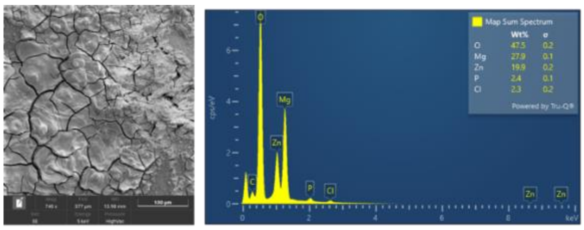

Figure 1: . SEM images of the surface of AZ31

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Micro-Computed Tomography in the Qualitative Assessment of a Ceramic Prosthetic Crown Manufactured by the Pressing Method and CAD/CAM

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Abstract:
The lithium disilicate is a material belonging to the glass ceramic group, which shows an incredible level of aesthetics of the prosthetic works made thanks to translucency similar to natural enamel. Additionally, prosthetic works made of lithium disilicate can be manufactured using different technologies, unlike other dental materials. The method of manufacturing has an impact on their quality, therefore the aim of the work was to compare the quality of ceramic prosthetic crowns manufactured using modern CAD/CAM-assisted milling technology and traditional pressing method.

The final quality was assessed using micro-computed tomography, wettability, surface roughness, and microscopic observations. The use of micro-computed tomography examination showed significant differences between the tested samples by the revealing imperfections hidden under the surface. Dental crowns produced by the pressing method showed a number of defects and cavities. In addition to empty spaces inside the samples, uneven edges, edge cavities and deformations were also observed. In the case of the crown pressed from the wax model, the number of such defects was very high. That's why, CAD/CAM technology has shown a significant advantage over the pressing technology due to greater accuracy of model reproduction, without cavities and bubbles. Additionally, CAD/CAM technology has shown high stability of the product edge, and therefore better reproduction of the model geometry. The described quality of workmanship translates into long-term functionality, efficiency of the work performed without the need for corrections, high aesthetics and overall satisfaction and comfort of the patient. It is also worth noting that CAD/CAM technology is less time-consuming, unlike the pressing method, in which the process is complicated, requires a number of activities, and the final product has many imperfections.

Keywords: dental prosthetics, microtomography, CAD/CAM, pressed ceramics, lithium disilicate.

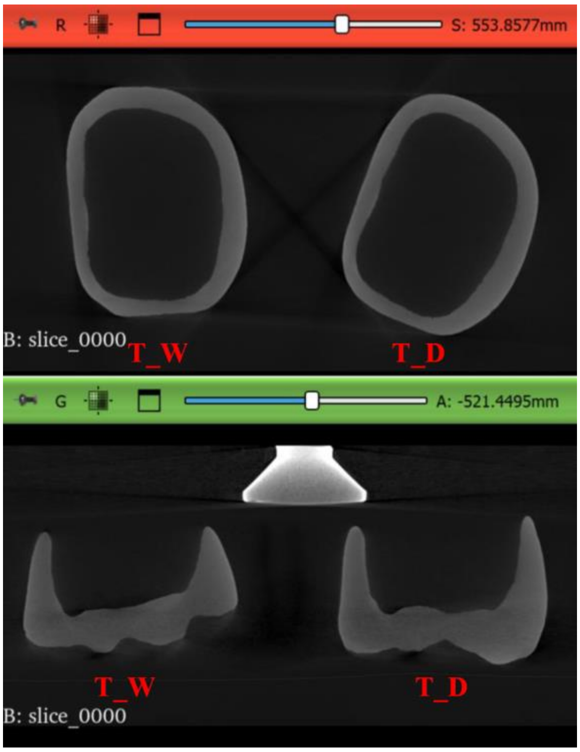

Figure 1: Figure illustrating the micro-computed tomography image (cross-section of pressed crowns).

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3D Artificial Skin Model as a Novel Strategy for the Detection of Inflammasome-cascade Activation to Predict Amyotrophic Lateral Sclerosis

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Abstract:
Amyotrophic Lateral Sclerosis (ALS) is among the most common and incurable adult-onset neurodegenerative diseases [1]. Emerging evidence suggests that NOD-like receptor pyrin domain containing protein 3 (NLRP-3) inflammasome plays a key role in ALS pathogenesis [2] and has been recently linked to TAR DNA-binding protein 43 (TDP-43) aggregates associated with motoneuron degeneration in the central nervous system (CNS). Previous studies have consistently demonstrated that cutaneous nerve degeneration can mirror neurodegenerative mechanisms acting at the CNS [3]. Even if skin biopsy technique is widely used in clinical practice, it requires the removal of patient tissue and the use of local anesthesia. Here, 3D artificial skin model was developed by using 3D printing technique [4] to overcome skin biopsy-related drawbacks. Later, 3D artificial skin was colonized with fibroblasts isolated from skin biopsy of ALS patients and characterized from chemical/physical and morphological analysis point of view. 3D artificial biological features were defined on the basis of inflammasome biomarker detected on skin biopsies and serum of ALS patients and their controls [i.e., NRLP-3, related cytokines levels (transforming growth factor β1 (TGF-β1), interleukin 18 (IL-18) and interleukin 6 (IL-6), oxidative stress marker expression and CD8+ or CD4+ lymphocytes infiltration through western blot, ELISA and fluorescence analyses]. Morphological analysis showed that 3D artificial skin possesses porosity suitable for cell colonization. Biological results revealed an increase of p-TDP-43, NLRP-3 and NEK-7 and their related cytokines in skin biopsies and serum of ALS patients thus suggesting inflammasome cascade activation related to neurodegenerative marker accumulation. Finally, these results were confirmed with analyses performed on fibroblasts isolated from skin biopsies and cultured on our 3D artificial skin model, thus emphasizing the importance of microglial NLRP-3 inflammasome-mediated activation for disease activity in ALS.

Keywords: inflammasome, nerve degeneration, skin biopsy, 3D printed artificial skin.

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Epitope Mapping and DNA-Scaffold Sensors for Improved Diagnosis of Infectious Diseases

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Abstract:

The diagnosis of infectious diseases often depends on detecting antibodies that target specific pathogen-derived antigens (1). However, diagnosing diseases with complex or low-abundance antigens can be particularly challenging (2,3,4). To overcome these obstacles, epitope mapping techniques are employed to highlight antigenic regions capable of triggering robust immune responses in infected individuals (5). Although multiple epitopes have been evaluated for their diagnostic utility, additional refinement is necessary to maximize their performance in clinical settings.

Simultaneously, DNA-scaffold biosensors have emerged as a cutting-edge solution for detecting antibodies with high sensitivity and speed (6). These biosensors consist of a structured nucleic acid framework attached to an electrode, presenting antigenic epitopes and a redox-active reporter (7). Antibody binding induces steric interference, limiting the movement of the redox reporter and reducing electron transfer (7). This measurable change correlates with the antibody concentration, enabling precise and specific diagnostics (6).

Our research explores the synergistic use of epitope identification and DNA-scaffold biosensor platforms to enhance antibody-based diagnostic tests. This combined strategy provides a fast, optimized process, ideally suited for point-of-care diagnostics (6,7,8). By integrating antigenic epitopes into DNA-scaffold technologies, we aim to address the limitations of traditional testing methods and improve diagnostic accuracy for diseases with complex antigenic profiles.

This project received funding from the Pla de Doctorats Industrials del Departament de Recerca i Universitats de la Generalitat de Catalunya, the public-private collaboration project CPP2022-009773 supported by MCIN/AEI and the EU NextGenerationEU/PRTR, and the industrial PhD grant DIN2022-012602 funded by MCIN/AEI.

Keywords: DNA-scaffold sensors, antibodies, infectious diseases, diagnosis, point-of-care applications.

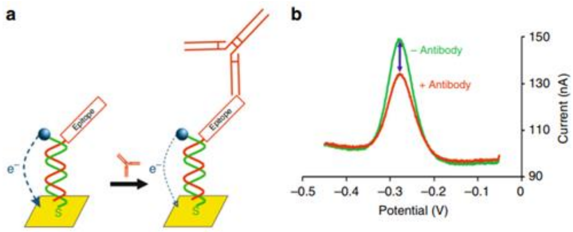

Figure 1: Figure illustrating the functionality of the DNA scaffold sensor for the rapid measurement of specific antibodies. (a) In the absence of the targeted antibody, the DNA scaffold facilitates efficient electron transfer to the gold electrode. However, upon antibody binding, steric hin-drance reduces electron transfer. (b) This al-teration in electron transfer rate is readily dis-cernible through square wave voltammetry. (7)

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Towards new breast tumor models for personalized medicine: synthesis and characterization of marine biopolymer-based hydrogels

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Abstract:
Breast cancer is the most common malignancy among women, and also the one that causes the highest mortality [1]. In countries with a high development index (HDI), 1 in 8 women will be diagnosed with breast cancer in their lifetime, and 1 in 71 will die from it [2][3].
The mammary gland is composed of different types of tissue, each with its own extra-cellular matrix (ECM) and cell types. ECMs are tridimensional networks composed of proteins, such as collagens, and glycosamines (GAGs), chains of oses, whose composition and characteristics evolve according to the state of carcinogenesis [4].
The present work focuses on creating innovative 3D models - hydrogels - with specific properties, using marine biopolymers like chitosan or collagen. The biocompatible hydrogels aim to reproduce as closely as possible the characteristics of the extracellular matrix of healthy and/or tumoral breast tissue, while at the same time meeting technical requirements. These hydrogels are then characterized in term of mechanical (viscoelastic), morphological (pore size, roughness and architecture at different scales), chemical (functional grougs) and biological properties.
The aim is to use these hydrogels to seed new breast tumoroid models to facilitate personalized medicine for each patient, so that effective treatment can be introduced sooner. The cellular models used in this project are patient-derived xenografts (PDXs) which are human tumors that have proliferated in the mammary gland of an immunodeficient mouse. Once collected, they are characterized, digested to remove unwanted material, and encapsulated in the hydrogels. Finally, the biocompatibility and the cellular response are assessed.
The results obtained offer a perspective for the development of new breast cancer models in the context of personalized medicine and drug testing, and demonstrate the interest of marine biopolymers for these applications.

Keywords: Marine biopolymers, 3D biomaterials, biomimicry, collagen, chitosan, bioactive molecules, breast PDX tumoroids, breast cancer model

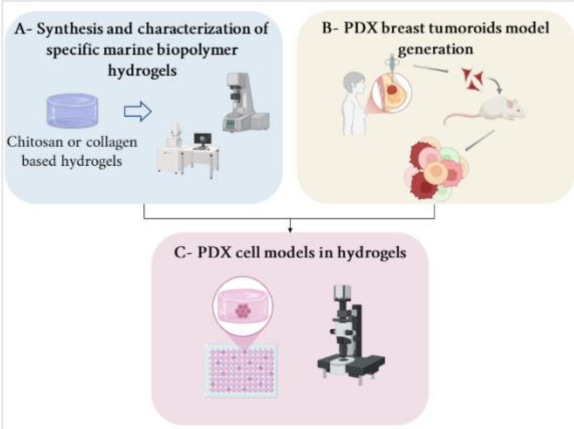

Figure 1: Overview of the aim and methodology used for this study. A- Synthesis of marine biopolymer hydrogels to meet specific requirements. The hydrogel has to be biocompatible and mimic cancerous breast tissue to obtain a cellular response as close as possible to that of *in vivo.* B- Patient-Derived Xenograft (PDX) breast tumoroid model development. C- Setting up a model between PDX tumoroids and hydrogel and assess the cellular response.

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Study of the antibacterial and hemocompatibility properties of hydroxyapatite obtained by sonochemistry for applications in biomedicine

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Abstract:
Hydroxyapatite (HA) (Figure 1) is a bioceramic with a wide range of bioapplications and is one of the fundamental constituents of the bone system. There are different methods for obtaining HA, one of the most innovative uses sonochemistry. Therefore, in this research work, HA was synthesized using high-frequency ultrasonic irradiation as an energy source, and the influence of the ultrasonic irradiation time and the type of solvent used as a reaction medium on the physicochemical characteristics, morphology, hemocompatibility and potential inhibitory properties of *Pseudomonas aeruginosa* was studied. In general, a synthesis yield of over 80% was obtained. Characterization by FTIR, XRD and TGA certified the formation of carbonated HA similar to biological apatite with nanometric particle sizes and with appreciable thermal stability. Using SEM, significant variations in the morphology of HA were detected, depending on the type of solvent used. HA was found to be hemocompatible since it did not induce significant changes (less than 10%) in platelet activation and hemolysis of blood cells. Preliminary, a decrease in the growth of *P. aeruginosa* and in the production of biomass was estimated in biofilms formed by this bacteria exposed to variants of hydroxyapatite and its solvents. Further *in vitro* and *in vivo* studies are necessary to identify the characteristics of hydroxyapatite that present the best antibacterial properties associated with better biocompatibility. This work represents a contribution to the knowledge of nanostructures and their potential applications in the design of bone and joint prostheses in the field of biomedicine.

Keywords: sonochemistry, ultrasonic irradiation, solvent mixture, hydroxyapatite, biomaterial

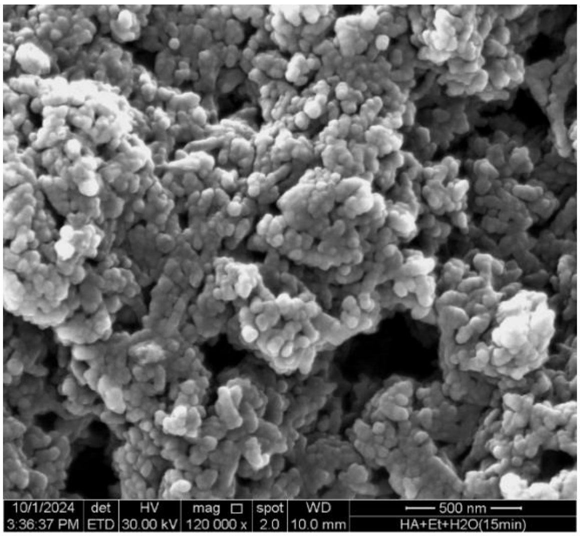

Figure 1: SEM image of HA obtained by ultrasonic irradiation at 15 min in ethanol-water

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Biomedical Potential of Chitosan extracted from the *Suillus Mushroom Granulatus*: Analysis of its Physicochemical Properties and Antibacterial Potencial.

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Abstract:

In this work, chitin was extracted from the *Suillus Granulatus* fungus, belonging to the Boletaceae family of the Fungi kingdom, which was collected from the green areas of the Venezuelan Institute of Scientific Research (IVIC), during the first fruiting cycle between the months May-June derived from symbiotic associations with the roots of pine trees. After a process of demineralization, deproteinization and discoloration of the fruiting bodies, the extracted chitin was transformed into chitosan through a partial N-deacetylation reaction. Through Infrared Spectroscopy, the transformation of Chitin into Chitosan was evidenced. Similarly, through FTIR, the degree of N-deacetylation was determined, reaching 70.56%, associated with the area under the curve of the bands corresponding to the wave numbers of 1320 cm^{-1} and 1420 cm^{-1}. SEM characterization (figure 1), for chitosan, revealed a polymeric structure with fractal patterns, spicules and interconnected pores. and the simultaneous Thermal Analysis by DSC-TGA, showed three (3) thermal transitions associated with moisture loss, depolymerization and pyrolysis. In relation to the studies carried out by XRD, diffractions were evident for chitosan at $2\theta=19.5°$ and at $2\theta=10°$, characteristics of the biopolymer. The molecular weight determined by capillary viscosimetry obtained was $1.56x10^6$ g/mol, giving this polymer. great potential towards its application in formulations used in the controlled release of drugs and in antimicrobial activity.

A significant reduction in the growth and biomass production of *P. Aeruginosa* was observed in biofilms treated with chitosan *Suillus Granulatus* of fungal origin, compared to a commercial sample. These findings suggest the promising potential of chitosan to inhibit bacterial growth, with potential important applications in biomedical and pharmaceutical research. Further in vitro and in vivo studies are needed to determine optimal antibacterial properties along with improved biocompatibility.

Keywords: Kingdom Fungi, N-deacetylation, chitosan, antibacterial activity.

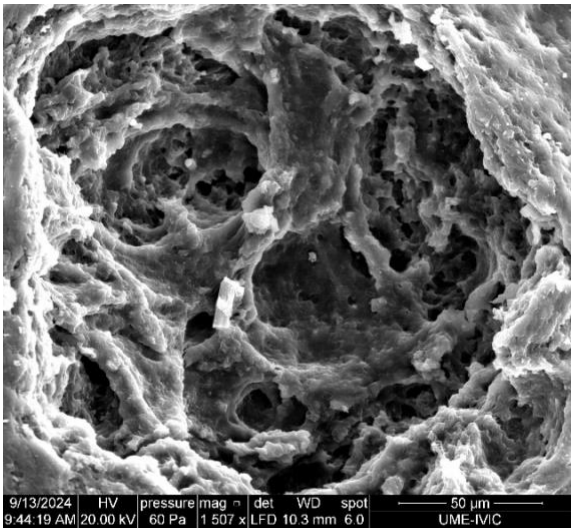

Figure 1: SEM image of chitosan extracted from the fungus *Suillus Granulatus*.

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Selenium Nanoparticles Stabilized in Tannic Acid: Toxicology Studies and Antibacterial Properties

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Abstract:
Selenium is an essential trace elemental in the diet, required for maintenance of health and growth. Give that the least toxic form of selenium is elemental Se, its nano-form has attracted significant attention. In recent years, selenium nanoparticles (SeNps) attracted the interest of many researchers due to their biocompatibility, bioavailability and low toxicity. Several studies have pointed out the ability of SeNps to exhibit anticancer, antioxidant, antibacterial and anti-biofilm properties. So far, remarkable antimicrobial activity of these nanoparticles have been evidenced against pathogenic bacteria, fungi and yeasts. SeNps have been synthesized in various forms such as nanowires, nanorods and nanotubes through sonochemical, microwave, hydrothermal methods. In this study, we discuss the synthesis of SeNps using tannic acid (SeAT Nps) as reducing and stabilizing agent (Figure 1A). We explores their potential as a novel strategy against bacterial (*H. pylori*) infections and toxicology studies. Tannic acid, a plant derived polyphenolic compound, is one such agent which embodies characteristics of being harmless and environmentally friendly combined with being a good reducing and stabilizing agent, these gives an eco-friendly agent to the green synthesis of SeNps. The synthesis of monodisperse SeNps by tannic acid was conducted under slightly basic conditions (pH=8). The characteristic absorption peak of the SeNps appearance of a sharp peak at 266 nm as well as the red color of the colloidal suspension shows formation of SeAT Nps. TEM images shows the spherical nanoparticles in form. (Figure 1B). SeAT NPs demonstrate an impressive capacity to deter biofilm formation across multiple strains of H. pylori, encompassing both the reference strain ATCC 43504 and clinically resistant variants like helicobacter pylori 239A and 239C. This inhibitory prowess is evident even at concentrations equivalent to half of the minimum inhibitory concentration (MIC) recorded across the diverse bacterial strains under scrutiny. As a control measure, BHI was employed

Keywords: selenium nanoparticles, tannic acid, toxicity, antibacterial properties, inhibition of biofilm

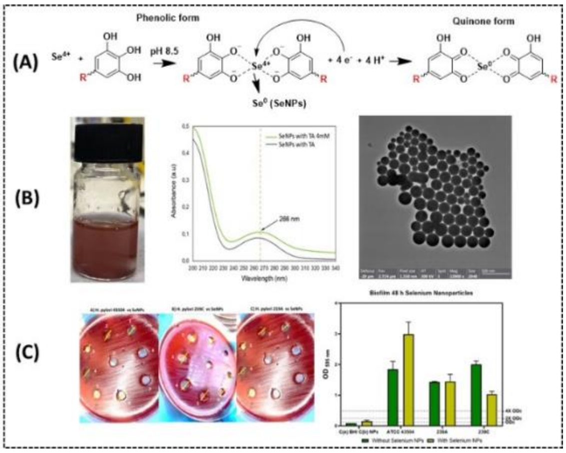

Figure 1: (A) Scheme of dual action of tannic acid as reducing agent in phenolic form and electroesteric stabilizer in quinone form during the formation of zero selenium nanoparticles. (B) Red in colours, Absorption Spectrum, TEM image of SeAT Nps. (C). Antibacterial activity against antibiotic-resistant H. pylori strains and Inhibition of biofilm formation of H. pylori of SeAT Nps.

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