Book of Abstracts

III Convegno Nazionale della Divisione di Chimica per le Tecnologie (DCT-SCI)

XIV Convegno Nazionale dell'Associazione Italiana di Chimica per l'Ingegneria (AICIng)

Eolian Milazzo Hotel
Milazzo (ME)
1 – 4 settembre 2025

Società Chimica Italiana
Divisione di Chimica per le Tecnologie

AICIng
Associazione Italiana di Chimica per Ingegneria

Indice

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Saluto del Presidente della Divisione di Chimica per le Tecnologie e del Presidente dell'Associazione Italiana di Chimica per l'Ingegneria

Care Colleghe e Cari Colleghi,

siamo lieti di darvi il benvenuto al III Congresso della Divisione di Chimica per le Tecnologie della Società Chimica Italiana e alla XIV edizione del Convegno Nazionale AICIng.

In una rinnovata e rafforzata collaborazione strutturata fra DCT e AICIng, grazie alla condivisione di obiettivi e visione, prende il via una importante piattaforma scientifica per esplorare l'intersezione tra materiali e chimica, discutere gli avanzamenti delle più recenti ricerche e il loro impatto anche nello sviluppo di innovazione tecnologica nei settori industriale, ambientale e biomedico.

Momento saliente del Convegno sarà il conferimento della Medaglia Rosario Pietropaolo, recentemente istituita dalla Divisione di Chimica per le Tecnologie in memoria del Prof. Rosario Pietropaolo. La medaglia è stata assegnata alla Prof.ssa Silvia Licoccia, Prof.ssa Ordinaria di Fondamenti Chimici delle Tecnologie, la cui attività di ricerca si è distinta per innovatività, originalità e approccio interdisciplinare con risultati di significativo impatto per la comunità scientifica nazionale ed internazionale.

Si rinnova il conferimento del riconoscimento istituito dall'Associazione ovvero del "Premio AICIng" per preclari meriti scientifici e didattici nonché per i servizi resi all'Associazione che vede destinataria la Prof.ssa Marilena Tolazzi Prof.ssa Ordinaria di Fondamenti Chimici delle Tecnologie già Presidente AICIng.

Durante il Convegno l'AICIng riserva, inoltre, un momento per commemorare la figura del Prof. Vincenzo Lorenzelli, Prof. Ordinario di Fondamenti Chimici delle Tecnologie già Rettore dell'Università Campus Biomedico di Roma, promotore e fondatore dell'Associazione nel 2002.

Infine, coerenti con la visione comune di supportare la crescita e la formazione di giovani ricercatori, valorizzandone il merito, la Divisione di Chimica delle Tecnologie e l'AICIng sono particolarmente lieti di dare il benvenuto ai giovani vincitori delle borse di studio finanziate dalla Divisione e di premiare i Dottori di Ricerca vincitori dei premi finanziati da AICIng per la migliore tesi di Dottorato di Ricerca.

Un sentito ringraziamento va al Comitato Organizzatore Locale che con dedizione e passione ha reso possibile la realizzazione di questo importante evento scientifico e a tutti i partecipanti, con l'augurio di un convegno ricco di stimoli e nuove prospettive.

Il Presidente DCT-SCI Prof. Piero Mastrorilli

Il Presidente dell'AICIng Prof. Roberto Paolesse

Saluto del Comitato Organizzatore

Care Colleghe e Cari Colleghi,

come Comitato Organizzatore, vi diamo il più caloroso benvenuto al III Convegno Nazionale della Divisione di Chimica per le Tecnologie della Società Chimica Italiana (DCT-SCI) e al XIV Convegno Nazionale dell'Associazione Italiana di Chimica per l'Ingegneria (AICIng).

I numerosi contributi scientifici pervenuti e l'elevata qualità scientifica degli stessi ci ha consentito di organizzare un programma stimolante e ricco di spunti. Nelle lectures su invito e negli speech che saranno tenuti dai vincitori dei premi Medaglia Rosario Pietropaolo e del Premio AICIng, saranno condivise intuizioni, visioni e nuove prospettive che siamo certi arricchiranno enormemente la vostra esperienza. Tutti i contributi sono pubblicati negli atti del Convegno esclusivamente in formato elettronico.

In questi giorni intensi di relazioni, discussioni, confronti, condivisioni e convivialità ci auguriamo che la vostra esperienza sia proficua e memorabile.

Auguriamo a tutte e tutti buon lavoro e un piacevole soggiorno a Milazzo.

Il Comitato Organizzatore

Candida Milone (Chair),

Consuelo Celesti,

Giuseppina Anna Corrente,

Claudia Espro, Daniela Iannazzo,

Giovanni Neri, Alessandro Sinopoli

Programma

Lunedì 1° settembre

18:00-21:00 Registrazione Partecipanti & Cocktail benvenuto

Martedì 2 settembre

8:00-9:00 Registrazione partecipanti

8:45-9:00 Apertura Lavori Del Congresso – **Prof.ssa Candida Milone** (Chair), **Prof. Gianluca Farinola** (Presidente della Società Chimica Italiana), **Prof. Luigi Mondello** (Presidente Eletto della Società Chimica Italiana), **Prof. Roberto Paolesse** (Presidente AICIng), **Prof. Piero Mastrorilli** (Presidente della Divisione di Chimica per le Tecnologie della SCI)

Sessione I

Chairs: Piero Mastrorilli – Silvia Licoccia

9:00-9:25 KN1– **Eliodoro Chiavazzo** Politecnico di Torino "*AI tools for material enhancement and discovery in thermal storage and other energy applications"*

9:25-9:40 OC1 – **Maurizia Seggiani** Università di Pisa *"Multifunctional Flexible Bio-based Polyurethane Foams Incorporating Phase Change Materials"*

9:40-9:55 OC2 –**Matteo Bonomo** Università La Sapienza *"A sustainable Deep Eutectic Electrolyte based on glycerol and NaCl for electrochemical energy storage devices"*

9:55-10:10 OC3 –**Emmanuel De Gregorio** Università di Napoli Parthenope *"Innovations in fuel cells: towards sustainable membranes"*

10:10-10:25 OC4 –**Isabella Natali Sora** Università di Bergamo *"Cation doping and transition metals exsolution in complex perovskites"*

10:25-10:40 OC5 –**Matteo Battaglia** Università di Roma Tor Vergata *"Synthesis and characterization of pelletized perovskites for green hydrogen production by two-step thermochemical water splitting cycle"*

10:40-10:55 OC6 – **Rubia Zampiva** Università di Roma La Sapienza *"From waste to added-value materials: sustainable carbon-based electrodes for supercapacitors and Li-ion batteries"*

11:00-11:30 Coffee Break & Posters

Sessione II

Chairs: Alessandra D'Epifanio – Giuseppe Marcì

11:30-11:45 OC7 –**Vito Di Noto** Univerità di Padova *"Interplay Between Synthetic Parameters, Physicochemical Properties and PEMFC performance for PtNix "Core-Shell" Carbon Nitride Electrocatalysts for the Oxygen Reduction Reaction"*

11:45-12:00 OC8 – **Federico Bella** Politecnico di Torino *"Nitrogen species electroreduction into ammonia: industrial chemistry frontiers in the SuN2rise project"*

12:00-12:15 OC9 – **Manuela Montalto** Università di Roma Tor Vergata *"Spinel-type High-Entropy Oxides Electrocatalyst for Anion Exchange Membrane Water Electrolyzers"*

12:15-12:30 OC10 – **Alberta Genco** Università di Palermo *"Carbon-based photocatalysts for H2 production by photo-thermal catalysis"*

12:30-12:45 OC11 – **Arooj Asif** Università del Salento *"Eco-Friendly Graphene-Like Materials from Coffee Silverskin as Photocatalyst for SolarDriven H2 Production"*

12:45-13:00 OC12 – **Barbara Di Credico** Università di Milano Bicocca *"A New Life for Tionite Industrial Waste as Photocatalytic Active Material"*

13:00-14:00 Light Lunch

Sessione III

Chairs: Nadia Lotti – Fabio Ganazzoli

14:00-14:15 OC13 – **Patrizia Cinelli** Università di Pisa *"Advancing sustainable packaging: production and recycling of novel furan-based polyester films"*

14:15-14:30 OC14 – **Aurelio Bifulco** Università di Napoli Federico II *"AI-driven design and optimization of flame retardant epoxy nanocomposites and textiles"*

14:30-14:45 OC15 – **Antonio Cosimo Pio Trimboli** Università Mediterranea di Reggio Calabria *"Mechanocatalytic Upcycling of Polyethylene Promoted by the Ru/Al_2O_3 Catalyst"*

14:45-15:00 OC16 – **Michelina Soccio** Università di Bologna *"Synthesis of fully biobased aliphatic/aromatic polymer systems for flexible food and biomedical packaging: the role of chemical structure, composition and architecture"*

15:00-15:15 OC17 – **Annafelicia Civitavecchia** Università Politecnica delle Marche *"Innovative Nonwoven Antimicrobial Fabrics from Discarded Fishing Nets"*

15:15-15:30 OC18 – **Monica Orsini** Università degli Studi Roma Tre *"From Starch to Advanced Biodegradable Films with Tunable Properties"*

Sessione Flash Oral

Chairs: Sara Maria Giannitelli –Emanuela Muscolino

15:30-15:34 FO1 – **Mattia Bonuso** Centro Ricerche Enrico Fermi: CREF *"New high-Z plastic scintillators for total-body SPECT and theranostic dosimetry*"

15:34-15:38 FO2 – **Federica Gulino** Università di Palermo *"Radiation-Crosslinked Wound Dressings Containing Egg White Proteins"*

15:38-15:4 FO3 – **Maya Nobatova** Università di Palermo *"Solar-Driven Photocatalytic Reductions for Sustainable Applications"*

15:42-15:46 FO4 – **Alessia Fata** Università di Roma Tor Vergata *"The Formylation Of N,N-Dimethylcorroles"*

15:46-15:50 FO5 – **Irene Anguillesi** Università di Pisa *"Synthesis and Characterization of Waste Cooking Oil-Derived Polyols for Use as Biolubricants"*

15:50-15:54 FO6 – **Marina Petroselli** Università Politecnica delle Marche *"Ab initio characterization of HfO_2 and its Zr-doped derivatives for energy harvesting applications"*

15:54-15:58 FO7 – **Miriam Cappello** Università di Pisa *"Biodegradable Nanocomposites for a Greener Future: Investigating Nano-SiO_2 in PLA and PBSA-based systems"*

16:00-16:30 Coffee Break & Posters

Sessione IV

Chairs: Roberta Bongiovanni –Michelina Catauro

16:30-16:45 OC19 – **Dario Allevi** Politecnico di Milano *"Renewable rubber composites towards a sustainable future"*

16:45-17:00 OC20 – **Immacolata Climaco** Università di Napoli Federico II *"Selfextinguishing epoxy nanocomposites containing coffee biochar and other additives"*

17:00-17:15 OC21 – **Francesca Baldassarre** Università del Salento *"Agro-food wastes as source of bioactive phytochemicals: extraction, characterization and their nano-encapsulation for cosmeceutical applications."*

17:15-17:30 OC22 – **Damiano Rossi** Università di Pisa *"Polyamide 6 recycled fishing nets modified with biochar fillers and reclaimed carbon fibers: an effort toward sustainability and circularity"*

17:30-17:45 OC23 – **Angelo Ferlazzo** Università degli studi di Catania *"A Photochemical pathway towards green functional nanostructures"*

17:45-18:00 OC24 –**Francesca Derobertis** Politecnico di Bari *"Copper recovered from waste printed circuit boards as catalytic drive for methanol dehydration to dimethyl ether"*

18:00-18:15 OC25 –**Virginia Venezia** Università di Napoli Federico II *"Electrospun fibers from biowaste for the selective and reductive adsorption of precious metals from e-waste"*

Mercoledì 3 settembre

8:30-9:00 **"Medaglia Rosario Pietropaolo" – Prof.ssa Silvia Licoccia**

Sessione V

Chairs: Cristina Leonelli –Vito Gallo

9:00-9:25 KN2– **Gianfrancesco Licandro** Raffineria di Milazzo "*RAM Sustainability"*

9:25-9:40 OC26 – **Lorenzo Viganò** Politecnico di Milano *"Silica derived from hexafluorosilicic acid waste valorization for CO2 capture and re-use"*

9:40-9:55 OC27 –**Alessandro Francini** Università di Modena e Reggio Emilia *"Comparing environmental metrics for noble metal recovery from e-waste: a dual assessment using the ESCAPE approach and the LCA methodology"*

9:55-10:10 OC28 – **Ciro Migliaccio** Università di Napoli Parthenope *"Innovative Acid and Alkaline Red Mud-Metakaolin Based Geopolymers: Characterization and Applications in Construction and Environmental Remediation"*

10:10-10:25 OC29 – **Claudio Imparato** Università di Napoli Federico II *"Valorization of biochar and aqueous phase derived from the hydrothermal liquefaction of sewage sludge"*

10:25-10:40 OC30 – **Francesco Lanero** Università di Padova *"Cationic fluorinated polyphosphazenes for the decontamination of wastewater from anionic pollutants"*

10:40-10:55 OC31 –**Muhammad Umair** Università di Palermo *"Photocatalysis Applications: Photoreforming of Biomass Derivatives and Organic Drugs Removal. Preparation and Characterization of Nanocomposites Materials"*

11:00-11:30 Coffee Break & Posters

Sessione VI

Chairs: Marcella Trombetta –Clelia Dispenza

11:30-11:45 OC32 – **Martina Marsotto** Università di Roma Tor Vergata *"Synthetic challenges and opportunities in corrole chemistry: the reaction of beta-alkylcorroles with Ag(I) salts"*

11:45-12:00 OC33 – **Emanuela Muscolino** Università di Palermo *"Injectable Degalactosylated Xyloglucan Hydrogel for Mitochondrial Transplantation in Cardiac Repair"*

12:00-12:15 OC34 – **Lucia Mergola** Università del Salento *"Green preparation of gold nanoparticles and their activity in photothermal cancer therapy"*

12:15-12:30 OC35 – **Viviana Vergaro** Università del Salento *"Light-Responsive Flavone–Platinum Complexes: Photochemical Activation and Anticancer Evaluation in 3D Cell Models"*

12:30-12:45 OC36 – **Giulia Guidotti** Università di Bologna *"Aromatic copolyesters containing furan and isophthalic rings for vascular tissue engineering: from design to device"*

12:45-13:00 OC37 – **Andrea Cocco** Università di Cagliari *"Synthesis and characterization of new heteroleptic platinum complexes with second-order nonlinear optical properties"*

13:00-14:00 Light Lunch

Sessione VII

Chairs: Salvatore Failla –Marilena Tolazzi

14:00-14:15 OC38 – **Simona Crispi** Università degli studi di Messina *"New Nanomaterials for the Development of High-performance Chemical Sensors for Environmental Applications"*

14:15-14:30 OC39 – **Fabrizio Caroleo** Università di Roma Tor Vergata *"Catch, Signal, Remove: Dual-Function porphyrinoid materials for fluorinated pollutant Sensing and Remediation"*

14:30-14:45 OC40 – **Ivan Pietro Oliveri** Università di Catania *"Vapochromic and vapoluminescent paper-based sensors based on a Zn(salen-type) complex for the discriminative detection of volatile primary aliphatic mono- and diamines vapours"*

14:45-15:00 OC41 – **Amerigo Beneduci** Università della Calabria *"Smart optical materials and devices based on organic mixed valence compounds"*

15:00-15:15 OC42 – **Francesco Pizzoli** Università di Roma Tor Vergata *"Novel N-alkylcorrole-based sensing materials for the development of e-nose platforms"*

15:15-15:30 OC43 – **Roberta Bongiovanni** Politecnico di Torino *"Green electrospinning processes for membranes suitable for water treatment"*

Sessione Flash Oral

Chairs: Antonella Sola –Claudio Imparato

15:30-15:34 FO8 – **Micaela Vannini** Università di Bologna *"Decoding the Chemistry-Performance Link in Furan-Based Polymers"*

15:34-15:38 FO9 – **Federica Bucolo** Università di Messina *"ZnO@GQDs based gas sensor for the detection of H_2S"*

15:38-15:4 FO10 – **Annamaria Greco** Politecnico di Bari *"Metabolomic changes in xylem tissue of susceptible and resistant olive cultivars to Xylella fastidiosa infection"*

15:42-15:46 FO11 – **Elodia Spinelli** Università di Roma Tor Vergata *"Organically Modified Mesoporous Silica for Controlled Release of Thyme Oil as an Antivegetative Agent in Artwork Conservation"*

15:46-15:50 FO12 – **Simona Ciurciù** Università della Calabria *"Recovery of Cu(II) from Printed Circuit Boards leachate via Capacitive Adsorption on Micro/Mesoporous Biochar"*

15:50-15:54 FO13 – **Alessio Carmelo Perri** Università della Calabria *"Neodymium and Yttrium adsorption on citrate-modified cellulose: experimental and computational insights"*

15:54-15:58 FO14 – **Marika Fiorentino** Università di Napoli Federico II *"SiO_2-Sodium Alginate Hybrids: Structural and Biocompatibility Assessment"*

16:00-16:30 Coffee Break & Posters

16:30-17:30 Assemblea AICIng

17:30-18:30 Assemblea Divisione Chimica per le Tecnologie

20:00 Cena sociale

Giovedì 4 settembre

9:00-9:40 **Premio AICIng – Prof.ssa Marilena Tolazzi & Ricordo del Prof. Vincenzo Lorenzelli**

Sessione VIII

9:40-9:55 OC44 – **Simone Ranieri** Università Politecnica delle Marche *"Lignin-Based Cationic Hydrogels for the Adsorption of Emerging Pollutants from Aqueous Media"*

9:55-10:10 OC45 – **Viviana Bressi** Università degli studi di Messina *"Development of Innovative Technologies for the Synthesis of Materials for Sensing and Environmental Applications"*

10:10-10:25 OC46 —**Ilaria Di Filippo** Università di Roma Tor Vergata *"Porphyrin-based SURMOFs: from synthesis to application"*

10:25-10:40 OC47–**Antonio D'Angelo** Università della Campania Luigi Vanvitelli *"Understanding the behaviour of natural and artificial dyes in metakaolin-based geopolymers"*

10:40-10:55 OC48 – **Giulia Fioravanti** Università dell'Aquila *"Tuning Paramagnetism in Graphene Oxide Derivatives: Impact of Reduction Degree and Metal Impurities Revealed by EPR and MRI Analyses"*

11:00-11:30 Coffee Break

Sessione IX

Chairs: Pierluigi Stipa –Isabella Chiarotto

11:30-11:45 OC49 – **Maria Trisolini** Politecnico di Bari *"Accuracy and Reproducibility of a ^{1}H NMR protocol for Quantification of Betaine in Wheat and Pasta"*

11:45-12:00 OC50 – **Andrei Ungureanu** Università di Modena e Reggio Emilia *"Environmental Life Cycle Assessment (LCA) of Curcumin-stabilized Silver Nanoparticles (Cur-AgNPs)"*

12:00-12:15 OC51 – **Gabriele Magna** Università di Roma Tor Vergata *"Disposable Sensor Array Embedded in Facemasks by using PEDOT:PSS doped with porphyrins"*

12:30-13:00 Premiazioni

13:00-14:00 Conclusione lavori

SESSIONE POSTER

Martedì 2 settembre

FO1	**Mattia Bonuso**	*New high-Z plastic scintillators for total-body SPECT and theranostic dosimetry*
FO2	**Federica Gulino**	*Radiation-crosslinked wound dressings containing egg white proteins*
FO3	**Maya Nobatova**	*Solar-Driven Photocatalytic Reductions for Sustainable Applications*
FO4	**Alessia Fata**	*The formylation of N,N-dimethylcorroles*
FO5	**Irene Anguillesi**	*Synthesis and Characterization of Waste Cooking Oil-Derived Polyols for Use as Biolubricants*
FO6	**Marina Petroselli**	*Ab initio characterization of hfo_2 and its Zr-doped derivatives for energy harvesting applications*
FO7	**Miriam Cappello**	*Biodegradable Nanocomposites for a Greener Future: Investigating Nano-sio_2 in PLA and PBSA-based systems*
PO1	**Isabella Lancellotti**	*Alkali activation for ceramic exhausted lime inertization*
PO2	**Giovanni Angelo Riva**	*Through-Plane Ionic Conductivity Measurements of Commercial Membranes and Separators Toward Industrial Nonaqueous Redox Flow Batteries*
PO3	**Ilenia Acquaro**	*Innovative composite materials based on biochar and salt hydrate...*
PO4	**Marianna Bellardita**	*Photocatalytic CO_2 reduction*
PO5	**Sara Filippi**	*Eco-sustainable recycling of red gypsum waste in road pavements*
PO6	**Gianluca Viscusi**	*Fabrication of a novel cellulose-based bio-adsorbent functionalised with Mn-doped Fe_3O_4*
PO7	**Saman Fatima**	*Physico-chemical and Cytotoxicity Study of Silica/Sodium Alginate Hybrid Biomaterials*
PO8	**Gian Paolo Suranna**	*Photodegradation vs. Adsorption Activity in Dye Removal by Surface-Modified TiO_2 Nanorods*
PO9	**Maria Michela Dell'Anna**	*Waste cooking oil valorization in the field of sustainable mobility*
PO10	**Marialuigia Raimondo**	*Improving the properties of Poly(ethylene-co-methacrylic acid) (EMAA) using carbon nanotubes and expanded graphite*
PO11	**Viviana Bressi**	*Sustainable Conversion of Plastic Waste into Valuable Liquid Fuels via Mild Catalytic Processes*
PO12	**Valentina Siracusa**	*Life cycle assessment of non-thermal technologies: Cold Plasma & HHP*
PO13	**Federica Giuliano**	*Sol-Gel Synthesis and Characterization of Biomaterials with Ferulic Acid*
PO14	**Roberto Nicoletti**	*Sodium Iron Phosphate: Cathode Material for Large Scale Batteries*
PO15	**Ignazio Blanco**	*Physicochemical Characterization of LDPE greenhouse films treated with agrochemicals*
PO16	**Ignazio Blanco**	*Thermal Conductivity Measurements: a Combined Instrumental Approach*
PO17	**Federica Mandoj**	*Novel hybrid nanocellulose-porphyrins based optical chemical sensors for heavy metal ions detection*

PO18	**Giuseppe Vitiello**	*Amphiphiles-functionalized colloidal F/ZnO quantum dots as biocompatible fluorescent nanoprobes*
PO19	**Andrea Melchior**	*Application of a natural zeolite for the recovery of neodymium*
PO20	**Matteo Bonomo**	*A new push-pull dye for semi-transparent p-type DSSCs*
PO21	**Alessandro Francini**	*Porous geopolymers for thermal insulation: insights from a Life Cycle Assessment study*
PO22	**Alessia Iennaco**	*Waste Ceramic Capacitors as Efficient and Recyclable Catalyst...*
PO23	**Giuseppina Luciani**	*Hybrid nanomaterials from biowastes for sustainable agriculture*
PO24	**Antonio Aronne**	*Synthesis of nonlinear optical materials for quantum sources*
PO25	**Mengistu Gelaw**	*Comparative Study of Adsorption and Mechanical Characteristics of Composite Coatings using Zeolite 13X, SAPO-34, and Silica gel for sorption technologies*
PO26	**Naghmeh Fallah**	*Carbon-Based Materials in Combined Processes for Removal and Functional Application of Indigo Dye*
PO27	**Cristina Leonelli**	*Chemical characterization of heavy metals and anions in geopolymers*
PO28	**Erica Sonaglia**	*Nanocellulose from Industrial By-Products as a Renewable Platform for Advanced Materials*

Mercoledì 3 settembre

FO8	**Micaela Vannini**	*Decoding the Chemistry-Performance Link in Furan-Based Polymers*
FO9	**Federica Bucolo**	*ZnO@GQDs based gas sensor for the detection of H_2S*
FO10	**Annamaria Greco**	*Metabolomic changes in xylem tissue of susceptible and resistant olive cultivars to Xylella fastidiosa infection*
FO11	**Elodia Spinelli**	*Organically Modified Mesoporous Silica for Controlled Release of Thyme Oil as an Antivegetative Agent in Artwork Conservation*
FO12	**Simona Ciurciu'**	*Recovery of Cu(II) from Printed Circuit Boards leachate via Capacitive Adsorption on Micro/Mesoporous Biochar*
FO13	**Alessio Carmelo Perri**	*Neodymium and Yttrium adsorption on citrate-modified cellulose: experimental and computational insights*
FO14	**Marika Fiorentino**	*SiO_2-Sodium Alginate Hybrids: Structural and Biocompatibility Assessment*
PO29	**Maria Stella Leone**	*Preliminary Characterization of Synthetic Fibers from Fast Fashion*
PO30	**Sara Maria Giannitelli**	*Microfluidic-assisted synthesis of bioactive glass nanoparticles*
PO31	**Alberto Rainer**	*In vitro models of marine ecotoxicology*
PO32	**Mariagrazia Musolino**	*Bifunctional nickel-based compounds as electrocatalysts for green hydrogen production*
PO33	**Giulia Maria Itri**	*Direct recovery of spent lithium-ion battery for catalytic hydrogenation reaction*
PO34	**Emiliano Laudadio**	*Tunable antioxidant properties of mixed lipid-PLGA matrix encapsulating polyphenols*

PO35	**Marilena Tolazzi**	*Recovery of cobalt from lithium-ion batteries by extraction with zeolite modified with ionic liquids*
PO36	**Michelina Soccio**	*Chemical modification of potatoes by-products for PLA-based smart packaging*
PO37	**Simona Ciurciu'**	*Hybrid nanostructured polyethylene sulfone sulfonate membranes for water remediation*
PO38	**Luigi Vertuccio**	*Strain and damage monitoring of expanded graphite /nylon composites*
PO40	**Salvatore Failla**	*Dinuclear semi-rigid Zn(salen-type) complex as chemosensor of ditopic amines*
PO41	**Paola Paoli**	*Efficient Capture and Dynamic Solvent-Exchange of VOCs via Cu(II)-Bispidine*
PO42	**Margherita Colombo**	*Engineering of biomass: bioplastic films from proteins*
PO43	**Alberto Bottari**	*A circular approach to flexible electronics: biobased PET recycling*
PO44	**Roberta Del Sole**	*Green gold nanoparticles for pollutants removal from water*
PO45	**Giovanni Sotgiu**	*An integrated electrochemical system for the purification of polluted water*
PO46	**Mimimorena Seggio**	*Advanced Plasmonic-based PoCTs for Attomolar-Level Cytokine Detection*
PO47	**Giuseppe Marcì**	*Hydrochar from orange peel waste and Black Mass from Spent Li-batteries as co-catalyts of C_3N_4 for H_2 generation form aqueous solutions of organics*
PO48	**Francesca Anna Scaramuzzo**	*Sustainable materials from industrial waste for beyond lithium devices*
PO49	**Tayyaba Kanwal**	*Photoreforming of glucose via BiOX-TiO_2 composites*
PO50	**Luisa Barbieri**	*Green solution for ceramic glazes using vitreous fibers waste*
PO51	**Piero Mastrorilli**	*Utilization of Lignin-Rich Biorefinery Residues to Produce Biofuels*
PO52	**Lavinia Pitari**	*Pd-catalyzed Suzuki-Miyaura in soy-protein cryogels*
PO53	**Andrea Ravicini**	*Pd-decorated carbon nanostructures for sustainable catalysis*
PO54	**Alessia Scarpiello**	*Safe and Sustainable Development of Functional Materials for Technical Documentation Systems*
PO55	**José Miguel Silva Ferraz**	*A Dual-Mode Knudsen/Langmuir Apparatus with QCM Detection for High-Sensitivity Vapor Pressure Measurements*
PO56	**Dhanalakshmi Vadivel**	*From Regolith to Resilience: Geopolymer Materials for Space Construction Under Vacuum Conditions*
PO57	**Pietro Argurio**	*Membrane Scale-Up for Chemical Industries (MEASURED)*

Medaglia Rosario Pietropaolo
Prof.ssa Silvia LICOCCIA

La Prof.ssa Silvia Licoccia, Professore Ordinario di Fondamenti Chimici per le Tecnologie presso Università degli Studi di Roma 'Tor Vergata', è una figura di riferimento nel campo della ricerca scientifica, con una carriera dedicata allo sviluppo di materiali avanzati per l'accumulo e la conversione dell'energia. Autrice di oltre 320 pubblicazioni, 4 brevetti e 2 libri, ha coordinato progetti di ricerca nazionali e internazionali, formando nuove generazioni di ricercatori e contribuendo all'innovazione tecnologica sostenibile. La Prof.ssa Silvia Licoccia ha collaborato con prestigiose istituzioni in USA, Canada e UK; ha fondato e diretto il gruppo di ricerca Materials and Devices for Energy, ed è stata coordinatrice dell'Infrastruttura di Ricerca ISIS@MACH ITALIA, riconosciuta dal MUR come prioritaria nel Piano Nazionale delle Infrastrutture. Ha rivestito il ruolo di Esperto tecnico Scientifico per il MUR, Componente del Comitato per la Missione e Visione Università degli Studi di Roma 'Tor Vergata' nonché di Delegato del Rettore per la Ricerca. E' stata insignita del Premio AICIng 2018 per meriti scientifici, didattici e di servizio ed è stata Presidente dell'Associazione Italiana di Chimica per l'Ingegneria (AICIng) dal 2010 al 2014. Nella sua carriera accademica la Prof.ssa Licoccia ha rivestito anche importanti ruoli gestionali quali Direttore del Dipartimento di Scienze e Tecnologie Chimiche dell'Università degli Studi di Roma 'Tor Vergata' dal 2012 al 2018.

Premio AICIng Prof.ssa Marilena TOLAZZI

Marilena Tolazzi si laurea in Chimica *cum laude* presso l'Università di Padova e inizia il suo percorso accademico come ricercatrice presso l'Università di Udine, dopo un breve periodo di attività di ricerca svolto presso la Direzione Ricerche della Electrolux, dove è coordinatrice della Sezione Chimica.

Risulta vincitrice il concorso nazionale a professore associato nel 1998 e presta servizio prima presso la Facoltà di Ingegneria del Politecnico di Torino e poi presso la Facoltà di Ingegneria dell'Università di Udine, ove attualmente è professore ordinario di Fondamenti di Chimica per le Tecnologie. Durante la sua carriera, ha tenuto e tiene corsi di Chimica, Chimica Ambientale e Chimica-Fisica Ambientale presso corsi di Laurea e Laurea Magistrale in Ingegneria e ha contribuito alla scrittura di due libri di testo universitari. L' attività di ricerca di Marilena Tolazzi si è sviluppata dell'ambito dello studio della chimica in soluzione di ioni metallici (lantanidi e metalli di transizione) e dei loro complessi con particolare attenzione a tematiche di applicazione in ambito ambientale, industriale e biomedico. Gli interessi di ricerca più recenti riguardano gli studi di speciazione applicati a ioni lantanidi per *sensing* chimico e il recupero di metalli critici (CRMs). La prof. Tolazzi ha partecipato e coordinato progetti di ricerca nazionali e internazionali e ha collaborato con numerose e prestigiose istituzioni in Italia e all'estero. L'attività scientifica è documentata da oltre 100 pubblicazioni su riviste internazionali e da altrettante partecipazioni a convegni nazionali ed internazionali. È stata componente del Consiglio direttivo e scientifico dell'Associazione Italiana di Calorimetria e Analisi termica (AICAT), del Consiglio direttivo della Divisione di Chimica per le Tecnologie della Società Chimica Italiana e del Consiglio direttivo dell'Associazione Italiana Chimica per Ingegneria (AICIng). È stata Presidente AICIng dal 2019 al 2021 e componente del Comitato scientifico e organizzatore di vari congressi Nazionali e Internazionali. Attualmente ricopre il ruolo di commissario ASN per il settore concorsuale 03/B2.

Premio AICIng 2025- Tesi di Dottorato

Il *Premio AICIng 2025* è stato conferito alle migliori tesi di dottorato, selezionate nell'ambito di un bando riservato a giovani dottorandi, e che verranno presentate durante il convegno.
I contributi relativi ai lavori premiati sono inclusi nel presente volume e sono consultabili alle seguenti pagine:

Keynote Lectures

KN1

AI tools for material enhancement and discovery in thermal storage and other energy applications

P. De Angelis[1], G. Trezza[2], G. Barletta[1], P. Asinari[1,3], E. Chiavazzo[1,3*]

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The accelerated development of advanced materials is a cornerstone for realizing transformative progress in energy applications. In this talk, I will present the most recent advancements from my group at the intersection of artificial intelligence (AI), energy and materials science. I shall specifically focus on AI-driven strategies for material performance enhancement, novel material discovery and generalization of results by complex data-driven models.

First, I will discuss active learning strategies for material performance enhancement. Traditional materials optimization often relies on extensive experimental or computational campaigns that are time- and resource-intensive. By integrating active learning with material modelling workflows, it is possible to strategically select the most informative experiments or simulations to rapidly drive material improvements. I will showcase examples from our recent studies[1,2] where active learning was leveraged to optimize energy materials in the context of long term Thermal Energy Storage (TES) and other energy applications.

Importantly, I will discuss the critical topic of black-box AI models generalization. To this end, I will discuss how our recent work on feature grouping[3] can be used to possibly promote the rational design of new materials beyond the explored configurations.

Future broader perspectives will also be shortly presented as far as the frontier of new material discovery for energy applications is concerned. Here, the goal is even more ambitious: predicting promising materials that have not yet been synthesized. I will briefly present our latest work, which combines machine learning, domain expertise, and one of the latest generative modelling to dive into the unexplored regions of the material space[4,5]. Importantly, to this end, I will address the challenge of cross-domain data bias and how to alleviate it[6].

In conclusion, this talk aims at highlighting how the smart integration of several AI tools into the materials science pipeline can significantly accelerate the pace of discovery and innovation in energy-related applications.

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[3]G. Barletta, G. Trezza, E. Chiavazzo *Machine Learning and Knowledge Extraction*, **2024** 6(3), 1597-1618 [4]P. De Angelis, G. Trezza, G. Barletta, P. Asinari, E. Chiavazzo *arXiv preprint* **2024,** 2411.10125
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KN2

RAM Sustainability

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Milazzo Refinery (RAM), a joint venture between Eni and Q8, is an important player in the national energy system, operating with the aim of producing high-quality fuels through modern technologies and highly qualified personnel. In the present context of energy transition, RAM addresses environmental and industrial challenges with a pragmatic approach, aimed at integrating operational efficiency and environmental responsibility. To support that, RAM has adopted an Integrated Management System (IMS) compliant with international standards (ISO 9001, 14001, 45001, 50001), which allows continuous monitoring and progressive improvement in key areas such as quality, energy, safety and the environment. The integration of sustainability into business decisions is supported by constant investments in technological innovation. The most significant initiatives include optimization of energy consumption and reduction of emissions, progressive integration of renewable sources (e.g. photovoltaic systems), use of organic by-products and raw material for the production of fuels at low environmental impact, water recovery and waste valorization in a circular economy perspective, advanced systems for monitoring emissions and odors. The awareness of the culture of safety is deeply rooted in the management of RAM, which promotes continuous training, practical application and digital technologies to guarantee health and safety at work. Predictive and scheduled maintenance of the systems contributes to operational reliability, environmental protection and asset integrity. Attention to human resources takes the form of professional development paths, inclusion policies and active relationships with the territory: RAM maintains an open dialogue with local stakeholders, institutions, schools and universities, contributing to the socio-economic development of the area. RAM has been publishing the sustainability report on a voluntary basis for over 14 years, according to GRI standards, demonstrating a concrete commitment to transparency and environmental, social and governance (ESG) responsibility.

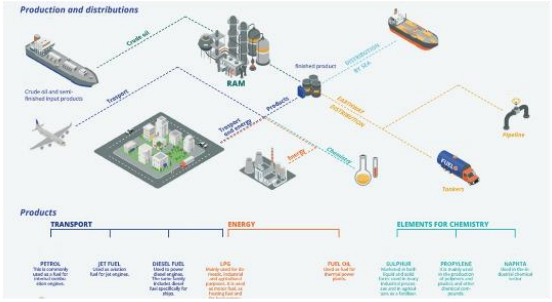

Figure 1. Simplified flowchart of the production and distribution process

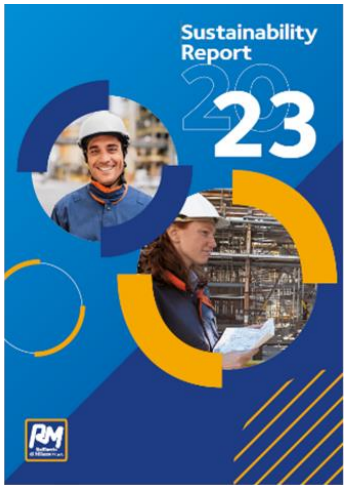

Figure 2. 2023 Sustainability Report of the Milazzo Refinery

References

[1] 2023 Sustainability Report of the Milazzo Refinery

Comunicazioni Orali

OC1

Multifunctional Flexible Bio-based Polyurethane Foams Incorporating Phase Change Materials

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Sustainable, multifunctional flexible polyurethane foams (PUFs) incorporating microencapsulated phase change materials (PCMs) were synthesized using a polyol derived from waste cooking oil (WCO) and a partially bio-based isocyanate. The PCM-loaded foams achieved an energy storage capacity of up to 26.2 J/g at a PCM content of 15 phr. Microcapsules were uniformly dispersed within the foam matrix, slightly reducing cell size and increasing density (from 128 to 157 kg/m³), which improved mechanical strength and rigidity. However, a reduction in elasticity was observed, with compression force deflection (CFD) increasing up to 234.8 kPa. Fatigue testing demonstrated the biobased-foam's ability to withstand cyclic loading, with increased dynamic stress and stiffness attributed to PCM integration. DSC confirmed a consistent phase-change temperature of 36 ± 0.1 °C. Thermal conductivity showed a slight increase (from 46.55 to 48.58 mW/m·K) with higher PCM content, due to the presence of the conductive silica-based capsule shell. Fire performance remained essentially unchanged, likely resulting from a balance between the flammable paraffin core and the flame-retardant properties of the silica shell. These results highlight the potential of bio-based PCM-PUF foams as lightweight, energy-efficient materials capable of providing both thermal insulation and energy storage near room temperature. Such multifunctional systems are promising candidates for applications in the automotive and building sectors, while also contributing to the valorisation of WCO as a renewable resource.

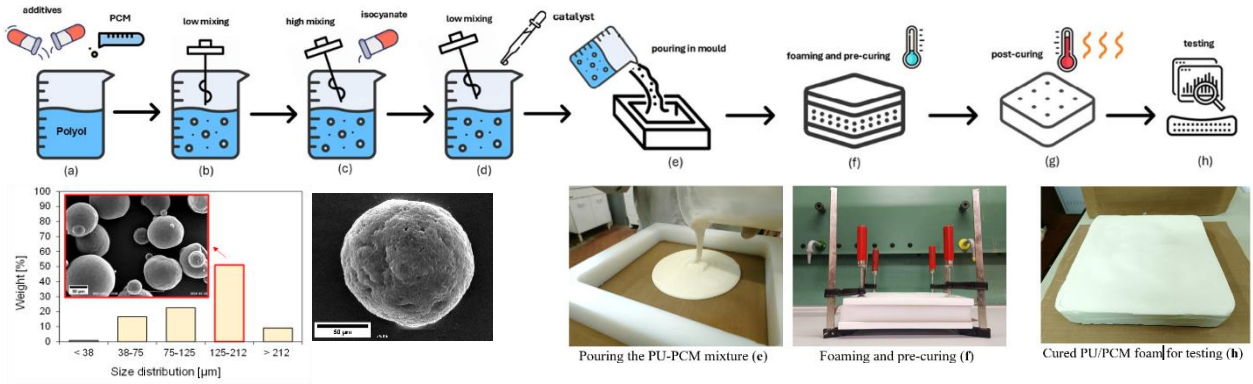

Figure 1. Scheme and photos of PU-PCM panel preparation and size distribution of EnFinit® PCM 35CP.

This research was funded by the European Union - Next Generation EU (National Sustainable Mobility Centre. CN00000023. Spoke 11 - Innovative Materials & Lightweighting - Projects "ECO-FRIEND" and "CO-SMART".

OC2

A sustainable Deep Eutectic Electrolyte based on glycerol and NaCl for electrochemical energy storage devices

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Photovoltaic and wind energy systems are effective alternatives for reducing our reliance on fossil fuels. However, due to their intrinsic intermittent nature, efficient electrochemical energy storage systems (EESS) must be integrated to ensure a reliable energy supply[1]. For a truly sustainable energy future, EESS must rely on non-toxic or not hazardous materials[2].

In recent years, deep eutectic solvents (DESs)[3] have emerged alongside ionic liquids (ILs) as promising alternative electrolytes for a variety of applications. Their appeal as electrolytes lies in their low volatility, non-flammability, and wide electrochemical stability[4]. Moreover, DESs can be synthesized under mild conditions, which significantly lowers production costs[5]. Despite these advantages, a deeper understanding of the relationship between their structure and properties is essential to fully exploit their potential as environmentally friendly electrolytes.

In this work, we introduce a sustainable electrolyte composed only of NaCl and glycerol[6]. Through a comprehensive multi-technique analysis - including Raman and FIR-spectroscopy - we explore how the system's structural organization influences its transport and electrochemical behaviour. Among others, the 1:10 molar ratio mixture qualifies as a DES and demonstrates unexpected performance as electrolyte in a supercapacitor, achieving a high operating voltage of 2.6 V and retaining 96% of its capacitance after 1000 cycles. These results underscore the promise of glycerol-based DESs as viable green alternatives for electrochemical energy storage technologies.

Acknowledgements: this project has received support from Project CH4.0 under the MUR program "Dipartimento di Eccellenza 2023–2027" (CUP D13C22003520001). This study was part of the GENESIS project funded by the Ministero dell'Università e della Ricerca within the PRIN 2022 program.

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OC3

Innovations in fuel cells: towards sustainable membranes

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Polymer membrane fuel cells (PEMFCs) are now recognized as one of the most effective solutions for the decarbonization of transport and stationary power generation due to their high efficiency and near-zero greenhouse gas emissions.[1] Almost all of the membranes used are based on fluoropolymers containing perfluoroalkyl groups (PFAS), such as the famous Nafion®, which guarantees excellent proton conductivity and chemical-thermal stability.[2] However, the recent decision by the European Chemical Agency (ECHA) to introduce a blanket ban on PFAS has thrown the entire production chain into crisis, searching for PFAS-free alternatives. In this paper, we propose a critical analysis of the impact of the new regulation on the development of PEMFCs and present recent and preliminary results on the use of a non-fluorinated polymer, the sulphonated polyphenylene oxide (sPPO), as a polymer electrolyte for PEMFC; in particular, we report in detail the polymer synthesis, the membrane production, and preliminary electrochemical tests. The results show that sPPO membranes achieve promising performance and present advantages regarding production costs, simplified regulatory compliance and reduced environmental risks related to PFAS. Sulphonated hydrocarbon membranes represent a real alternative for PEMFC applications by combining good thermal and mechanical stability with ion exchange properties (Figure 1). Furthermore, to make these membranes competitive, it is also necessary to approach the development of scalable synthesis processes and the optimization of blends with organic and/or inorganic reinforcements to facilitate the industrial transition towards sustainable and regulatory-compliant technologies.

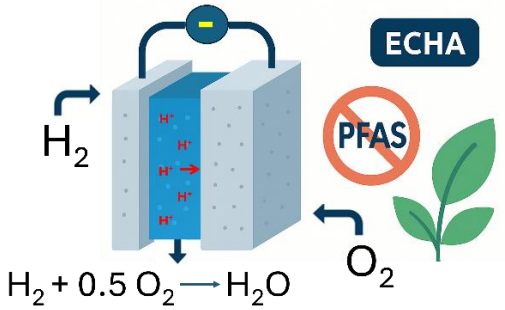

Figure 1. Polymer electrolyte membrane fuel cell (PEMFC): Hydrogen (H_2) is fed to the anode, producing protons (H^+) that pass through the membrane, while electrons flow through the external circuit to generate electricity; at the cathode, the protons combine with oxygen (O_2) to form water. The PEMFC is designed following ECHA guidelines and is free of PFAS for clean, sustainable power.

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OC4

Cation doping and transition metals exsolution in complex perovskites

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New perovskite oxide materials recently synthesized by our group and of interest for energy applications will be presented here. Sol-gel methods can be used to substitute Mn, or Mn/Ni in place of Fe at B-site of ABO_3 perovskite, giving e.g. $La_{0.6}Sr_{0.4}Fe_{0.8}Mn_{0.2}O_{3-\delta}$[1], and the complex perovskites $La_{0.6}Sr_{0.4}Fe_{0.8-x}Ni_xMn_{0.2}O_{3-\delta}$ with notable electrocatalytic properties. However, these compounds can be doped further, obtaining high-entropy perovskite oxides[2] such as $La_{0.6}Sr_{0.4}Fe_{0.8-2x}Cu_xNi_xMn_{0.2}O_{3-\delta}$. Structural and microstructural investigations of doped lanthanum strontium ferrite were carried out under oxidizing and reducing conditions. The results of X-ray diffraction, Rietveld refinement, and TEM analyses are presented. In oxidizing atmosphere, Mn substitution reduces the concentration of oxygen vacancies. Under reducing conditions, it facilitates the transition from perovskite to Ruddlesden-Popper phase (n=1), promoting the exsolution of metallic phases.

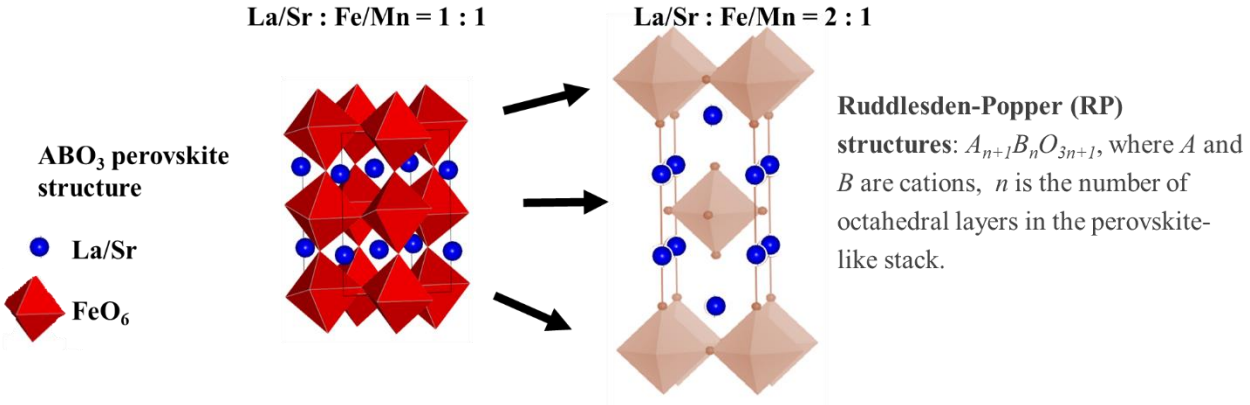

Figure 1. The transition from perovskite structure to Ruddlesen-Popper (n=1) phase in reducing environment.

Studio condotto nell'ambito del Progetto "Advanced materials for reversible solid oxide cells (AMARILLO) " CUP: F53D23002570006 - PRIN 2022 M4,C2, Investimento 1.1 - finanziato dall'Unione europea – Next Generation EU (DD MUR n. 104 del 02-02-2022)

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OC5

Synthesis and characterization of pelletized perovskites for green hydrogen production by two-step thermochemical water splitting cycle

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The European strategy for energy transition envisages a strategic role for green hydrogen as a fuel since its production process limits CO_2 emissions and uses renewable energies. Concentrating solar plants (CSP) convert heat from concentrated solar power into chemical energy which can then be used for several applications, such as thermal green hydrogen production. In this regard, two-steps thermochemical water-splitting cycles (TWSC) using perovskite powders are pioneering technologies for contributing to decarbonize the energy sector, as these processes can reduce operating temperatures, facilitating a more efficient coupling with CSP. The present work, carried out within the National framework of "Piano Operativo della Ricerca sull'Idrogeno (POR H2)", concerns with the evaluation of the redox capabilities of different types of perovskites. The aim is to optimize a two-step thermochemical cycle such as:

Thermal reduction: $$ABO_3 \rightarrow ABO_{3-\delta} + \frac{\delta}{2} O_2$$

Water shift: $$ABO_{3-\delta} + \delta H_2O \rightarrow ABO_3 + \delta H_2$$

where both reactions are ideally to be performed below 1100 °C and δ should be maximized. Several perovskites have been synthetized using different methods and they have been analyzed by thermogravimetric analysis with high pressure steam. The best perovskites in terms of hydrogen production have been selected and pelletized to increase their performance. Moreover, the synthetized perovskites and pellets have been characterized by XRD analysis and also analyzed against their morphology and granulometry by scanning electron microscopy (SEM). The most promising materials will be considered and proposed for fixed bed application.

Acknowledgments

This work was carried out within the Operational Research Plan (POR) on green hydrogen developed by ENEA and financed by the Ministry of the Environment and Energy Security - project code: I83C22001170006 -National Recovery and Resilience Plan (Mission 2. Investment 3.5) financed by the European Union as part of the Next Generation EU program.

OC6

From waste to added-value materials: sustainable carbon-based electrodes for supercapacitors and Li-ion batteries

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Coupling the use of sustainable materials with the development of efficient energy conversion and storage systems is among the highest desirable goals for a successful green transition. With this aim, our group currently focuses on the exploitation of the abundant agricultural waste rice husk (RH) for the synthesis of carbon-based materials for energy storage devices (Figure 1).
In detail, starting from RH we obtained carbon aerogels (CAs) through a synthetic process including a two-step pre-treatment removing lignin, hemicellulose, and silica, followed by gelation, drying, and carbonization. Subsequently, a single solventless, ball milling step allowed to get graphene quantum dots (GQDs). Both CAs and GQDs have been fully characterized from morphological and structural point of view through a broad variety of techniques and then tested as electrode materials in lithium-ion batteries and supercapacitors.
Cyclic voltammetry and galvanostatic cycling tests demonstrate that the obtained GQDs are able to (i) intercalate ions and (ii) accumulate charges over the surface with a purely capacitive behaviour. However, their performances quickly fade probably because of a poor contact with the rest of the electrode mixture and the current collector, which can be in principle overcome with a different formulation.[1] On the other hand, CAs display exceptional stability, with a capacitance retention up to 81.2 % after 10,000 cycles.[2]

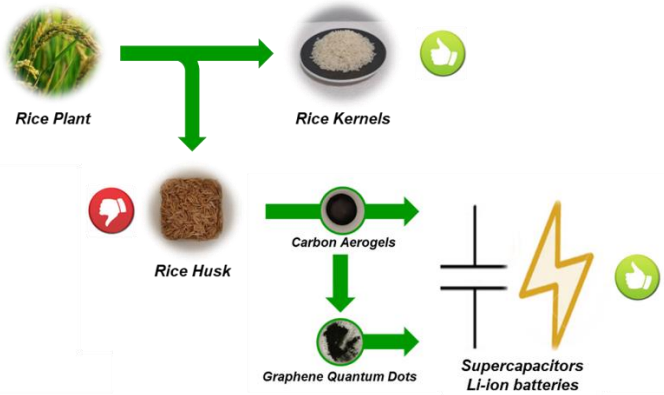

Figure 1. Overview of the work: synthesis of CAs and GQDs from rice husk for energy storage devices

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OC7

Interplay Between Synthetic Parameters, Physicochemical Properties and PEMFC performance for $PtNi_x$ "*Core-Shell*" Carbon Nitride Electrocatalysts for the Oxygen Reduction Reaction

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The sluggish kinetics of the oxygen reduction reaction (ORR) represents one of the main bottlenecks in the operation of proton exchange membrane fuel cells (PEMFCs). This technology is highly promising for large-scale adoption, aiding the transition away from fossil fuels [1]. The most effective electrocatalysts (ECs) for the ORR in acidic media are based on platinum-group metals (PGMs), but their scarcity raises concerns over supply limitations in view of widespread PEMFC deployment. Therefore, a key research focus is the development of efficient and durable ORR ECs that can reduce the amount of PGMs required in PEMFC cathodes [2].

This study introduces a novel class of ORR ECs, featuring a carbon-based support *"core"* coated with a carbon nitride (CN) *"shell."* The C and N ligands on the *"shell"* form *"coordination nests"* stabilizing $PtNi_x$ nanostructures, which bear the ORR active sites. These ECs are synthesized by tightly integrating the carbon support with a macromolecular system where Pt and Ni atoms are bridged by cyano groups. The resulting precursor undergoes multi-step pyrolysis, during which: (i) the CN *"shell"* forms on the *"core"*, and (ii) $PtNi_x$ species ($x \approx 2$-4) nucleate on the CN *"shell"*. A final chemical/electrochemical treatment enables selective etching of excess Ni used as a *"co-catalyst"*.

The study explores the relationship between: (i) synthesis parameters, with emphasis on binder type, pyrolysis and electrochemical activation; (ii) physicochemical properties, especially chemical makeup, structure and morphology; and (iii) electrochemical behavior. The latter is assessed both: (i) *"ex-situ"*, using cyclic voltammetry with the rotating ring-disk electrode method (CV-TF-RRDE) to probe ORR kinetics and mechanism; and (ii) *"in-situ"*, by assembling membrane-electrode assemblies (MEAs) and testing them under real PEMFC operating conditions.

Acknowledgements

This work has been supported under: (a) the National Recovery and Resilience Plan (NRRP), funded by the European Union - NextGenerationEU [Award Number: CNMS named MOST, Concession Decree No. 1033 of June 17, 2022, adopted by the Italian Ministry of University and Research, Spoke 14 "Hydrogen and New Fuels"]; and (b) the project PERMANENT financed in the framework of the Italian PNRR, M2C2, Investment Line 3.5.

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OC8

Nitrogen species electroreduction into ammonia: industrial chemistry frontiers in the SuN$_2$rise project

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Electrochemical nitrogen (species) reduction reaction (E-NRR) represents the most promising process for renewable-driven and delocalized NH_3 and fertilizers production. Finding a complementary pathway to the Haber-Bosh (HB) process allows a step forward to the net-zero carbon emission policy, essential to contrast the climate crisis. Indeed, HB causes a global average of 2.86 tons of CO_2 emitted per ton of NH_3.
The current scenario is mainly focused on the electroreduction of molecular nitrogen or, more simply, of nitrate ions present in an ad hoc prepared solution or in a sample of polluted water. The process can be conducted in different types of reactors and the effect of fluid dynamics is significant. Among other salient aspects, the choice of the electrolyte, the presence of mediators (typically cations of the first group), and the selection of an electrocatalyst emerge.
In the ERC-StG SuN$_2$rise project we are exploring both Li-mediated processes for nitrogen electroreduction and low-impact processes for nitrate electroreduction. Efficiencies above 30%, with high reproducibility, have been achieved and will be the subject of this contribution.[1,2]

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OC9

Spinel-type High-Entropy Oxides Electrocatalyst for Anion Exchange Membrane Water Electrolyzers

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Electrochemical water-splitting, essential for green hydrogen production, involves the hydrogen evolution reaction (HER) at the cathode and the oxygen evolution reaction (OER) at the anode. However, the sluggish OER kinetics limit overall reaction efficiency[1]. While PGM-based catalysts like RuO_2 and IrO_2 are effective catalysts, their scarcity, cost, and low durability drive the search for PGM-free alternatives[2]. Transition metal-based high-entropy oxides (HEOs), composed of five or more metals in a single lattice, show promise as tunable and durable OER catalysts[3]. In this work, spinel-type HEOs, composed of Ni, Co, Mn, Fe, and Mg, were developed through tailored synthesis parameters and composition. Structural characterization, including Rietveld refinement and HRTEM-EDX, confirmed the formation of single-phase, and highly crystalline nanoparticles, with uniform element distribution. Morphology and surface composition were explored by SEM and XPS. After tailoring the metal stoichiometry, electrochemical tests revealed enhanced OER activity (E_{J10}= 1.62 V *vs*. RHE), driven by surface reconstruction and the formation of active (oxy)hydroxide species under operating conditions. Integration of the optimized HEO into a membrane electrode assembly demonstrated excellent performance in anion exchange membrane water electrolyzer single cell tests, achieving high current densities (J=1.57 Acm^{-2} at 1.8 V) and outperforming many leading PGM-free OER catalysts.

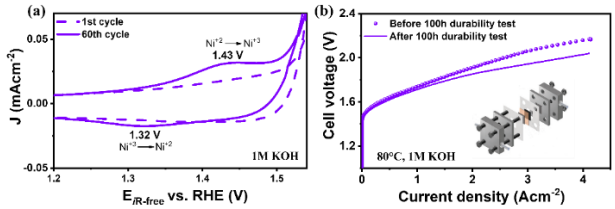

Figure 1. Optimized HEO's OER performance in (a) half-cell test and in (b) AEMWE single-cell test, showing in both cases an activation process under operating conditions.

Acknowledgments

This work was partly supported by the Italian Ministry of Foreign Affairs and International Cooperation, grant number CN23GR06. This work also received funding from the European Union – NextGenerationEU – under the public notice of the Italian Ministry of University and Research (MUR) no. 3138 of 16/12/2021 and subsequent correction no. 3175 of 18/12/2021, Project No. CN00000023 MOST – Sustainable Mobility Center.

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OC10

Carbon-based photocatalysts for H 2 production by photo-thermal catalysis

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Hydrogen is a versatile energy carrier in the context of decarbonisation and the energy transition towards renewable sources. Photoreforming of aqueous solutions containing organic compounds is a process that combines the generation of hydrogen from water and the oxidation of an organic substrate in a single process occurring under ambient conditions[1]. In the present research, various formulations of composite photocatalysts Nb_2O_5-carbon material were prepared (Figure 1) and tested for the non-selective photo(thermo)reforming of glycerol to produce hydrogen. Reduced graphene oxide (rGO) and expanded graphene oxide (expGO) were chosen for this study owing to their photothermal ability when exposed to sunlight (based on an initial screening with an IR camera).

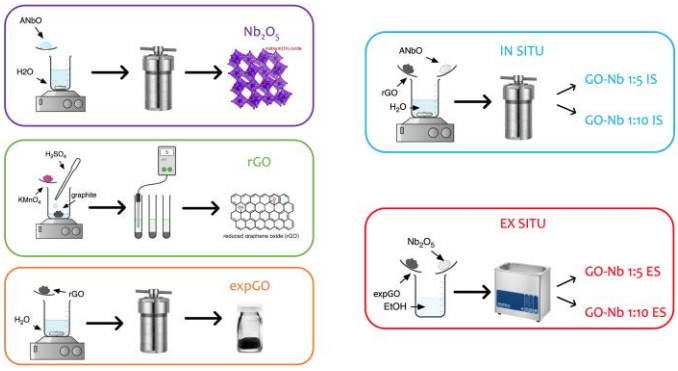

Figure 1. Schematics of the approaches used for the synthesis of the photocatalyst.

The activity of the Nb_2O_5-carbon photocatalysts was determined as a function of the amount of H_2 produced under UV irradiation, and the improvement in activity due to the thermal effect was studied. The catalysts were tested with and without platinum as co-catalyst. The assays showed that the photocatalysts containing higher amounts of carbonaceous material were more active, especially when the temperature was increased to 100 °C (thermal-dominated systems[2]). Furthermore, the composites synthesized by sonication (ex situ ES approach) proved to be more active. The most effective photocatalyst was GO-Nb 1:5 ES, which delivers hydrogen through photo(thermo)catalysis at 12 mmol g^{-1} h^{-1} or 51 mmol g^{-1} h^{-1} and 6 or 10 mmol g^{-1} h^{-1} by photocatalysis without or with 1 wt.% Pt, respectively.

Acknowledgements

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OC11

Eco-Friendly Graphene-Like Materials from Coffee Silverskin as Photocatalyst for Solar-Driven H_2 Production

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Production of hydrogen through water splitting using efficient and environment-friendly photocatalysts has been receiving wide interest in the research field searching for sustainable energy solutions is crucial to accessing this technology considering their economic and environmental benefits. An eco-friendly process to prepare graphene oxide (SGO) like derived from coffee silver skin precursors and its application in promoting the photocatalytic water splitting has been summarized in Figure 1.

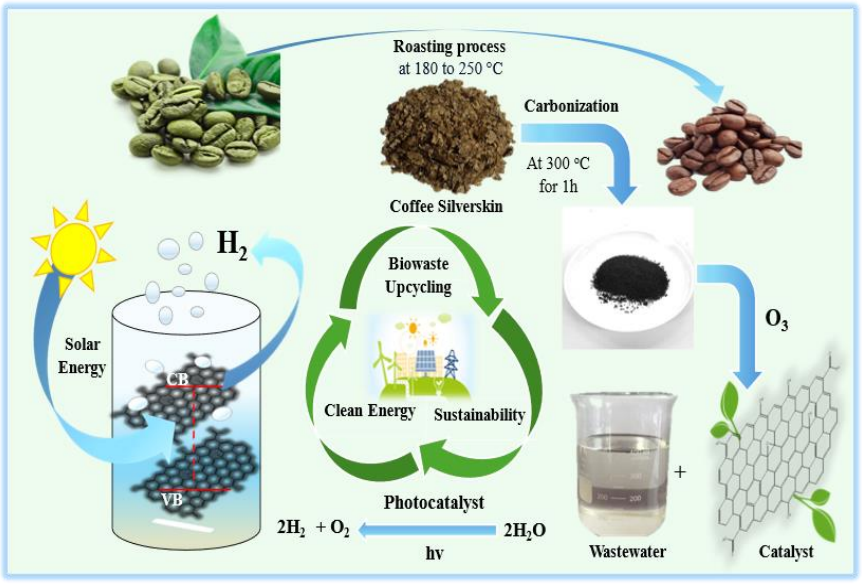

Figure 1. SGO production process and its application for solar driven promoted H_2 production

Further details about the preparative steps for the preparation of SGO and its precursors as well as their morphological, chemical and physical characterizations (SEM, XRD, UV-vis, FT-IR and Raman spectroscopies) will be presented and discussed. Furthermore, SGO has garnered significant interest because of its photocatalytic activity in promoting the water splitting from different types of water matrices. In particular, the photocatalytic water splitting under direct sunlight irradiation produced 2455ppm (24.34 $mmolg^{-1}h^{-1}$) and 2771ppm (27.50 $mmolg^{-1}h^{-1}$) of H_2, respectively, in ultrapure water and secondary treated wastewater. Mechanism of reaction, durability of SGO catalyst and scalability of the process under specific experimental conditions have been evaluated. In summary, this study presents a novel approach to waste management through sustainable hydrogen production, highlighting the potential of biomass-derived carbon catalysts for green energy solutions.

OC12

A New Life for Tionite Industrial Waste as Photocatalytic Active Material

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One of the most pressing challenges of current materials research is valorising industrial waste consisting of reusing, recycling or composting waste materials and converting them into more useful products or other sources of energy. Titanium dioxide (TiO_2) is a highly versatile semiconductor with photocatalytic properties, widely used in coatings, plastics, papers, printing inks, pharmaceuticals, foodstuffs, and cosmetics, with the worldwide production of millions of tons each year. The sludge generated as a waste of the titanium dioxide manufacturing process has become an urgent issue because it is usually disposed in landfills and contains metallic oxide-bearing impurities, potentially dangerous for the environment.

This scenario prompted us to investigate the Ti-rich waste material, obtained by neutralisation of TiO_2 industrial production residuals, known as tionite, with the aim to obtain a photocatalytic active material through a suitable TiO_2 regeneration strategy. Step by step, we designed specific chemical treatments to improve the catalytic performance and provide a new life for the tionite waste. The treatments were established to remove impurities and improve the TiO_2 accessibility in a simple way, by using acid and basic aqueous solutions. Each single purification step was monitored by a careful multi-technique characterization, based on chemical, structural and morphological analysis. As part of this recovery strategy, recovered tionite materials were tested for different photocatalytic applications, in particular for the partial oxidation of ferulic acid to vanillin, a relevant sustainable green reaction, being vanillin an industrially relevant high added value compound and ferulic acid an abundant component of lignin present in industrial waste.

All the tionite catalysts have shown significant efficiency in terms of vanillin selectivity respect to the benchmark TiO_2 P25. The present study shows, as a proof of concept, that it is possible to take advantage of the peculiar features of a waste material and to propose regeneration strategies enabling applications in specific and tailored field

Acknowledgements

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OC13

Advancing sustainable packaging: production and recycling of novel furan-based polyester films

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The 2,5-Furandicarboxylic acid (FDCA), derived from renewable natural sources, is a promising building block for producing bio-based polyesters. Within the framework of the FURIOUS project, innovative furan-based thermoplastic polyesters have been successfully developed, targeting demanding, high-value applications in the packaging and automotive sectors. This study initially evaluated the feasibility of producing films from three novel furan-based polyesters synthesised within the project. These polyesters include one homopolymer, the semicrystalline poly(butylene-2,5-furandicarboxylate) (PBF), and two random amorphous copolymers: the poly(trimethylene-2,5-furandicarboxylate-*r*-2-butyl-2-ethyl-propylene-2,5-furandicarboxylate), P(TF_{85}-*r*-BEF_{15}), and the poly(trimethylene-2,5-furandicarboxylate-*r*-trimethylene-azelate), P(TF_{80}-*r*-TAz_{20}). Subsequently, preliminary studies were conducted to investigate the possibility of mechanically recycling the obtained films. All the materials underwent comprehensive characterisation using Fourier-Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Gel Permeation Chromatography (GPC), and mechanical testing, before and after mechanical recycling. All tested polymers exhibited excellent processability via film casting. However, the semicrystalline PBF proved challenging for blown-film extrusion, whereas both amorphous copolymers were successfully processed using this method. Moreover, the mechanical recycling studies demonstrated notable material stability, with minimal degradation in polymer properties after recycling.

Acknowledgements

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OC14

AI-driven design and optimization of flame retardant epoxy nanocomposites and textiles

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The development and optimization of flame retardant (FR) materials usually require time-consuming, expensive, and destructive measurements. However, in most cases the material available for flammability and fire performance testing is limited. In this view, machine learning (ML) tools can be very useful to predict the fire parameters of polymeric materials or textiles, starting from an input dataset of properties (e.g., thermal or physico-chemical characteristics accessible in the literature) belonging to similar systems. Herein, we demonstrate the suitability of ML algorithms for the design and development of FR hybrid epoxy nanocomposites and functional textiles. Artificial neural network-based systems built on fully connected feed-forward artificial neural networks can successfully be employed for the prediction of heat release capacity of FR hybrid $Mg(OH)_2$-epoxy nanocomposites. Electrospun fibres can be used to coat hemp blankets and obtain a fire shielding multilayer material. Despite the incomplete starting datasets, ML with generative AI (ChatGPT) approaches allow to exploit made-on-purpose decision trees and artificial neural networks to finely predict the time to ignition and the peak of heat release rate of the multilayer material.

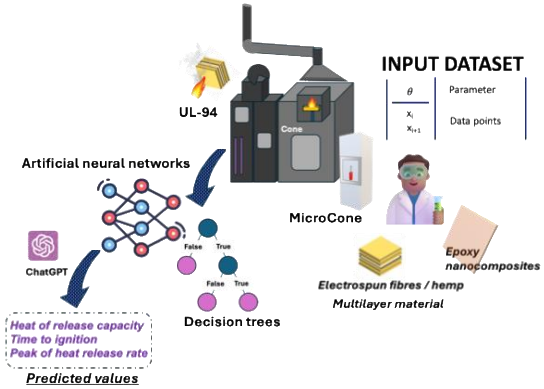

Figure 1. Decision trees and artificial neural networks as predictive methods in flame retardancy.

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OC15

Mechanocatalytic Upcycling of Polyethylene Promoted by the Ru/Al_2O_3 Catalyst

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Polyethylene (PE) is one of the most widely produced and discarded plastics globally, yet current recycling technologies fall short of addressing its environmental burden. There is an urgent need for alternative recycling strategies that are both energy-efficient and capable of transforming plastic waste into valuable products.[1] This study presents preliminary findings on the mechanocatalytic upcycling of polyethylene into liquid hydrocarbons using 2-propanol as a hydrogen donor. Conventional thermal and catalytic approaches such as pyrolysis and hydrogenolysis have shown potential but typically require high temperatures and pressures, limiting their sustainability and scalability. In contrast, mechanocatalysis—where mechanical energy drives chemical transformations—offers a promising, scalable solution that operates under ambient conditions.[2,3] With this approach, polyethylene was subjected to vibratory ball milling in the presence of a ruthenium-on-alumina (Ru/Al_2O_3) catalyst, without external hydrogen. After just six hours of milling at room temperature, over 40% conversion was achieved, with more than 60% of the products falling within the C_5–C_{20} hydrocarbon range—ideal for liquid fuels and chemicals. These results indicate that Ru/Al_2O_3 not only facilitates effective C–C bond cleavage but also enhances selectivity toward valuable liquid fractions.[4] Overall, this work underscores the potential of mechanocatalysis as a sustainable and efficient platform for plastic upcycling. By integrating mechanical activation with heterogeneous catalysis, it is possible to depolymerize polyethylene under mild conditions, offering a promising pathway toward chemical circularity for polyolefin waste.

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OC16

Synthesis of fully biobased aliphatic/aromatic polymer systems for flexible food and biomedical packaging: the role of chemical structure, composition and architecture

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Poly(butylene succinate) is a biobased semicrystalline aliphatic polyester very promising for a wide range of employments, since it is fully compostable and characterized by excellent processability, impact resistance and toughness, but too stiff for some application[1]. Poly(pentamethylene 2,5-furanoate) is a relatively new biobased aromatic polyester, rubbery and flexible at room temperature and with excellent barrier properties[2]. Aiming to explore the evolution of solid-state characteristics and suitability in flexible food and biomedical packaging, the two parent homopolymers have been combined, both physically and chemically, varying composition and molecular architecture. After molecular analysis, the polymers were processed in form of films and subjected to thermal, structural, mechanical and gas barrier characterization. Additionally, gamma irradiation was applied to the neat homopolymers and the equiponderal blend to investigate the effects on the materials thermal and physico-mechanical properties. All the polymers show very high thermal stability and modulated melting temperatures, enhanced flexibility and elongation, already in the physical blends, together with surprising elastic response in the copolymers. The presence of furan moieties reduced gas permeability. Lastly, the results obtained highlight the possibility of using gamma irradiation as sterilization method without compromising the materials performance and resistance. The study shows how it is possible to obtain different materials by playing with chemical structure, composition and repeating unit distribution along the macromolecules.

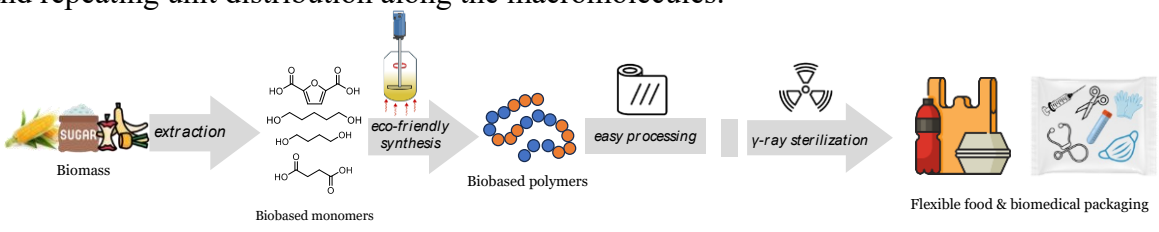

Figure 1. Scheme of the study.

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OC17

Innovative Nonwoven Antimicrobial Fabrics from Discarded Fishing Nets

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The automotive company regularly needs innovative and sustainable solutions to enhance the hygiene and comfort of passengers. These goals are strategic due to the growing demand for antimicrobial solutions for vehicle interiors, especially in shared mobility and public transport. One of the major concerns, is to prevent the spread of harmful microorganisms by direct contact with contaminated objects or surfaces (e.g. steering wheels, handles, door panels, gearshift…). In this context and according to the decarbonization need, a sustainable material was prepared employing recycled polyamide 6 (rPA6)[1] derived from discarded fishing nets combined with proper functionalized nanostructures (Layered Double Hydroxides, LDHs) characterized by antimicrobial properties. Electrospinning was used to produce antimicrobial and anisotropic nonwoven fabrics (Fig. 1) through the application of an intense electrostatic field to a polymer solution across a finite distance[2].

This research was financed by the PNRR MOST project (National Center for Sustainable Mobility) and carried out within the AMATEVI and CO-SMART calls.

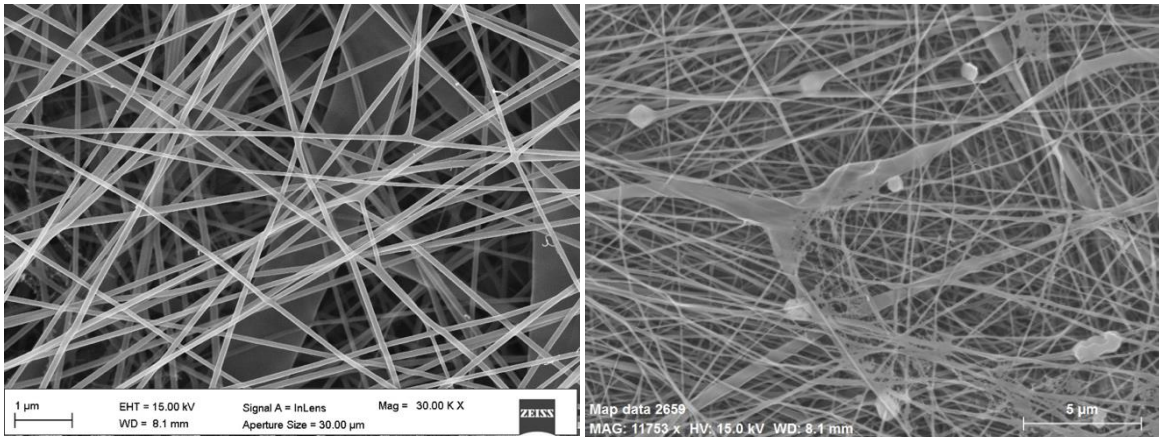

Figure 1. SEM images of the Nonwoven Antimicrobial Fabrics without LDHs (left) and with LDHs (right).

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OC18

From Starch to Advanced Biodegradable Films with Tunable Properties

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Biodegradable bioplastics were introduced as a sustainable alternative to conventional petroleum-derived materials that degrade into microplastics if not properly recycled, contaminating land and aquatic ecosystems. Consequently, the demand for bioplastics in various applications is inevitably increasing. Biodegradable plastics can be produced from biopolymers such as starch, which offers multiple advantages, including wide availability, low cost, and good film-forming properties[1]. However, the use of pure starch films is limited due to their high hydrophilicity and inadequate mechanical properties. To overcome these limitations, plasticizers can be incorporated. Additionally, starch can be chemically modified and blended with other biopolymers[2]. As a result, the starch films produced have good flexibility and acceptable strength and may offer other valuable properties. When mono- and dicationic ionic liquids are used as plasticizers[3,4], conductive films with antibacterial properties are produced. By including reduced amounts of polydopamine in the starch polymer matrix, active films with UV barrier and antioxidant properties can also be obtained. Conductive films can be used as solid electrolytes or have applications in flexible electronics, while films with polydopamine emerge as promising packaging materials (Figure 1).

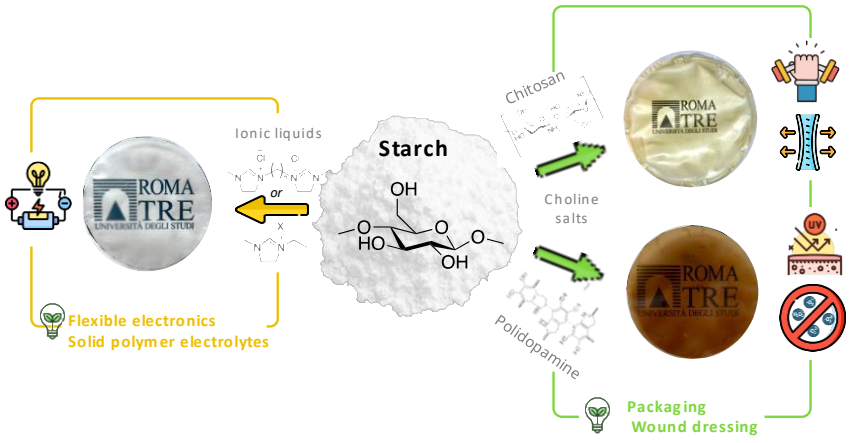

Figure 1. Composition and photograph of prepared starch-based films

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OC19

Renewable rubber composites towards a sustainable future

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As resources become more limited and global population continues to rise, there's a growing need for components that are easy to recycle and reuse — a key element for building a more sustainable economy[1]. Rubber, being used in various sectors[2] from tyres, automotive to clothes, coatings and flexible sensors, represents a great candidate for innovation in this area.

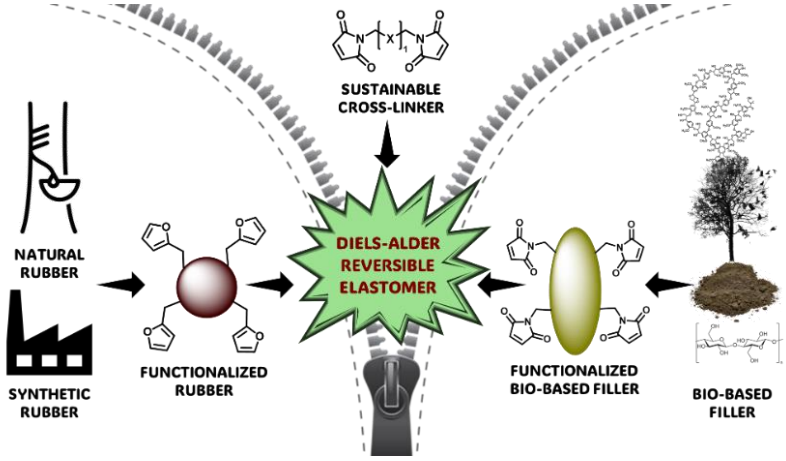

Figure 1. Reversible crosslinking of elastomers to structural filler.

One of the main challenges in rubber materials is their limited recyclability[3]. This study aims to enhance the reusability of rubber products by improving their recycling properties, following green chemistry principles. Our approach involves the modification of liquid rubber with bio-sourced compounds that introduce specific groups, such as cellulose-derivative furans, able to form reversible Diels–Alder type[4,5] bonds with a modified filler, a reinforcing material that also comes from renewable sources, like lignin or nanocellulose. Once the temperature for the retro-Diels–Alder reaction is reached, the rubber and the filler can be separated again, making both easier to recycle or reuse. This strategy opens new possibilities for developing flexible, sustainable, and recyclable rubber-based materials.

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OC20

Selfextinguishing epoxy nanocomposites containing coffee biochar and other additives

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To counter the depletion of phosphorus and reduce the flammability of epoxy-based composites, the scientific community is fostering the reuse of biowastes as flame retardant additives. Among the biowastes released by the food industry, spent coffee grounds (SCGs) is one of the most abundant (~6 million tons/year). The pyrolysis of SCGs gives a biochar showing high thermal stability and amphiphilic character[1]. Herein, the epoxy matrix was modified by a coupling agent to obtain polar nano-environments and thus a better dispersion of the coffee biochar through the silanized resin[2]. Sol-gel chemistry was applied to synthesize a new ternary Si-Ti-Mg oxide by a sustainable approach. The ternary oxide was employed together with coffee biochar and ammonium polyphosphate to manufacture no dripping selfextinguishing (UL94-V0) nanocomposites, even with a very low content of phosphorus (1 wt.%). Interestingly, the chemical composition of the ternary oxide also guaranteed a decrease (~11%) in the smoke production of the final products.

Figure 1. Selfextinguishing epoxy nanocomposites containing coffee biochar, APP and ternary oxide.

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OC21

Agro-food wastes as source of bioactive phytochemicals: extraction, characterization and their nano-encapsulation for cosmeceutical applications.

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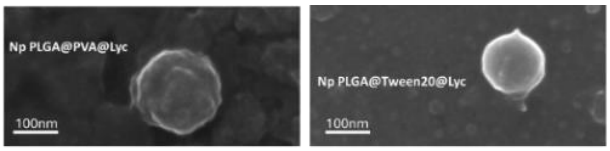
Plants matrices and agro-industrial wastes are rich in compounds with dying, antioxidant, antimicrobial, chemopreventive, neuroprotective and anti-inflammatory activities. They have attracted the interest not only of the pharmaceutical sector but also of the growing nutraceutical and cosmetic industries [1,2]. The recovery of tomato and walnut husk wastes have been applied to produce extracts rich in interesting biomolecules such as lycopene, juglone and polyphenols [3, 4]. These extracts have been characterized by UV-vis, FT-IR, and UPLC-Q-Orbitrap HRMS and HPLC, to study their composition, stability and ROS scavenging capacity. PLGA nanoparticles were investigated to improve the bioavailability and stability of extracted phytochemicals [5]. The synthesis protocol has been studied to encapsulate both polar and apolar compounds, and to tune size distribution and colloidal stability using two different surfactants. Human keratinocytes and melanocytes 2D and 3D cultures were treated to investigate nano-encapsulated phytochemicals internalization, cytotoxicity and antioxidant activity to support the cosmeceutical application.



Sample	ζ-potential mV	PdI	Z-average nm
PLGA@PVA@Lyc	-28,6±1,15	0,4±0,021	394±25,2
PLGA@Tween20@Lyc	-43,6±1,47	0,4±0,016	178±8

Figure 1. SEM images and DLS parameters of Lycopene-loaded PLGA nanoparticles using two different surfactants, PVA and Tween 20. Tween 20 produced a more negative potential and smaller particles than PVA, as can be seen in the microscopy images.

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OC22

Polyamide 6 recycled fishing nets modified with biochar fillers and reclaimed carbon fibers: an effort toward sustainability and circularity

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Purpose. The accumulation of plastics, including 640000 tons annually from discarded fishing gear (20 % of marine plastics), poses a severe threat to marine ecosystems. Circular economy strategies aim to address this issue by promoting the reuse and recycling of marine plastic waste.
Method. In this context, this study focuses on developing sustainable composites using recycled polyamide 6 (rPA6) from fishing nets, reinforced with biochar and recycled carbon fibers (rCF).
Results & Conclusions. In the first polymer composite, lignocellulosic biochar (5-15 wt.%) enhanced rPA6's mechanical properties and moisture resistance. The elastic modulus increased from 2.6 to 4.5 GPa, while water uptake decreased from 3.6 to 1.8 %. Additionally, rice husk-derived biochar, rich in silica, acted as a flame retardant by improving combustion resistance without significantly altering water uptake or mechanical behaviour [1]. The second polymer composite incorporated rCF produced through an innovative two-step thermo-oxidative process. This method enhanced rCF's compatibility with rPA6 by increasing surface activation (O/C weight ratio of 0.054 vs. 0.021 for virgin fibers) while preserving fiber dimensions (7-8 µm), mechanical strength (282 ± 35 vs. 293 ± 20 GPa), and surface smoothness (Figure 1). At 15 wt.% loading, rCF/rPA6 composites achieved a tensile modulus of 13.1 GPa and impact toughness of 28.4 kJ/m², compared to rPA6 alone (3.2 GPa and 11.8 kJ/m²) [2]. A Life Cycle Assessment (LCA) compared scenarios involving virgin materials and recycled components. The fully recycled scenario achieved a reduction of approximately 5.74×10^3 kg of CO_2 equivalents, demonstrating significant emission savings despite slight increases associated with wastewater treatment.

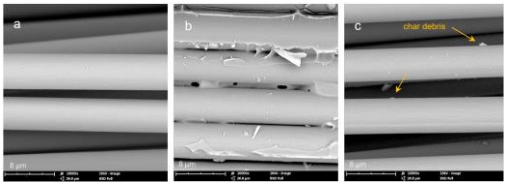

Figure 1. SEM images of vCF (**a**), rCF after pyrolysis (**b**) and rCF after pyrolysis and gasification (**c**).

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OC23

A Photochemical pathway towards green functional nanostructures

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The development of green methods for nanomaterials is crucial, for environmental sustainability, health and safety, energy efficiency, cost-effectiveness, biocompatibility and regulatory compliance. Noble metal nanomaterials are important for the development of sensors, catalysts, etc but their limited availability and high cost severely restricts their applications.[1] It is, therefore, stringent to find viable alternatives that, in turn, maintain excellent performances. Copper nanoparticles show physico-chemical properties well suited to substitute for gold or silver analogues, even though, these nanoparticles may be rather unstable towards oxidation.[2]
In this work, we report on a green photochemical synthesis in aqueous solution and extensive characterization of Cu nanocluster that show excellent thermal, optical and electrical properties with temporal stability up to one year.[3] Also, some preliminary sensing properties have been studied.

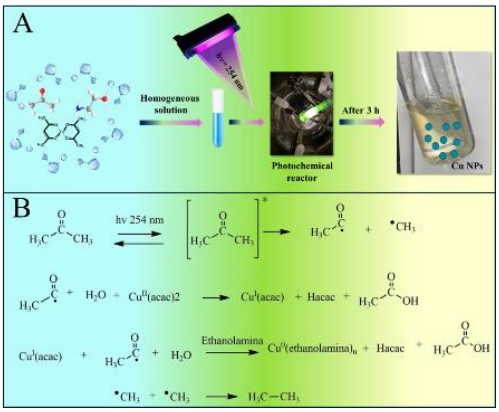

Figure 1. (a)Photochemical procedure for the synthesis of Cu NCs; (b) possible mechanism of Cu NCs formation.

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OC24

Copper recovered from waste printed circuit boards as catalytic drive for methanol dehydration to dimethyl ether

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Nowadays the short lifecycle of electronic devices combined with the unrelenting advancement in modern technology has made the generation of electronic waste (e-waste) a major environmental problem.[1] One of the most diffused component of electronic equipment are printed circuits boards (PCBs) which usually contains precious metals like Cu, Ni, Fe, Au, some of which are also present in the EU Critical Raw Material list.[2]

Copper is widely used in catalysis, for example, as tuner of aluminosilicates catalytic properties. These materials, especially zeolites, are commonly used as acid catalysts for methanol-to-olefins (MTO) reaction thanks to their strong acid sites, but the reaction course could be also driven to methanol-to-dimethyl ether (MTD) decreasing the strength of the acid sites. The first step of this work was to test copper as tuner of the acidic properties of a commercial zeolite (ZSM-5) employed in MTO/MTD reactions. Especially, MTD reaction is helpful for the ecological transition because it makes possible to obtain dimethyl ether (DME), which can be used as a green fuel, alternative to diesel, owing to its high cetane number and low NO_x emissions; from a feedstock (methanol) obtainable from biomass or syngas.[3]

The obtained results show that copper-loaded ZSM-5 allow to obtain DME as main component of the product mixture, while employing zeolite ZSM-5 as catalyst, no DME was produced, only olefins. The second step of this work was dedicated to test a novel material as catalyst, which was prepared using mesoporous silica MCM-41 functionalised with organic ligands to selectively recover copper from lixiviate of PCBs powder. Indeed, for this study, PCBs from old and disposed computers were collected, crushed and lixiviate. The as-prepared materials were characterized by X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray Photoelectron Spectroscopy (XPS), N_2 adsorption-desorption analysis and Temperature Programmed Desorption (TPD).

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OC25

Electrospun fibers from biowaste for the selective and reductive adsorption of precious metals from e-waste

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The use of electrical and electronic equipment has increased enormously because of technological progress, leading to the generation of significant amounts of waste electrical and electronic equipment (WEEE) containing hazardous elements such as lead, mercury and flame retardants that release dioxins when incinerated, posing serious environmental and health risks [1]. However, WEEE is rich in base metals (Cu, Fe, Ni and Zn) but also in precious metals (Au, Pt and Pd). Just one tonne of e-waste, especially printed circuit boards (PCBs), can contain about 0.35 kg of Au, 0.21 kg of Pd, and 130 kg of Cu, far exceeding natural ore concentrations and driving urban mining. WEEE is an important source of precious metals whose sustainable recovery is essential to meet the demand for metal resources. This study explores a sustainable approach for the adsorption of precious metals from model leachate solutions, employing biopolymers such as lignin (L) as functional components in biocompatible polymeric matrices as binder (e.g., polyvinylpyrrolidone, PVP) to develop electrospun fibers as precious metal ion biosorbents. SEM microscopy analysis suggested homogeneous and smooth fibers without significant defects, while swelling tests proved the great capacity of such mats to adsorb large amounts of water without breaking. The resulting materials were subjected to a physicochemical investigation and adsorption tests for the recovery of metals (i.e. Au, Pd, Cu) under optimal pH conditions and by varying the selected metal ion concentrations in solutions simulating real leachates. Preliminary adsorption results suggested very good reductive adsorption capacities of Au^{3+} ions to Au^0 (Figure 1), and no significant interaction with Cu^{2+} ions, thus suggesting high selectivity towards precious metal ions. These capabilities can be related to the large amount of carboxylic/ phenolic groups within the L chemical structure [2], which are the main moieties responsible for the chelation and reduction of gold ions, respectively.

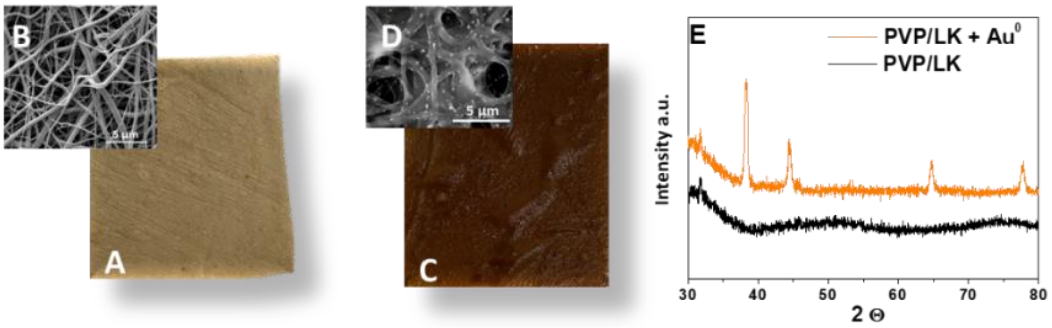

Figure 1. A,B) Photo and SEM images of electrospun fibers before Au^{3+} adsorption; C,D) after adsorption; E) XRD spectra of fibers before (black pattern) and after adsorption (orange pattern).

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OC26

Silica derived from hexafluorosilicic acid waste valorization for CO_2 capture and re-use

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In recent years, the recovery of silica from waste or end-of-life products has become a challenging issue as an effective waste management strategy and a sustainable circular economy initiative. Hexafluorosilicaic acid (H_2SiF_6, FSA) is a hazardous and corrosive industrial waste from the fluoride and phosphate industries, with an estimated annual production of nearly 2 million tons. Despite its limited direct applications, FSA is typically neutralized and disposed at sea. As such, developing efficient methods to recover and valorise FSA offers both environmental and economic benefits.[1] In this context, the aim of the present work relies in the up-conversion of FSA into SiO_2 with controlled morphological and surface properties, which can be functionalized and applied as functional supports for CO_2 capture and catalytic conversion.

SiO_2 material were synthetized with various porosity: i) macroporous SiO_2 prepared using polyethylene glycole-based templates featured surface area of 110 m^2/g and an average pore diameter of 346 nm; ii) mesoporous SiO_2 was obtained using Pluronic P123 or cetyltrimethylammonium bromide (CTAB) surfactants, achieving surface areas of 119 and 659 m^2/g, with average pore sizes of 18.9 and 2.81 nm, respectively. FT-IR spectroscopy confirmed the presence of various silanol groups across all samples, revealing a combination of free, geminal, and hydrogen-bonded hydroxyl groups with surface characteristics modulated by porosity and residual fluoride species. In addition, weak protonic acidity was determined by FT-IR spectroscopy of in situ pivalonitrile adsorption-desorption method. To enhance CO_2 adsorption capacity, SiO_2 materials were successfully functionalized with amine groups through silane grafting or polyethyleneimine impregnation, as demonstrated by TGA and IR analysis.

Preliminary CO_2 adsorption tests are ongoing; however, the combination of high surface area, tunable porosity, and weak acidity suggest strong potential for these materials as sustainable supports for advanced catalytic applications. Indeed, once modified with suitable promoters (metals, basic oxides), these materials will be tested for CO_2 methanation.

Acknowledgements
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OC27

Comparing environmental metrics for noble metal recovery from e-waste: a dual assessment using the ESCAPE approach and the LCA methodology

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The development of environmentally safer techniques for recovering critical raw materials from waste sources requires the application of simplified yet robust sustainability assessment tools early in the process design phase. The ESCAPE approach (Evaluation of Sustainability of material substitution using CArbon footPrint by a simplifiEd approach) was developed to provide a simplified sustainability index based on carbon footprint and embodied energy, enabling a rapid comparison between recovered or substitute materials and their primary counterparts[1]. In this study, both the ESCAPE approach and the Life Cycle Assessment (LCA) methodology were applied to a hydrometallurgical method for recovering copper, silver, and gold from waste Random Access Memories. The process relies on benign, selective, and recyclable reagents under mild conditions, aiming to develop a more sustainable alternative to conventional recovery methods[2]. This study aimed to assess the consistency between ESCAPE and LCA in identifying key environmental impact contributions. Additionally, results were used to preliminarily benchmark the sustainability of the recovery process against conventional primary extraction methods for noble metals, using available industrial data. The ESCAPE approach effectively identified a significant portion of the system's potential environmental impacts, closely aligning with LCA findings. However, differences were observed in certain impact categories and under economic allocation scenarios in LCA. Based on these findings, we propose a dual-assessment framework integrating ESCAPE and LCA, to promote the adoption of sustainable practices particularly during the development phase.

This work was carried out in the framework of the "SMART PCBs - Sustainable Materials Recycling Technology for Printed Circuit Boards" project co-funded by the Italian Ministry of Environment and Energy Security (MASE), Call RAEE 2020, CUP F57G20000050001.

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OC28

Innovative Acid and Alkaline Red Mud-Metakaolin Based Geopolymers: Characterization and Applications in Construction and Environmental Remediation

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Red mud (RM), a by-product of the Bayer process produced in enormous quantities worldwide, poses serious environmental challenges due to its high alkalinity and metal content.[1] In the context of sustainable material development and circular economy, this study explores the valorisation of RM by synthesising innovative geopolymers in combination with metakaolin (MK). Two distinct activation strategies were employed: conventional alkaline activation using sodium silicate and a novel acid activation approach based on phosphoric acid.[2]

The resulting geopolymeric matrices were extensively characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDS), Thermogravimetric analysis (TGA) and Fourier-transform infrared spectroscopy (FT-IR).

Compressive strength tests demonstrated that the mechanical performance was suitable for construction applications, with the best achieving values above 60 MPa.[2]

Furthermore, we have investigated the ability of these materials to act as adsorbents of organic pollutants. In particular, adsorption experiments using methylene blue (MB) as a model contaminant revealed the potential for wastewater treatment. RM-based geopolymers showed enhanced adsorption capacity due to iron oxides interacting with the cationic dye through electrostatic attraction and surface complexation.[3]

This dual-purpose approach highlights the versatility of RM-based geopolymers as sustainable materials for both the construction sector and environmental remediation. The high incorporation of industrial waste (50 wt% RM) and the adoption of low-energy synthesis routes underline the alignment of this research with the principles of green chemistry and industrial symbiosis.

Figure 1. Red mud-metakaolin based geopolymers cubes.

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OC29

Valorization of biochar and aqueous phase derived from the hydrothermal liquefaction of sewage sludge

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Hydrothermal liquefaction (HTL) is a thermochemical process able to transform sludges from wastewater treatment into bio-fuels, thus recovering energy from waste matter. Our research group is investigating HTL as an effective route to produce bio-oil, as target product, from municipal sewage sludge.[1] The valorization of solid, aqueous, and gaseous by-products obtained through this process (Figure 1) is a key to enhancing the sustainability and circularity of HTL technology.

We propose the use of the solid residue (biochar) as a green flame-retardant additive in polymer composites. Owing to the large inorganic fraction and abundant surface functional groups, HTL biochar can improve the thermal and fire resistance of epoxy resins, providing self-extinction (i.e., V-0 rating in vertical flame spread tests) in combination with other additives.[2]

The aqueous phase resulting from HTL has a high organic content and needs to be treated before being recirculated in the system or reutilized in alternative ways. We are testing the purification of the aqueous phase through adsorption and photodegradation by means of different TiO_2-based hybrid materials,[3] aiming to reduce the concentration of organic contaminants, with particular attention to the most harmful ones (e.g., polycyclic aromatic hydrocarbons).

These activities are performed in the framework of the Programma per il Finanziamento della Ricerca di Ateneo (FRA) 2022 of the University of Naples Federico II (Project EPIC).

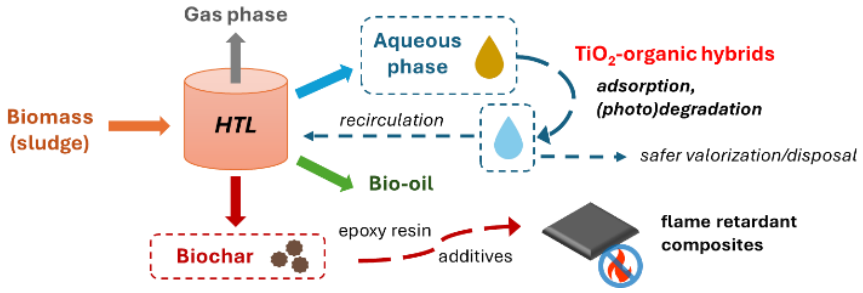

Figure 1. Scheme of HTL process and possible strategies for the reuse of its by-products.

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OC30

Cationic fluorinated polyphosphazenes for the decontamination of wastewater from anionic pollutants

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The detection of emerging pollutants in aquatic environments represents a growing concern for both environmental protection and public health[1,2,3].
In this context, polyorganophosphazenes bearing anion-exchange functionalities are introduced as effective materials for wastewater remediation. New polymers were obtained via a multi-step synthetic route, including the functionalization of polydichlorophosphazene with quaternary ammonium moieties and fluorinated groups in various molar ratios (Figure 1). These amphiphilic copolymers, fully soluble in water, display spontaneous self-assembly in water, forming large compound micelles (LCMs) or bilayer vesicles depending on their composition. The dual character of the materials, combining hydrophobic and hydrophilic domains, proved highly effective in the sequestration of anionic pollutants such as sodium diclofenac (SDF) and perfluorooctanoic acid (PFOA), which are commonly detected in wastewater.
Comprehensive structural characterization by ^{1}H, ^{19}F, and ^{31}P NMR spectroscopy, 2D HSQC NMR was performed and ATR-FTIR, while NMR-based binding studies confirmed the high affinity of these materials for anionic contaminants.

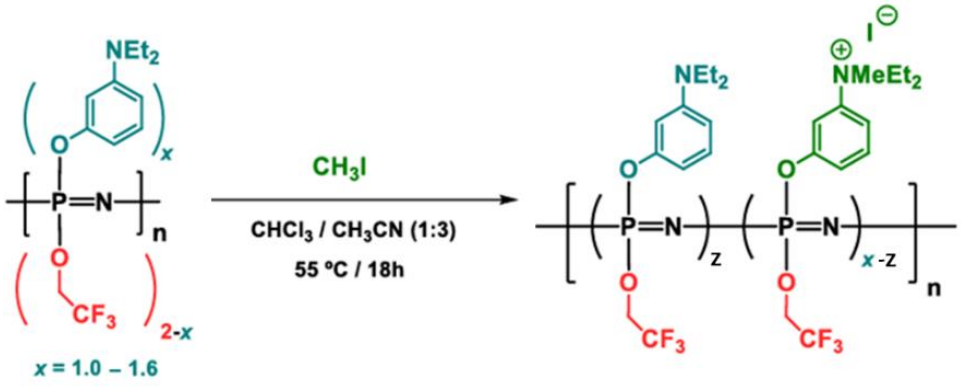

Figure 1. General synthetic pathway for cationic fluorinated co-polyphosphazenes

Acknowledgements
F.L. and P.S. thanks the UNIPD-DII BIRD2023 project "HYPURE-Hybrid 3D Printed Water Purification Systems for Emerging Pollutants" of the Department of Industrial Engineering, UNIPD, for the financial support.

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OC31

Photocatalysis Applications: Photoreforming of Biomass Derivatives and Organic Drugs Removal. Preparation and Characterization of Nanocomposites Materials

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To meet the energy needs of the world, most of the energy is still being obtained from fossil fuels including coal, oil and natural gas. Fossil fuels are not considered environmentally friendly because their combustion releases greenhouse gas emissions that cause global warming. There are several potential advantages to using more renewable energy, such as lowering emissions that contribute to global warming, diversifying energy sources, and reducing reliance on the fossil fuel energy market. Biomass includes all organic material that is derived from plants. The total carbon footprint associated with energy generation can be decreased by combining the use of solar light and fuels obtained from biomass. H_2 gas is considered a very efficient, clean and promising energy source. It can be generated from water and renewable energy resources. The importance of using H_2 as a fuel derives from the fact that it has an energy efficiency of 122 $kJ \cdot mol^{-1}$, which is higher than that of gasoline or of any other fossil fuel.

It is a big challenge to develop sustainable options for green H_2 production. In this context, photocatalysis is considered an environmentally friendly process used in photoreforming of organic compounds and pollutant removal to produce contemporary H_2 and high added value compounds. The main focus of this study is to synthesize different TiO_2 based and alternative photocatalysts and investigate their applications towards production of high value chemicals and green H_2 and organic drugs removal. The results obtained in laboratory scale were extended to pilot plant scale in the Plataforma Solar de Almería (Spain). Notably, some of the prepared TiO_2- based photocatalysts were used for H_2 production in a 25L photoreactor for photoreforming of glycerol (waste generated in biodiesel industries) and other organic compounds under direct sunlight irradiation. A ternary metal chalcogenide, $ZnIn_2S_4$, synthesized by a simple hydrothermal method in which the carcinogen universally used thioacetamide was, for the first time, successfully replaced the harmless thiourea, was synthetized as alternative solar light activated TiO_2 photocatalyst. Its photocatalytic efficiency was investigated for the selective oxidation in water solution of aromatic alcohols to their corresponding aldehyde, of the lignocellulose derivative 5-hydroxymethyl-2-furfural, and for photoreforming of furfuryl alcohol. A part of this study has been also focused on the photocatalytic degradation of most used organic drugs such as tetracycline, oxytetracycline and lincomycin in the presence of different photocatalysts under both UV and simulated solar light irradiation.

OC32

Synthetic challenges and opportunities in corrole chemistry: the reaction of beta-alkylcorroles with Ag(I) salts

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Corrole can be considered the prototypical example of contracted porphyrins, with one of the meso carbon bridges missing. This class of compounds has received great attention, because of their promising exploitation in different fields, ranging from medicine to material chemistry. The increase of interest in corrole chemistry at the beginning of this century was possible due to the discovery of simple synthetic procedures for the preparation of 5,10,15-triarylcorroles[1,2] that show unique reactivity and coordination chemistry.[3] However, so far, the properties and the coordination chemistry of β-alkylcorroles are little known.[4] Silver corrolates are attractive compounds from both practical and theoretical points of view. Indeed, they play a key role in peripheral functionalization reactions occurring at the macrocycle, enabling high-yield and regioselective group insertions, that are useful to further elaborate the molecular skeleton.[5,6] In this context, the research activity, herein discussed, aims to investigate the properties of β-alkylcorrole silver complexes. The reactions between 2,3,7,13,17,18-esaethyl-8,12-dimethylcorrole and Ag^+ salts result in concomitant oxidation, metalation and peripheral substitution of the corrole depending on the experimental conditions used, representing a useful tool to further develop the synthetic chemistry of other corrole compounds.

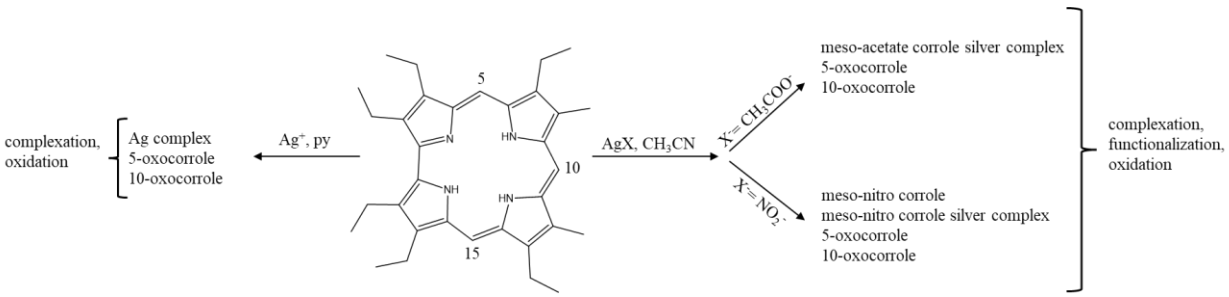

Figure 1. Synthetic scheme.

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OC33

Injectable Degalactosylated Xyloglucan Hydrogel for Mitochondrial Transplantation in Cardiac Repair

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Mitochondria play an essential role in a plethora of physiological functions, and mitochondrial dysfunction is a key contributor to cardiovascular disease[1], yet no clinical therapies currently target mitochondria directly. Mitochondrial transplantation (MT) has emerged as a promising strategy to restore bioenergetics by replacing damaged mitochondria[2]. However, challenges such as extracellular oxidative stress and poor mitochondrial retention at target sites hinder its therapeutic efficacy.
This study presents a novel MT approach utilizing an injectable, biocompatible, and thermoresponsive hydrogel based on partially degalactosylated xyloglucan (dXG) to encapsulate and deliver viable mitochondria to damaged cardiac tissue. Rheological, morphological and injectability analyses were performed to understand the relation between the dXG structure and its properties. The dXG hydrogel protects mitochondria from oxidative stress, preserves their metabolic activity post-injection (as confirmed by MTS and JC-1 assays), and allows for sustained, localized mitochondrial release. Mitochondria released from the hydrogel retained functionality and were internalized by host cells. Morphological analysis confirmed a gradual increase in pore size, facilitating controlled release. When injected into myocardial tissue (Fig. 1), the hydrogel formed discrete spheres, preventing mitochondrial dispersion, supporting tissue geometry restoration, and potentially limiting ventricular dilation.
These findings support the potential of dXG hydrogel-based MT as a regenerative strategy for heart failure.

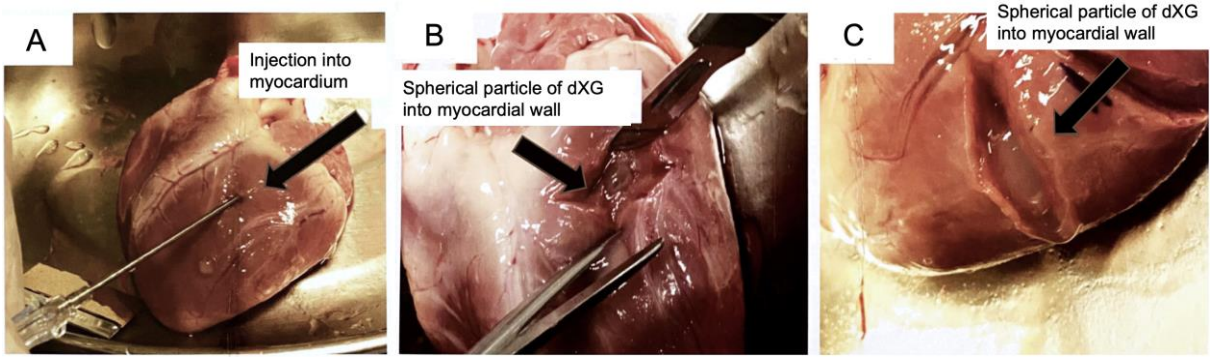

Figure 1. (A) Photograph of an injection of dXG gel; (B, C) Visual inspection after 24 h incubation.

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OC34

Green preparation of gold nanoparticles and their activity in photothermal cancer therapy

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In this work, a simple strategy to valorise agricultural waste was developed and applied in the green synthesis of gold nanoparticles. Grape marc waste, obtained from Lambrusco winery production, contain high amounts of polar substances (tannins, polyphenolic compounds, and reducing agents) that can act as starting materials for nanoparticle formation[1]. In this way, hazardous substances generally used in conventional methodology can be avoided, enhancing their biocompatibility and favouring their possible use in medical applications. After a hydrothermal extraction at 65°C, grape marc extract (GM) was successfully employed in gold nanoparticles preparation (GM-AuNPs)[1]. After purification and characterisation their biocompatibility was demonstrated on human fibroblast (FibH) and MCF-7 breast cancer cells incubated with different concentrations of GM-AuNPs. Moreover, the in vitro photothermal capacity of GM-AuNPs was evaluated using a NIR (808nm) laser[2]. Different GM-AuNPs' concentrations were irradiated and the temperature variation was evaluated every minute until 10 minutes of irradiation. Starting from these interesting results, the applicability of GM-AuNPs in photothermal killing of MCF-7 and bacterial cells was finally evaluated.

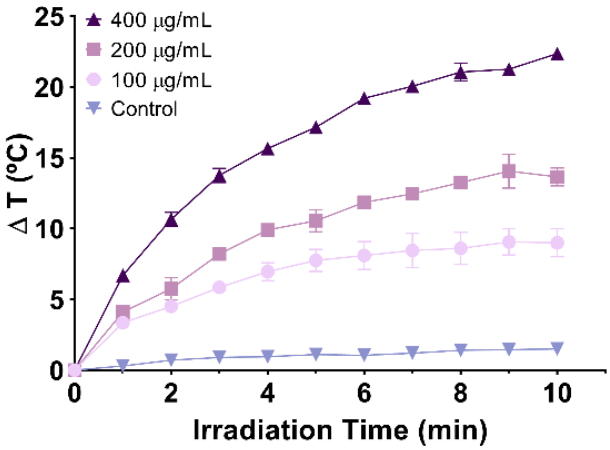

Figure 1. Characterization of the photothermal capacity of GMAuNPs at different concentrations; ΔT refers to the temperature variation after NIR laser irradiation.

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OC35

Light-Responsive Flavone–Platinum Complexes: Photochemical and Anticancer Evaluation in 3D Cell Models

V.Vergaro,[1,*] F. Baldassarre,[2,3] Federica De Castro,[2] Chiara Boncristiani,[1,3] Maria Michela Dell'Anna,[4] Piero Mastrorilli,[4] Francesco Paolo Fanizzi,[2] Giuseppe Ciccarella[2,3]

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This study presents the design and synthesis of two novel cisplatin-based complexes[1-2], *Platiflav* and *Platiflav(ppy)*, incorporating 3-hydroxyflavone, a natural bioactive substance known for its pharmacological properties. The compounds were thoroughly characterized using standard chemical techniques and subsequently evaluated for their anticancer potential in both 2D monolayer and 3D multicellular spheroid models, using HaCat and Sk-Mel-2 cell lines. Remarkably, both complexes exhibit photoactivatable properties and cytotoxicity assays revealed a significant reduction in IC_{50} values upon photoirradiation, highlighting the enhanced therapeutic efficacy mediated by light-triggered activation.
To gain mechanistic insights, a comprehensive biological investigation was carried out, including ultrastructural analysis via confocal laser scanning microscopy combined with immunofluorescence, as well as flow cytometric profiling of cell cycle progression.
Importantly, for the first time, the metabolic impact of *Platiflav* and *Platiflav(ppy)* was assessed in 3D spheroids using NMR-based metabolomics integrated with multivariate statistical analysis.

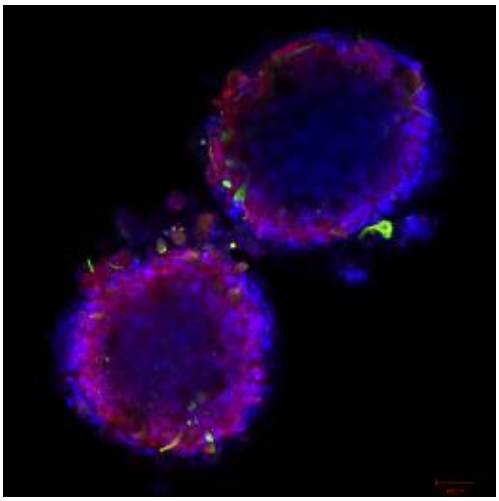

Figure 1. 3D Sk-Mel-2 spheroids

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OC36

Aromatic copolyesters containing furan and isophthalic rings for vascular tissue engineering: from design to device

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Cardiovascular diseases are responsible of deaths and severe disability worldwide, including the occlusion of small diameter (< 6 mm) vessels. [1] As the main limit of conventional vascular grafts, consisting of human tissue, is the lack of donor, the development of synthetic solutions is of great importance. [2] According to this, in the present research two random copolyesters of poly(butylene 2,5-furandicarboxylate) (PBF) and poly(butylene isophthalate) (PBI), were synthesized and fully characterized. The copolymeric compression-moulded films displayed high thermal stability together with high ultimate strength and values of elastic moduli tuneable with the copolymer composition. The long-term stability of these materials under physiological conditions, which is a key feature for this kind of application, was also confirmed. From the biological point of view, the viability of human umbilical vein endothelial cells (HUVECs) was assessed and the hemocompatibility has been tested by evaluating the adhesion of blood components. As the results obtained were particularly promising, the implementation of a device, in the form of a tubular electrospun scaffold, was also successfully performed. In conclusion, this study opens new and successful frontiers in the field of tissue engineering of soft tissues, including vascular one.

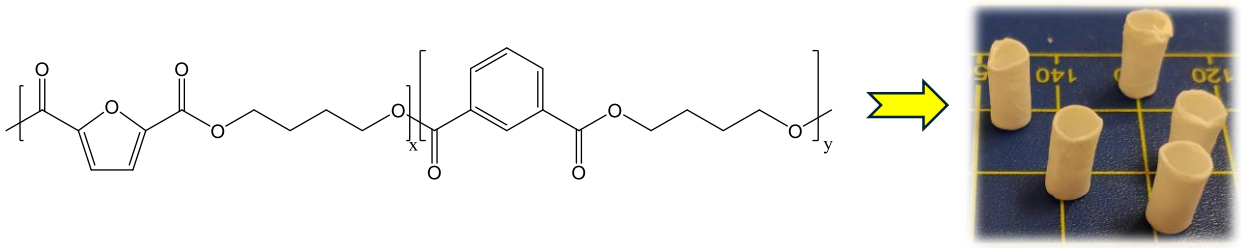

Figure 1. Chemical structure of the copolymers under study and picture of electrospun tubular scaffolds.

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OC37

Synthesis and characterization of new heteroleptic platinum complexes with second-order nonlinear optical properties

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The growing demand for advanced photonic technologies is driving interest in molecular materials with second-order nonlinear optical (NLO) properties. Heteroleptic Pt(II) complexes are promising due to their tunable structures and electronic features. A key strategy involves spatial separation of HOMO and LUMO to promote intramolecular charge transfer (ICT), enhancing the NLO response.[1,2] We report the synthesis and characterization of new Pt(II) complexes with π-conjugated ligands bearing donor and acceptor groups. Structural and optical properties were investigated by NMR, X-ray diffraction, UV-Vis-NIR, and SHG measurements. The compounds also exhibit pronounced solvatochromism, indicative of strong ICT. DFT calculations confirmed significant ICT and π-delocalization, correlated with high hyperpolarizability (β) values. These results highlight the potential of these complexes as second-order NLO materials.

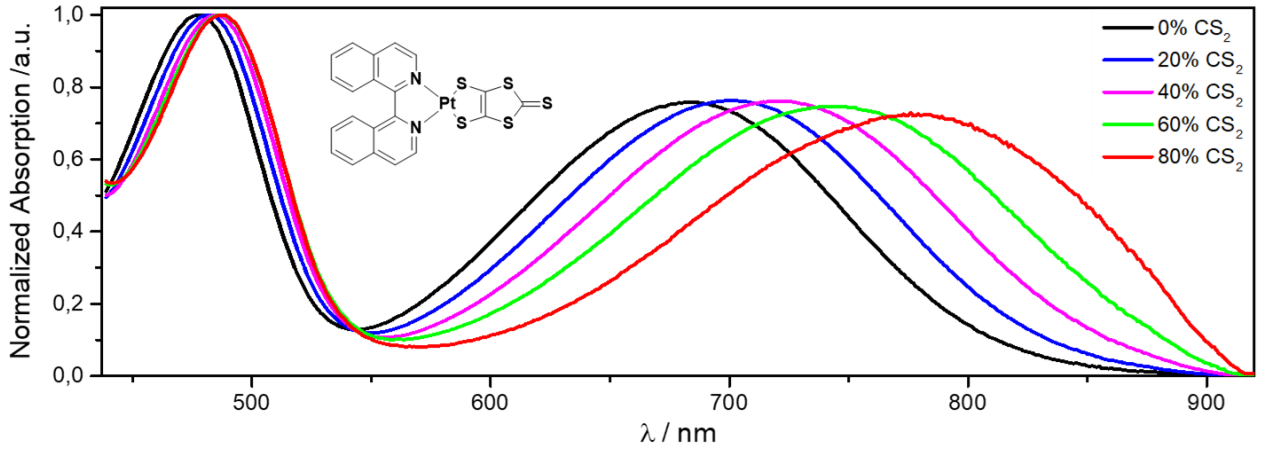

Figure 1. UV-Vis-NIR spectrum of the complex in DMF (10^{-4} M) with increasing amount of CS_2.

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OC38

New Nanomaterials for the Development of High-performance Chemical Sensors for Environmental Applications

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Anthropogenic pressures, caused by a socio-economic and technological increase, have profoundly altered the natural dynamics of ecosystems, disrupting the balance between biotic and abiotic components through excessive emissions of pollutants. These perturbations have resulted in environmental consequences, including acid rain, intensified climate change, greenhouse gas accumulation, and biodiversity loss. While regulatory measures have been implemented to mitigate these impacts, continuous and precise environmental monitoring remains essential[1].

This doctoral research focused on developing conductometric sensors as advanced analytical tools for gaseous contaminants detection. Various nanomaterials, including semiconductor metal oxides (Ca/Al-ZnO, Co_3O_4/CuO, Co_3O_4/Fe_2O_3,[2-5] $NbTiO_2$/NiO), transition metal dichalcogenides (WS_2)[6], carbon-based structures (CDs)[7], spinel ferrites ($NiFe_2O_4$), and metal-organic frameworks (MOFs)[8], were investigated as sensing layers. After their synthesis and characterization, these materials were deposited on sensor platforms, and the resulting sensors were validated for the detection of formaldehyde (CH_2O), nitrogen monoxide (NO), nitrogen dioxide (NO_2), ammonia (NH_3), ethanol (EtOH), and acetone (C_3H_6O).

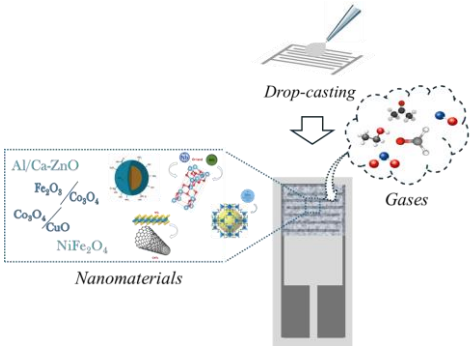

Figure. Graphical Abstract.

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OC39

Catch, Signal, Remove: Dual-Function porphyrinoid materials for fluorinated pollutant Sensing and Remediation

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Fluorinated species, including per- and polyfluoroalkyl substances (PFAS) and inorganic fluoride anions, are persistent contaminants of increasing environmental concern[1]. We present a multifunctional porphyrinoid-based receptor designed for selective interaction with fluorinated targets through non-covalent recognition. The porphyrinoid receptor exhibits optical responses upon binding, enabling effective detection of fluorinated pollutants. To enhance applicability, the receptor was immobilized on different solid supports—such as nanosponges[2], nanocellulose, and color catcher materials—each offering distinct advantages in sensitivity, selectivity, or pollutant removal capacity from water samples. This modular approach allows tuning the system for either optical detection, remediation, or both. Detection was performed using a low-cost optical sensor built from a PT-like setup assembled with 3D-printed components, Web-Cam and LEDs integrated with a peristaltic pump for fluid handling[3], enabling real-time, on-site analysis. The results demonstrate the potential of combining porphyrinoid chemistry with material engineering to create adaptable platforms for managing fluorinated contaminants in water. The platform offers a promising strategy for the development of affordable, portable tools for simultaneous detection and remediation.

Figure 1. a) PMMA holder designed to accommodate the nanosponge functionalized with the receptor. b) The PC-Webcam records the colorimetric variation while the peristaltic pump flows the sample. C) The evolution over time of the ΔHue during the flow of a 1000 ppm PFOA sample. Under the graph, it is reported the representation at different time points of the frame captured by the video.

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OC40

Vapochromic and vapoluminescent paper-based sensors based on a Zn(salen-type) complex for the discriminative detection of volatile primary aliphatic mono- and diamines vapours

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Volatile primary aliphatic mono- and diamines are compounds involved in various contexts, for example as raw materials in many industrial processes and for monitoring of environmental pollution and food-spoilage.[1] For these reasons, chemosensors able to discriminate vapours of these chemically similar analytes are highly desirable. Here, we present a study of paper-based sensors based on a vapochromic and vapoluminescent Zn(salen-type) complex **1** (PBS-**1**)[2,3] capable of discriminating *n*-butylamine (BA)[3] and ethylenediamine (EDA)[4] vapours, as prototypes of volatile primary aliphatic monoamines and diamines, respectively (Figure 1).

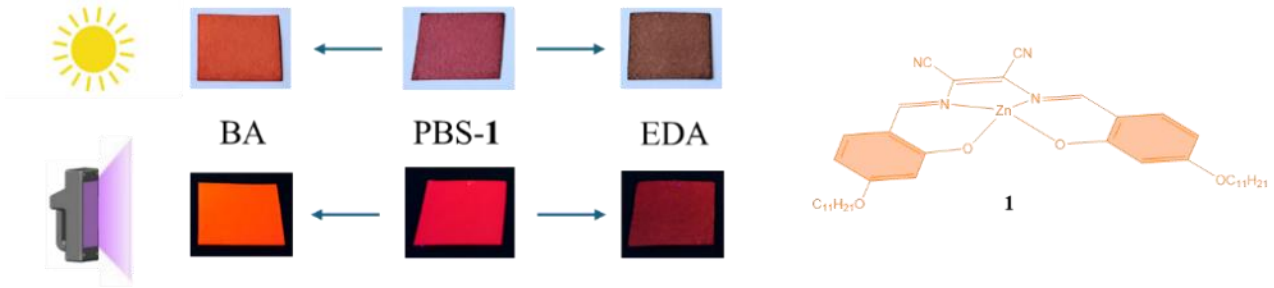

Figure 1. (Left) Photographic images of PBS-**1** and after exposure to saturated vapours of BA and EDA under natural light (top) and 365 nm light (bottom). (Right) Molecular structure of complex **1**.

PBS-**1** show different colour and fluorescence changes upon exposure to vapours of BA and EDA, ascribable to the formation of mono- and di-adducts respectively, enabling their unambiguous discrimination.[3,4] Moreover, PBS-**1** allow to quantify BA (LOD = 2.0 ppm) and EDA (LOD = 6.6 ppm), with limits of detection below the permissible exposure limits (PELs) established by Occupational Safety and Health Administration (OSHA) for BA (5.0 ppm) and EDA (10.0 ppm).[3,4]

This work was supported by the University of Catania, PIACERI 2024/2026, Linee di Intervento 1, and partially funded by European Union (NextGeneration EU), through the MUR-PNRR project SAMOTHRACE (ECS00000022).

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OC41

Smart optical materials and devices based on organic mixed valence compounds

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Stimuli-responsive materials are crucial to modern technologies because they can reversibly change their properties when exposed to external stimuli like heat, light, pH, stress, electricity, or gases.[1,2] Their versatility underpins applications in sensors, actuators, drug delivery, optoelectronics.[1,2] A particularly promising class of these materials is based on small organic molecules that form mixed valence (MV) species through redox reactions. Their physico-chemical properties can be finely tuned by altering their structural components, such as the redox-active groups and bridging moieties. Compounds featuring substituted diarylamines[3-6] or dipyridinium ions (viologens)[7-10] are especially noteworthy due to their electroactive and optical responsiveness. Here we highlight selected examples of such compounds, whose optical properties (absorption and fluorescence) can be precisely controlled using external factors such as voltage, temperature, and solvent conditions. These materials demonstrate multi-stimuli responsive behaviors and exhibit a range of chromic effects, making them highly versatile for next-generation optical materials and smart devices.

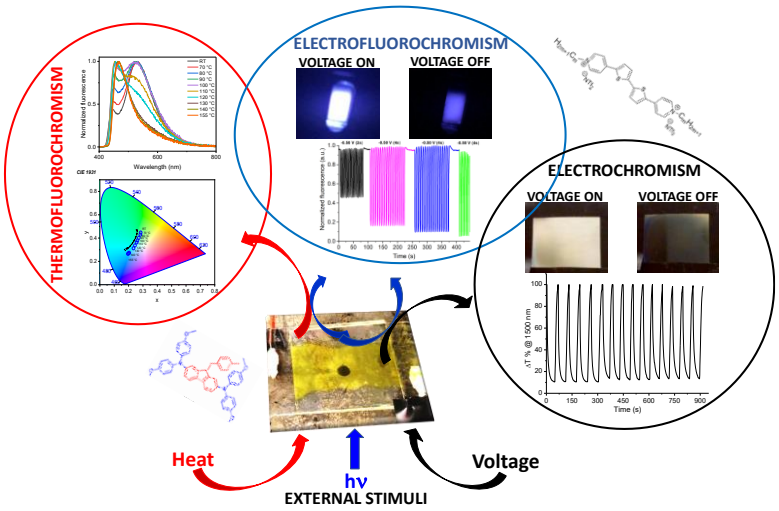

Figure 1. Smart optical devices based on diarylamines and dypiridinium ions

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OC42

Novel N-alkylcorrole-based sensing materials for the development of e-nose platforms

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Corrole was one of the first porphyrinoids to be reported in the literature,[1] discovered accidentally during the great rush to vitamin B12; over the years, numerous synthetic strategies and post-functionalizations have been developed, including complexation reactions with different metals. In recent years, we have been interested in the N-alkylation of corroles, a simple but quite interesting reaction, surprisingly still not fully investigated in literature [2]. Among other properties, the introduction of alkyl groups into the core of corrole makes the macrocycle intrinsically chiral[4], it is possible to modulate polyalkylation, select a discrete number of alkyl substituents[5] and carry out complexation reactions with divalent metals such as palladium, copper and iron. The different macrocycles have been characterized, and various possible applications have been studied, from photosensitizers for PDT to the field of sensors. Regarding the latter, an array was built based on a selection of N-alkyl corroles deposited on quartz microbalance transducers. The sensor-matrix was used considering an electronic nose approach to recognize a series of amines, alcohols and alkanes by evaluating the possible effects of alkylation on sensing performance. Finally, as a potential application, we have performed tests on six samples of Italian wines (red and white) and artificial wines to verify the possible use of our platform for detecting the addition of methanol to wine to increase its alcohol content.

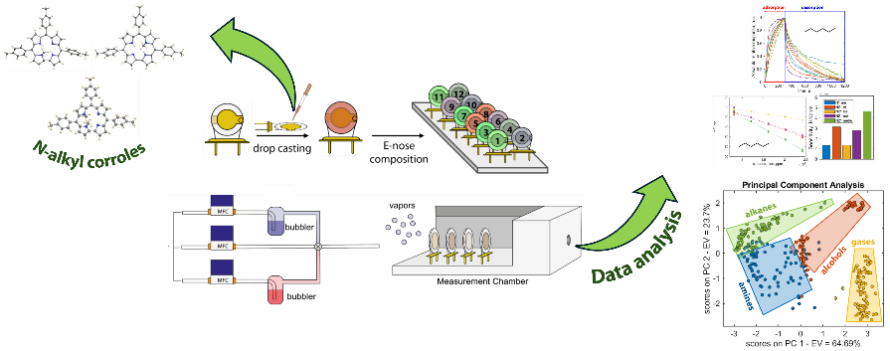

Figure 1. Summary of the study.

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OC43

Green electrospinning processes for membranes suitable for water treatment

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Electrospinning is a versatile technique to prepare polymeric micro- and nanofibers and nonwoven fibrous mats through the application of high electrostatic forces. To fabricate membranes with enhanced chemical resistance and better mechanical performance, coupling photo-induced crosslinking and electrospinning has been proved to be an effective approach[1] (Figure 1).

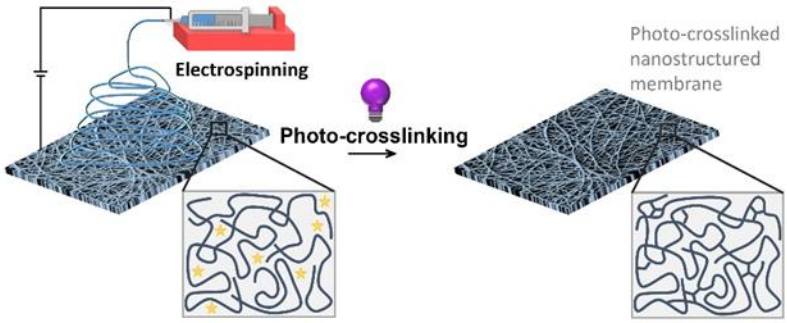

Figure 1. Coupling electrospinning and photo-crosslinking for the fabrication of nanofibrous membranes

By carefully selecting the composition of the electrospinnable system and the photo-crosslinking parameters, it is possible to efficiently and independently control the mat surface area, its porosity, its wettability, and the amount of active functional groups available on the surface of the crosslinked nanofibers[2]. In this way, multifunctional active fibrous membranes have been obtained, suitable for different application: they can be used for water treatment to remove metal ions and oily contaminants. Preliminary results on their application in reverse osmosis processes for water desalination[3] will also be presented.

Acknowledgement: This work was supported in part by the Italian Ministry of Foreign Affairs and International Cooperation, grant number EG24GR02.

Ministry of Foreign Affairs
and International Cooperation

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OC44

Lignin-Based Cationic Hydrogels for the Adsorption of Emerging Pollutants from Aqueous Media

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Water pollution remains one of the most pressing environmental issues of our time. Porous materials are widely investigated for wastewater treatment due to their high specific surface areas that promote effective interactions with target contaminants. However, many such materials are derived from fossil resources and suffer from drawbacks including high cost, non-degradability, and the risk of secondary pollution. Lignin-based porous materials represent a sustainable alternative. Lignin is the second most abundant natural polymer after cellulose and is composed of cross-linked aromatic units—coniferyl, sinapyl, and p-coumaryl alcohols—providing a heterogeneous structure[1]. In this work, acrylamide (AAm) and acryloxyethyltrimethylammonium chloride (DAC) were grafted onto lignosulfonate (LS) in water using potassium persulfate (KPS) and tetramethylethylenediamine (TEMED) as thermal initiator and catalyst at 40 °C, respectively.[2] The resulting cationic hydrogel (LS_pAAm_DAC) was characterized by FTIR to confirm its chemical structure, while SEM, rheology, and TGA analyses were performed to evaluate its morphological, mechanical, and thermal properties. Swelling studies revealed a water uptake of over 1200% after a few hours of immersion. The hydrogel was tested for the adsorption of diclofenac sodium (DCF-Na), an emerging pollutant, through batch and continuous-flow experiments. Batch tests showed high adsorption capacity for an initial DCF-Na concentration of 125 mg/L. Kinetic data followed a pseudo-second-order model, indicating chemisorption via electrostatic interactions. Adsorption isotherms were well described by Langmuir and Sips models, suggesting monolayer coverage and near-homogeneous surface behaviour. Notably, this is the first report of diclofenac removal using a lignin-based hydrogel in a packed-bed column, achieving a maximum capacity of ~50 mg/g. The column data were successfully modelled using Thomas, Yoon–Nelson, and Clark equations.

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OC45

Development of Innovative Technologies for the Synthesis of Materials for Sensing and Environmental Applications

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This doctoral research investigates the sustainable synthesis and application of carbon-based nanomaterials derived from renewable biomass and agro-industrial waste, with the overarching aim of developing functional materials for environmental remediation and sensing. The project was developed within the framework of Green Chemistry principles and in alignment with the 2030 Agenda for Sustainable Development, promoting the responsible use of natural resources and the reduction of hazardous substances. Various biomass precursors, including citrus peel residues, brewery bagasse, and invasive algal species, were subjected to hydrothermal carbonization (HTC) and related low-impact synthetic approaches to obtain carbon-rich solid products and carbon nanodots (CNDs). These processes enable the valorization of high-moisture content feedstocks under mild reaction conditions, overcoming limitations typical of conventional thermochemical methods such as pyrolysis. The resulting materials demonstrated high carbon content, surface functional group diversity, and favorable physicochemical characteristics, including fluorescence, aqueous dispersibility, and electrochemical responsiveness. A comprehensive characterization of the extracted and synthesized materials was performed using advanced analytical techniques. Structural and morphological features were correlated with functional performance to assess their suitability for target applications. The synthesized carbon-based nanomaterials were employed in three main application areas: *(i)* as adsorbents for the removal of persistent organic pollutants such as dyes from aqueous solutions, *(ii)* as catalytic supports for potential use in redox and degradation reactions, and *(iii)* as modifiers of commercial screen-printed carbon electrodes (SPCEs) for the fabrication of electrochemical sensors. These sensors enabled the detection of environmentally relevant analytes, including nitrobenzene, nitrites, sulfites, and heavy metal ions (e.g., Pb^{2+}, Cd^{2+}, Zn^{2+}, Hg^{2+}), through voltammetric and fluorescence-based strategies.

The integration of green-synthesized carbon materials into sensing platforms allowed the development of highly sensitive, selective, and reproducible detection systems with low detection limits and rapid response times. Furthermore, their use as sorbents demonstrated high removal efficiency and regeneration potential, making them promising candidates for water treatment technologies. Overall, this study provides a viable approach to transforming organic waste streams into multifunctional nanomaterials with applications in pollutant monitoring and mitigation. The findings support the advancement of sustainable material science and offer new insights into the development of environmentally benign technologies aimed at addressing current challenges in pollution control, circular economy, and resource efficiency.

OC46

Porphyrin-based SURMOFs: from synthesis to application

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Metal organic frameworks (MOFs)[1] are highly crystalline and porous materials, made by the self-assembly of two different types of building blocks: *i)* metal or metal-oxo units and *ii)* organic polytopic linkers. When porphyrins are used as struts, their magnificent physicochemical and electronic properties are added to the MOF's features[2], widening their use in fields as photocatalysis and sensing. However, the limited processability of these materials hampers their deposition in films, as most are required for fabricating electronic or photovoltaic devices. In this context, the surface-coordinated MOF thin films, SURMOFs, have been particularly investigated, as their thickness can be precisely controlled, they have a preferred growth orientation, and they give a homogeneous surface coverage. In this contribution, we will describe the preparation of the porphyrin-based SURMOFs (Figure 1), performed by a layer-by-layer (LbL) assembly technique[3] that alternates within one cycle the Zn acetate solution in THF, the rinsing solution (THF), the porphyrin solution in THF, and, again, the rinsing solution (THF). The fabrication was optimised by studying how the number of cycles, the deposition method and the type of substrate influence the crystallinity and morphology of the final films. Preliminary applications as gas sensing platforms will also be illustrated.

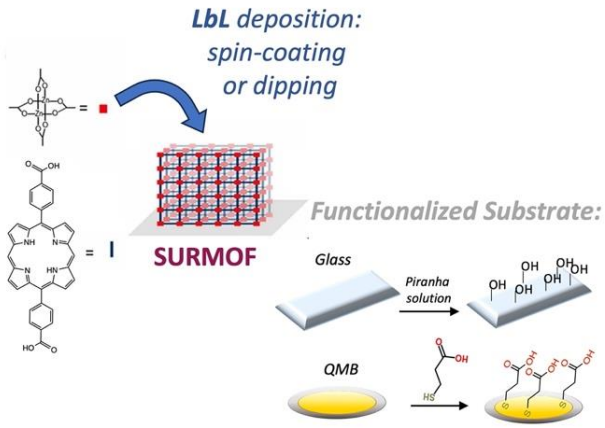

Figure 1. Building blocks, substrates and deposition techniques explored for the SURMOFs fabrication.

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OC47

Understanding the behaviour of natural and artificial dyes in metakaolin-based geopolymers

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Many items in our environment, such as ceramic plates, chandeliers, mugs, and other households, are coloured with artificial dyes. These dyes are extremely stable, but are rarely dangerous to humans or the environment when they are released[1]. On the other hand, there are several natural dyes (such as chlorophylls, phenols, carotenoids, and anthocyanins) that can serve as good substitutes for artificial ones. These natural colorants can be extracted from various wastes and by-products of the agri-food supply chains avoiding wastage, and be incorporated into a alkali-activated amorphous aluminosilicate matrix, a geopolymer, resulting in ceramic-like materials (see **Figure 1**). A comparison study between natural and artificial dyes has been done[2-5]. The main finding suggests that it is possible to synthesise geopolymers in the presence of both artificial and natural dyes without influencing the geopolymerization reaction. In both cases, the geopolymers were macroscopically stable and able to retain their colour in water for 1 hour testing. Although they are stable, there is a need to make a post-treatment to implement the colour stability.

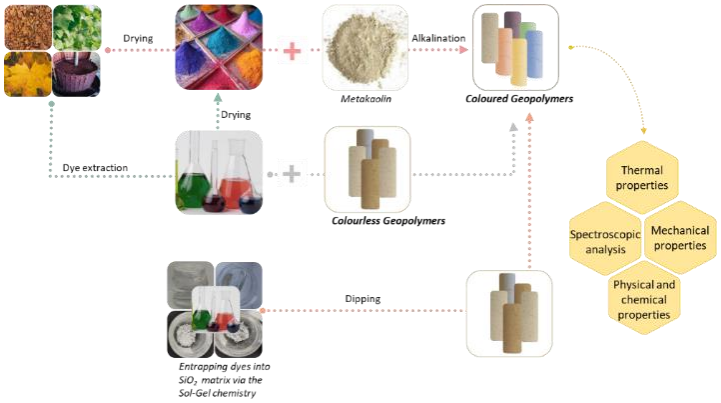

Figure 1. Scheme of the geopolymers synthesis in the presence of dyes.

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OC48

Tuning Paramagnetism in Graphene Oxide Derivatives: Impact of Reduction Degree and Metal Impurities Revealed by EPR and MRI Analyses

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GO-based materials have recently attracted substantial attention in the biomedical field as effective contrast agents (CAs) in nuclear Magnetic Resonance Imaging (MRI)[1]. Despite numerous publications in recent years, the complete understanding of the chemical-physical mechanisms underlying paramagnetism in graphene-based materials remains elusive, especially for pure graphene oxide (GO)[2] and reduced graphene oxide (rGO)[3] (**Figure 1**).

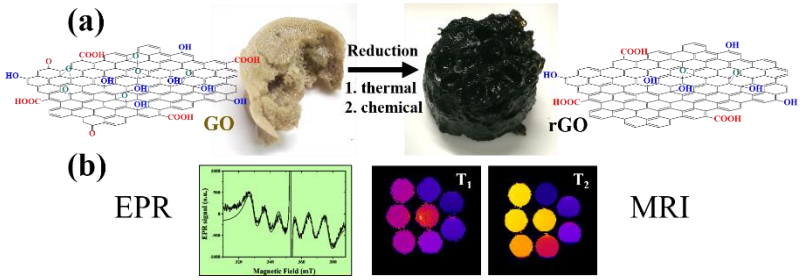

Figure 1. (a) Schematic representation of the GO reduction to rGO with photographic inserts of freeze-dried samples and (b) EPR spectrum and T_1/T_2 MRI maps for GO, adapted from[1].

To address this knowledge gap, GO and rGO derivatives - synthesized via thermal or chemical reduction - were rigorously characterized using a multidisciplinary approach. This included elemental analysis, spectroscopic techniques, thermal analysis and electron paramagnetic resonance (EPR) spectroscopy. By integrating X-band EPR with 1.0 T MRI, we systematically decoupled the paramagnetic contributions of structural defects from residual metal impurities, providing unprecedented insights into their MRI contrast mechanisms. Our findings show that reducing GO increases its MRI relaxivities (r_1, r_2), highlighting rGO's potential as a versatile platform for advanced MRI contrast agents and paving the way for enhanced diagnostic capabilities in medical imaging and targeted therapies.

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OC49

Accuracy and Reproducibility of a ^{1}H NMR protocol for Quantification of Betaine in Wheat and Pasta

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Quantitative nuclear magnetic resonance (qNMR) spectroscopy is a powerful tool for chemical analysis. However, its accuracy and reproducibility can be influenced by various factors when different spectrometers and operators are involved. In this contribution, an extensive inter-laboratory comparison, aimed at identifying the primary sources of variability in qHNMR data processing, was presented. The target molecule chosen for ILC was the betaine, a biomarker correlated to the plant resistance to water-stress.

Focusing on the quantification of betaine in aqueous extracts of durum wheat (*cv. Marco Aurelio* and *Iride*) and their corresponding pasta, the ILC involved 50 different spectrometers operating at magnetic fields ranging from 80 to 700 MHz.

Two distinct data processing approaches were evaluated: multi-operator processing versus single-operator processing. Five different software platforms were compared in the single-operator approach. Additionally, quantification was conducted through both an internal standard[1] and an external standard method[2].

This study underscores the importance of standardized correction strategies and harmonized data processing protocols, demonstrating that highly reproducible quantification methods based on ^{1}H-NMR can be achieved even without traditional calibration curves. This research paves the way to the application of qNMR on a wider number of complex matrices, that are traditionally challenging or expensive to analyse with other methods, in multiple fields, such as nutraceuticals, pharmaceuticals, agriculture, and environmental sciences.

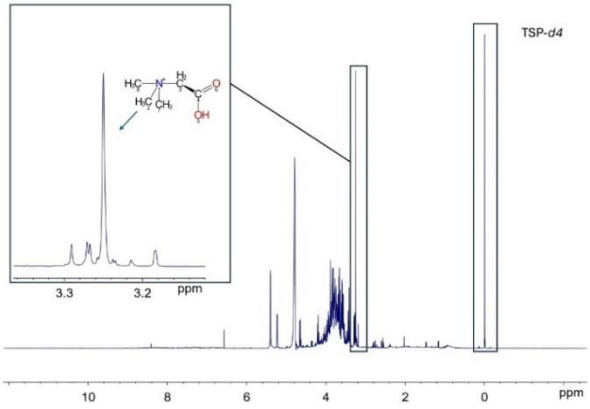

Figure 1. 1D ^{1}H NOESY spectrum of aqueous extracts of wheat using in Internal Calibration

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OC50

Environmental Life Cycle Assessment (LCA) of Curcumin-stabilized Silver Nanoparticles (Cur-AgNPs)

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Silver nanoparticles functionalized with curcumin (Cur-AgNPs) have recently garnered increasing attention as antimicrobial agents[1], combining the well-established antimicrobial properties of silver nanoparticles (AgNPs) with the bioactive potential of curcumin. While numerous studies have highlighted the impressive antimicrobial efficacy of Cur-AgNPs[2,3], their potential environmental impacts have not yet been evaluated using the Life Cycle Assessment (LCA) methodology.

LCA offers a comprehensive analysis of the environmental impacts associated with each stage of a product's life cycle—from raw material extraction to end-of-life disposal—and is widely recognized as a key tool for sustainable decision-making. This study applies LCA to assess the environmental footprint of Cur-AgNPs synthesized at laboratory scale using a low-energy, microwave-assisted method in aqueous solution.

Additionally, the study compares the environmental burdens of two curcumin sourcing pathways: chemical synthesis from vanillin and extraction from *Curcuma longa* rhizomes cultivated in India. Each stage of the extraction process, from cultivation and drying to final extraction, was evaluated.

The LCA results identified the key substances and processes contributing to the environmental footprint of both Cur-AgNPs and the two curcumin production routes—chemical synthesis and ethanol-based extraction. Ultimately, the analysis offers recommendations for more sustainable production of Cur-AgNPs for antimicrobial applications.

This study was funded through "PNRR–M4C2INV1.5, NextGenerationEU-Avviso 3277/2021 - ECS_00000033-ECOSISTER-spk 5 - CUP E93C22001100001 - Progetto PURE"

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OC51

Disposable Sensor Array Embedded in Facemasks by using PEDOT:PSS doped with porphyrins

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The early identification of chronic kidney disease (CKD) is crucial to improving clinical outcomes and reducing long-term healthcare burdens. In this contribution, we present a novel wearable diagnostic platform based on a disposable sensor array embedded within FFP2 facemasks. Each sensor combines the conductive polymer PEDOT:PSS with different charged porphyrins, organic macrocycles widely used as chemical receptors due to their synthetic flexibility and affinity to a large range of volatile compounds. The use of porphyrin-doped conductive polymers allows the integration of flexible, low-cost gas sensors directly onto or within the mask structure, enabling real-time, non-invasive breath analysis. Remarkably, the chemical structure of porphyrins dictates the chemical sensitivity of each sensor by a combination of hydrogen bonding, coordination, π-π interactions, achieving the combinatorial selectivity typical of "electronic noses."
In a first proof-of-concept study, these sensors were shown to discriminate changes in breath composition following food and beverage intake[1]. Subsequently, a refined sensor array was tested in a clinical setting to identify CKD-related VOC signatures. A tailored breathing protocol and advanced signal processing using continuous wavelet transform allowed robust feature extraction[2]. Classification via linear discriminant analysis yielded 93.3% sensitivity and 86.7% specificity in distinguishing CKD patients from healthy controls. Additionally, the system demonstrated potential for stratifying disease severity. These results underscore the promise of porphyrin-based wearable sensors for point-of-care diagnostics and continuous health monitoring.

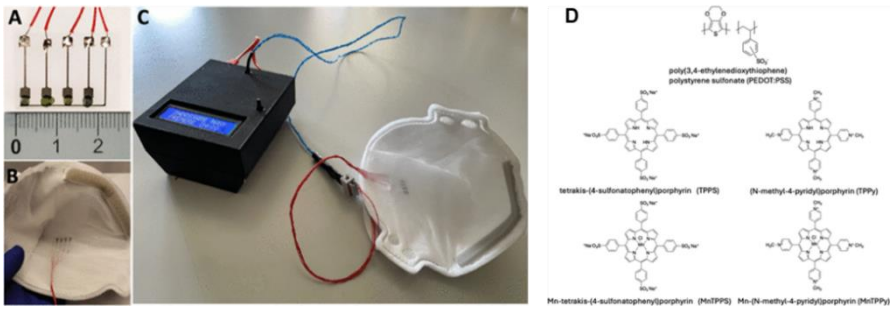

Figure 1. Interdigitated electrodes printed on the mask (A), wired (B), and connected to a portable reading unit (C). The sensor array was made by PEDOT:PSS and four different charged porphyrins (D).

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Comunicazioni Flash

FO1

New high-Z plastic scintillators for total-body SPECT and theranostic dosimetry

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Plastic scintillators represent one of the most promising solutions for advanced applications in medical imaging and dosimetry due to their low cost, light weight, and geometric flexibility. However, their performance still lags behind the inorganic scintillators, mainly due to the low atomic number (Z) of their components.[1] This project focuses on the development of high-performance plastic scintillators for total-body single-photon emission computed tomography (SPECT) and theranostic dosimetry. The approach involves the synthesis of innovative fluorophores and the integration of high-Z elements.

The main objectives include: synthesizing high-efficiency fluorophores; investigating new monomers for improved optical transparency; increasing the concentration of high-Z elements beyond the commercial 5% limit; and developing new fabrication methods—such as photopolymerization and 3D printing—to produce transparent, high-yield scintillators with versatile geometries.

Four new fluorophores were synthesized and characterized[2], with excellent yields and improved photophysical performance over commercial standards. Alongside thermal polymerization, photopolymerization and 3D printing[3] were introduced to explore new manufacturing strategies.

The synthesized fluorophores exhibited promising optical and timing performance compared to existing commercial solutions, particularly in terms of light output, time resolution, and rise time. Photopolymerization enabled the incorporation of high-Z elements at concentrations above 5%, enabling the design of plastics scintillators in various geometries. 3D printing demonstrated excellent geometric flexibility, but current structural limitations prevent the simultaneous integration of both our fluorophores and high-Z elements.

The results highlight the strong potential of these materials for advanced medical physics applications. Future efforts will focus on synthesizing more efficient fluorophores and optimizing 3D printing to create high-performance scintillators integrating custom fluorophores and high-Z elements. The goal is to develop customizable, efficient devices for total-body imaging and theranostic dosimetry.

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FO2

Radiation-crosslinked wound dressings containing egg white proteins

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The wound healing process is a complex and dynamic interaction among cytokines, growth factors, blood, and the extracellular matrix.[1] Due to the influence of potential physiological conditions, such as diabetes, any disorder of these factors will lead to chronic wound healing. In chronic wounds, an excessive inflammatory response prevents the proliferation of healthy tissue, causing a serious infection which can also result in an amputation. If not treated properly, chronic wounds might even be life-threatening.[2]
Egg white proteins, such as ovoalbumin, ovotransferrin and lysozyme, are attracting interest especially because of their demonstrated antioxidant and antibacterial activities.[3] These bioactive proteins can then be used to enrich advanced wound dressing films that can help control wound oxidative stress and thereby accelerate wound healing and/or prevent bacterial infection.
Wound dressing films can be easily produced crosslinking polymers, such as polyvinyl alcohol (PVA) or polyvinyl pyrrolidone (PVP), by high-energy radiation.[4] This technique does not require expensive initiators and catalysts and it can guarantee simultaneous product sterilization, depending on the irradiation doses. PVA hydrogels obtained by irradiation are also transparent, a desirable property for wound dressings. When PVA is mixed with selected polysaccharides, the hydrogel wound dressings have shown faster healing rates and scarless healing, probably due to antioxidant properties of polysaccharide fragments produced upon irradiation.[4]
The aim of this work is to develop novel hydrogel formulations, based on blends of synthetic polymers and polysaccharides, and incorporating egg white proteins and/or their peptides, to investigate their applicability as advanced wound dressings.

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Horizon Europe Project EURATOM-IA titled "RADiation harvesting of bioactive peptides from egg prOteins and their integration in adVanced functional products — RADOV" Project n. 101061694 is acknowledged.

FO3

Solar-Driven Photocatalytic Reductions for Sustainable Applications

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Photocatalytic valorization of real-world materials such as waste biomass, plastic pollutants, and wastewater offers a promising approach to addressing major global challenges like CO_2 emissions, water pollution, and the sustainable production of valuable chemicals and hydrogen. Despite this potential, most research still focuses on simple model compounds instead of actual waste, and the scale up of these technologies for real-world use remains limited[1].

Photocatalytic reduction reactions use solar energy to drive chemical transformations, especially the conversion of CO_2 into useful fuels and chemicals. These solar driven processes show great promise for clean energy generation and environmental cleanup. Incorporating real waste materials into these reactions supports the principles of a circular economy and sustainable development[2]. In today's scientific world, a multidisciplinary approach is essential for understanding solar light driven chemical processes. Inspired by natural photosynthesis a key process that supports life scientists aim to mimic nature by converting CO_2 into organic molecules using sunlight. To address environmental concerns, innovative methods such as photocatalysis, thermal catalysis, and electrocatalysis are being explored, alongside efforts to use biomass and CO_2 in value added chemical production[3].

This paper aims to better understand how solar light can power useful chemical reactions, especially for converting CO_2 to fuels. It also explores the role of biomass valorization transforming waste biomass into valuable chemicals and fuels using photocatalytic methods. The goal is to harness solar energy in chemistry to develop clean, efficient, and sustainable solutions for environmental and global challenges. This includes developing new materials for renewable energy, improving chemical processing efficiency, and creating cleaner fuels.

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FO4

The formylation of *N,N*-Dimethylcorroles

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Among the numerous functionalizations of corrole macrocycles reported over the last twenty years, N-alkylation is one of the least studied, despite its considerable potential.[1-3]Alkylation of internal pyrroles converts corroles into dianionic ligands, decreases their acidity, and induces a significant red shift of the Q-bands in the near-infrared (NIR) region. It is also possible to modulate polyalkylation and vary the alkyl group, obtaining a wide range of N-alkylated products.[4] In this work, we aimed to study β-functionalization reactions on N-alkylated corroles to investigate the effect of the N-alkyl group on regioselectivity and possible differences in reactivity between alkylated and non-alkylated macrocycles. Specifically, we chose formylation, since it represents the easiest way to introduce a carbon atom at a macrocyclic peripheral position, which can be modified further. The introduction of one or more methyl groups was hypothesized to influence both the regioselectivity of the products and reduce the formation of byproducts. Based on these considerations, the starting substrate TTC (5,10,15 p-tritolylcorrole) was subjected to two distinct functionalization strategies: (I) N-methylation followed by the Vilsmeier-Haack reaction (Figure 1), and (II) Vilsmeier-Haack reaction followed by N-methylation. By comparing the products obtained from these two approaches, we aimed to elucidate the distinct effects of the methyl and formyl groups on the reactivity of the macrocycle.

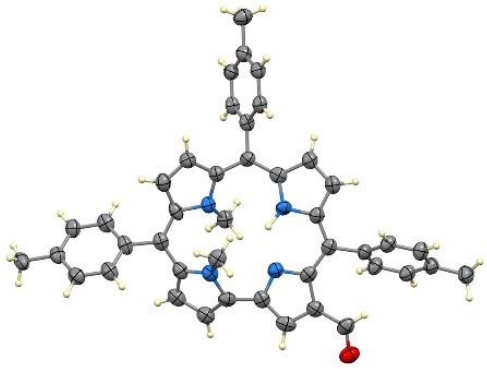

Figure 1. Crystallographic structure of 17-formyl-N21,N22-dimethylcorrole.

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FO5

Synthesis and Characterization of Waste Cooking Oil-Derived Polyols for Use as Biolubricants

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This study investigates the production and characterization of polyols synthesized from waste cooking oil (WCO) for potential use as biolubricants. WCO was epoxidized to varying extents (74–94%) through heterogeneously catalysed oxidation, followed by epoxide ring-opening reactions with ethanol to obtain polyols with hydroxyl numbers ranging from 145 to 177 mg KOH/g. The resulting polyols were characterized using FTIR spectroscopy, and their thermal stability was assessed by thermogravimetric analysis (TGA). Rheological and tribological properties, which define the functional behaviour of lubricants, were also evaluated. The polyols exhibited Newtonian behaviour across the entire shear rate range at the selected testing temperatures (25, 40, and 100 °C), indicating excellent thermal and flow stability. The high viscosity index of the polyol with the highest hydroxyl number, approximately 132 (well above 100), confirms its excellent viscosity–temperature performance. Tribological tests performed with a normal load of 10 N and a sliding speed of 10 mm/s revealed an average coefficient of friction of 0.19, demonstrating its effective lubricating performance under boundary lubrication conditions. These findings demonstrate the feasibility of producing biolubricants from WCO with favourable thermal, rheological, and tribological properties, making them promising candidates for industrial applications.

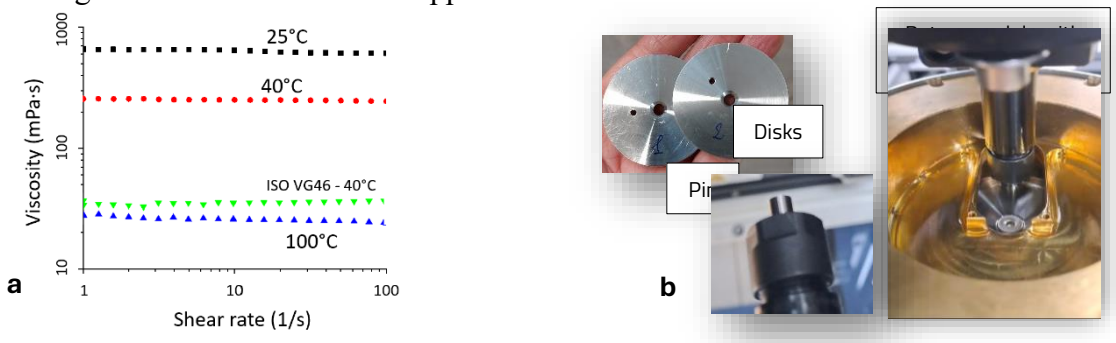

Figure 1. a) Viscosity vs shear rate for the synthesized polyol with high hydroxyl number, measured at three different temperatures, compared with a commercial ISO VG46 lubricant; and b) components and set-up for tribological tests.

This research was funded by the European Union - Next Generation EU (National Sustainable Mobility Centre. CN00000023. Spoke 11 - Innovative Materials & Lightweighting - Projects "REOBTAIN" and "CO-SMART".

FO6

Ab initio characterization of HfO_2 and its Zr-doped derivatives for Energy harvesting applications

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This work aims to investigate, through atomistic simulations, materials that can act as efficient components for energy harvesters, as schematically reported in Figure 1. As global energy demand continues to rise, energy harvesting techniques offer a promising approach to collect environmental energy that would otherwise be lost. In this context, numerous solutions have been proposed in the literature to exploit energy from solar and electromagnetic radiation, mechanical vibrations, or thermal differentials. Hafnium oxide (HfO_2), due to its unique combination of high dielectric constant, thermal stability, and compatibility with complementary metal-oxide-semiconductor (CMOS) technology, has emerged as a promising material for these applications. In nature, HfO_2, exists in the form of different polymorphs with peculiar stability and properties, explored in this work through the use of *ab initio* theoretical simulations.[1] In addition, this study investigates how doping HfO_2 with different elements, such as Zr, affects its properties in terms of unit cells, formation energy, optical properties, and dielectric functions.[2] In order to test the harvesting capability of this material, the pyroelectric behavior in capacitors based on $HfZrO_2$ is also analyzed. This work also illustrates the *ab initio* molecular dynamics simulations used to analyze temperature-dependent deformation of electron density, resulting in changes in the dielectric permittivity of the $HfZrO_2$.

Figure 1. Energy harvesting through HfO_2.

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FO7

Biodegradable Nanocomposites for a Greener Future: Investigating Nano-SiO_2 in PLA and PBSA-based systems

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Bio-based and biodegradable polymers are emerging as sustainable substitutes for traditional fossil-based plastics. These materials are particularly interesting because able to positively affect the environmental issues such as greenhouse gas emissions and plastic pollution. Among them, poly (lactic acid) (PLA) and poly(butylene succinate-*co*-adipate) (PBSA) have gained great attention thanks to their biodegradability, biocompatibility, bio-based and relatively low-cost production. To enhance the performance of these materials, such as mechanical and barrier properties, various modification strategies have been explored. One common approach involves the incorporation of nanoscale fillers to produce nanocomposites. Due to their nano-sizes, these fillers significantly influence the polymer matrix even at low concentrations, as the interfacial region between the polymer and the nanofiller occupies a significant volume fraction.
In this context, this study aimed to investigate the effect of a 0D nanofiller on the final properties of bio-based and biodegradable nanocomposites. Nanocomposites were prepared by extrusion using PLA and PBSA as the polymeric matrix and nano-SiO_2 as the nanofiller, using different amounts of filler (1, 2, and 5 wt.%). Morphological analysis was performed to investigate the filler dispersion into the matrix. Thermo-mechanical properties were evaluated by thermal analysis (DSC, TGA) and Dynamic Mechanical Thermal Analysis (DMTA). In addition, oxygen permeability and disintegration tests were carried out to investigate the barrier properties and the biodegradability of the prepared nanocomposites. Results indicated that the nanofiller influenced the final properties of the nanocomposites without affecting their biodegradability.

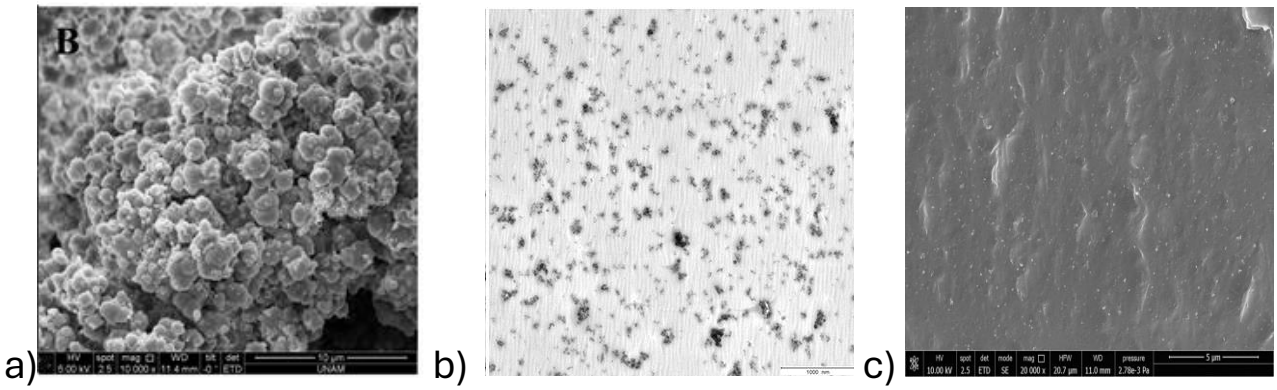

Figure 1. Nano-SiO_2 (a), PLA+5%SiO_2 (b), PBSA+5%SiO_2 (c).

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FO8

Decoding the Chemistry-Performance Link in Furan-Based Polymers

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In the field of bio-based polymers, which can substitute fossil-oil derived traditional materials, polymers containing furan rings, including poly(ethylene 2,5-furandicarboxylate) (PEF), are characterized by exceptional properties and remarkable performances, such as excellent gas barrier properties, as well as outstanding mechanical and thermal properties.
The power of furanic ring lies in its intrinsic polarity and its asymmetry: indeed, as revealed in the pioneering papers of Burgess and co-workers, unlike the active phenyl ring-flipping mechanism in PET, furan ring-flipping is greatly suppressed, thereby reducing β relaxation motions and diffusion in PEF due to the energy penalty associated with the nonlinear axis of ring rotation and ring polarity.[1] However, even if the synthesis of furan-based polyesters has been extensively studied, it still presents some critical issues, usually overcome by using an excess of glycol and a moderately high amount of catalyst. The high amount of diol allows compensation for its consumption due to side-reactions, reduces polymerization times, and achieves a higher polymerization degree. However, it also causes an increment in the content of ether units along the polymeric chain, as a consequence of dehydration side reactions.[2] The presence of ether groups is crucial for the final characteristics of the material, affecting the glass transition and melting temperatures, crystallization rate, and degradation resistance.[3] Moreover, the chemical characteristics of the comonomer can strongly influence the final properties: for example, the presence of aliphatic -CH_2- sequences, characterized by different length, along the macromolecular chain, can counterbalance the rigidity of the furan ring in a different way. Finally, the effect of polar interactions, involving the furan ring, between the polymeric chains has been considered. Then, accurate correlations between chemical structure and various properties of furan-based polyesters have been evaluated.

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FO9

ZnO@GQDs based gas sensor for the detection of H_2S

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The monitoring of atmospheric pollutants is critical in addressing climate change and mitigating its adverse effects on the environment, health, and cultural heritage.[1] Most of these contaminants are gaseous and include compounds such as carbon dioxide (CO_2), carbon monoxide (CO), hydrogen sulfide (H_2S), ozone (O_3), ammonia (NH_3), nitrogen oxides (NO_x), sulfur oxides (SO_x). Among these compounds, hydrogen sulfide (H_2S) has been shown to negatively influence ecosystem dynamics.[2] Due to its environmental relevance, this work focuses on enhancing the performance of well-known ZnO-based H_2S sensors by integrating them with graphene quantum dots (GQDs) to form a composite material.[3] GQDs are carbon nanomaterials often used in MOX p-n heterojunctions due to their quantum tunability, size-dependent light emission, high conductivity, large surface area, and excellent electron transport. To verify the chemical composition, we firstly employed several characterization techniques, including FTIR, TGA, and UV-Vis spectroscopy, on the ZnO@GQDs nanocomposites and compared the results with those of the bare ZnO and GQDs. The initial ZnO@GQDs nanocomposite (1:1 ratio), was applied to a sensor using a drop-casting technique for the detection of H_2S at different concentrations from 0.125 ppm to 4 ppm. The sensor demonstrated excellent performance, with optimal response and recovery times at various H_2S concentrations when operated at 200°C.

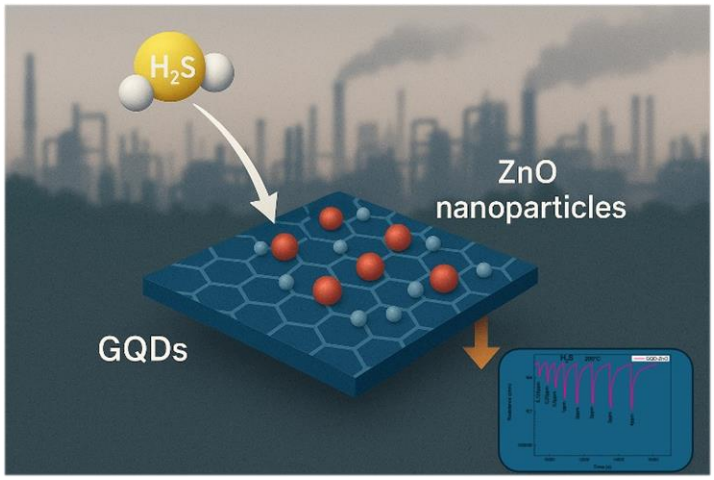

Figure 1. Schematic illustration of an environmental hydrogen sulfide (H_2S) sensor based on graphene quantum dots (GQDs) conjugated with zinc oxide (ZnO) nanoparticles.

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FO10

Metabolomic changes in xylem tissue of susceptible and resistant olive cultivars to *Xylella fastidiosa* infection

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Xylella fastidiosa subsp. *pauca* ST53 (*Xfp*) is a pathogenic bacterium causing one of the most severe plant diseases currently threatening the olive-growing areas of the Mediterranean, the "Olive Quick Decline Syndrome" (OQDS). The majority of the olive cultivars upon infections develop severe desiccation phenomena, while few are resistant, being less impacted by the infections. Currently, there are no curative solutions to rehabilitate *Xfp*-infected plants, and control is based on reducing the vector population and removing infected sources. The success of this depends on the timely application of the interventions.[1] In this context, one strategy proposed to mitigate losses is to replant susceptible crops with resistant or tolerant varieties. Several genetic, biochemical, and biophysical traits are associated with *Xfp* disease resistance or tolerance. Resistance refers to the ability of a plant to prevent or limit the establishment and spread of pathogens, effectively reducing the severity of disease symptoms. On the other hand, tolerance is defined as the capacity of a plant to sustain damage caused by pathogens without a significant loss in fitness or reproductive success.[2]
Recently, our lab has been involved in a number of projects based on the application of spectroscopy-based metabolomics to the study of *Xfp* infections in olive crops.[3,4] Some important clues on the resistance phenomenon against *Xfp* were obtained by investigating the composition of plant tissues collected from cultivars with different phenotypes towards *Xfp*.[5]
The main focus of the present study is to unveil changes in the metabolic composition due to the *Xfp* infection by investigating the xylem samples extracted from two different olive cultivars, namely FS17 and Arbequina. FS17 exhibits significant resistance and tolerance traits, while Arbequina shows a susceptible phenotype.[6] A non-targeted approach based on a combination of NMR and LC-HRMS data was applied to analyze aqueous xylem extracts to identify possible biomarkers correlated to the resistance or tolerance mechanism against *Xfp* infection in olive trees.

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FO11

Organically Modified Mesoporous Silica for Controlled Release of Thyme Oil as an Antivegetative Agent in Artwork Conservation

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Essential oils (EOs) are natural and renewable compounds widely recognized for their antimicrobial, antioxidant and antivegetative activities. However, their high volatility and susceptibility to external factor such as sensitivity to light and oxygen limit their direct use in long-term applications.[1] Nanocarriers offer an effective strategy to overcome these limitations. In particular, mesoporous silica nanoparticles (MSNs) are ideal candidates for encapsulating EOs due to their biocompatibility, high surface area, easy surface functionalization and excellent thermal and chemical stability.[2] MSNs protect EOs molecules from premature degradation, inhibit their rapid sublimation and enable controlled release. In our work, MSNs were synthesized and functionalized via one-step condensation method [3] by using tetraethyl orthosilicate (TEOS) as silica precursor and benzyl silane as modifying agents. By varying the TEOS/silane weight ratio, we obtained nanoparticles with tailored surface properties and homogeneous distribution of functional groups across both internal pores and external surfaces. The incorporation of benzyl moieties was specifically designed to exploit π–π interactions with EO components, improving encapsulation and retention efficiency. Thyme essential oil and its main active compound, thymol, were encapsulated using a vacuum-assisted loading method. Sublimation kinetics studies showed a significant reduction in volatilization rate for the encapsulated oil compared to the free one, when exposed to different temperatures. That confirms the nanocarriers' ability to stabilize and prolong EO activity. Biological assays evaluating antifouling activity against algal species demonstrated the enhancement of efficacy for the encapsulated oils. In particular, the higher the content of embedded nanoparticles, the greater and more enduring their effectiveness compared to pristine thyme oil. The final application of this research focuses on the conservation of cultural heritage, specifically in preventing biological colonization of stone artifacts. Traditional biocides often pose risks to both the environment and the material itself, whereas EO-loaded MSNs represent a sustainable, non-toxic alternative capable of long-lasting protection.

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FO12

Recovery of Cu(II) from Printed Circuit Boards leachate via Capacitive Adsorption on Micro/Mesoporous Biochar

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Waste Electrical and Electronic Equipment (WEEE), which is steadily increasing worldwide, is among the most difficult waste streams to manage due to the presence of toxic and non-biodegradable materials.[1] Nonetheless, WEEE also offers a unique opportunity for recovering critical and strategic metals essential for economic and environmental sustainability.[2]This study focuses on the development of innovative methods for the selective recovery of metals [3,4] from printed circuit boards (PCBs) of discarded computers. Relatively mild acid leaching experiments achieved the successful extraction of various metallic elements, with quantitative copper recovery within 24 hours. Concurrently, micro/mesoporous biochar materials derived from vegetables,[5] were utilized to assess their adsorption capacity and potential as electrode materials for the simultaneous capacitive adsorption and electrodeposition of Cu (II) on their porous surface. It has been verified that they function very effectively as supercapacitors and working electrodes in electrochemical cells, improving the adsorption of copper cations and their reduction to metallic copper.[6] The proposed technology paves the way for various applications, besides the selective recovery of copper from e-Waste. Indeed, it can be potentially used for water remediation from metal contaminants and for the development of metal-functionalized porous materials for use as catalysts in chemical synthesis.

Figure 1. Graphical abstract

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FO13

Neodymium and Yttrium adsorption on citrate-modified cellulose: experimental and computational insights

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Neodymium (Nd) and yttrium (Y), two Rare Earth Elements (REEs), play a crucial role in a wide range of technology applications.[1,2,3] Separation of REEs is a challenging process, with solvent extraction being the most widely used method.[1] Although efficient, it often involves the use of hazardous compounds such as strong acids and organic solvents, resulting in the generation of harmful by-products and waste. Conversely, adsorption-based approaches offer a sustainable, innocuous, and cost-efficient substitute for solvent extraction.[4] The purpose of this work is to examine, from both experimental and computational perspective, the adsorption of Nd an Y by cellulose functionalized with the citrate group (cellulose citrate), which has been previously used by our group to remove various heavy metals from aqueous matrices.[5] Specifically, final goal of the work is to shed light on the mechanism of rare earth adsorption by citrate-functionalized cellulose, interpreting the adsorption measurements by nano-scale models. The adsorption properties of the sorbent were investigated at different contact times, pH and metal concentrations. The results demonstrate that cellulose citrate is a highly effective material for the adsorption of Nd and Y, exhibiting comparable behaviour for both metals. The adsorption process was found to be pH-dependent, with equilibrium being reached after approximately 90 minutes. Interestingly, a certain degree of adsorption selectivity was observed at low pH (~3) toward Nd. Molecular mechanics (MM) simulations and DFT calculations showed that the above selectivity could arise from the different acidity of the two carboxylic binding sites involved in metal coordination.

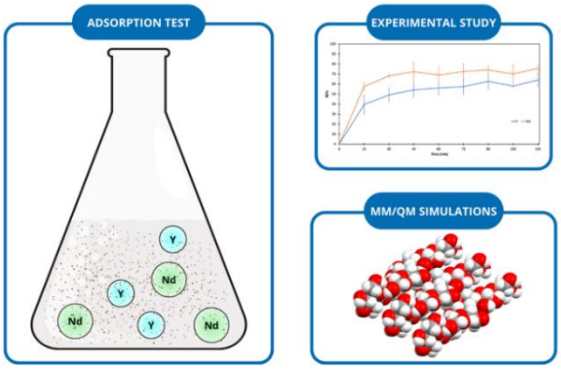

Figure 1. Graphical abstract

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FO14

SiO_2-Sodium Alginate Hybrids: Structural and Biocompatibility Assessment

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Silica-based materials synthesized via the sol-gel process are versatile matrices with great potential in biomedical and industrial fields. This technique enables precise control over key features such as porosity and morphology. These properties make them ideal candidates for drug delivery, biomedical imaging, biosensing, and bone tissue engineering[1]. Moreover, the sol-gel technique allows for the incorporation of natural polymers to form hybrid systems with enhanced physical and biological characteristics. Sodium alginate (SA), a natural polymer derived from brown algae, is widely used due to its excellent biocompatibility, low cost, and non-toxicity[2]. In this study, SiO_2 hybrids containing 2, 5, and 8 wt% SA were synthesized via the sol-gel method and characterized for their structural, morphological, chemical, thermal, and biological properties. FTIR analysis confirmed the formation of hybrid networks stabilized by hydrogen bonding interactions. X-ray diffraction (XRD) revealed the amorphous structure of the hybrids, while Brunauer–Emmett–Teller (BET) analysis showed an increase in surface area with higher SA content, which can enhance biocompatibility and cell adhesion. Thermogravimetric analysis (TGA) demonstrated improved thermal stability in the hybrid systems compared to pure SA, indicating enhanced resistance to thermal degradation. Cytotoxicity assays performed on HaCaT cells revealed that the hybrid containing 8 wt% SA induced a maximum cell viability inhibition (CVI) of 40%, indicating a moderate impact on cell proliferation at higher SA content. In contrast, hybrids with lower SA concentrations (2 and 5 wt%) exhibited negligible cytotoxicity, confirming their good biocompatibility. Furthermore, antibacterial assays against *Enterococcus faecalis* and *Escherichia coli* showed no significant antimicrobial activity.
These findings suggest that SiO_2–SA hybrid materials are promising candidates for advanced biomedical applications, particularly in drug delivery and tissue engineering, owing to their tailorable morphology, thermal stability, and biocompatibility.

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Comunicazioni Poster

PO1

Alkali activation for ceramic exhausted lime inertization

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Waste products management for most industries has become an important issue especially for those containing heavy metals that need to be disposed of in safe landfills. In the ceramic industry among the various wastes produced, the exhausted lime is classified as hazardous waste by Italian legislation, and it is produced in amount of about 15 kg per 1000 square meters of tiles. It derives from air emission treatment during the firing process, and it is composed of $Ca(OH)_2$, fluorides, sulphates, chlorides and heavy metals (such as Cu, Cd, Pb, Se etc.). Alkali-activated materials, named also geopolymers, can be used as matrix for the inertisation of exhausted lime, metals can be incorporated into the aluminosilicate network of geopolymers and bound into the structure for charge-balancing roles, or physically immobilized in the network. For the synthesis of the alkali activated material, metakaolin as aluminosilicate precursor was used, exhausted lime is added in percentage of 5 and 20wt%. with a L/S ratio of 1.10 and cured at room temperature (22 ± 3 °C) keeping the humidity level always >90%. L/S ratios of 1.40-1.60 were also studied for evaluating a possible improvement in terms of workability and curing time and trying to avoid efflorescence on the surface of the samples after exposure to air. In order to evaluate the immobilization efficiency, leaching test was performed and both cations and anions were quantified in the eluates. Interesting decrease in the release was found by comparing samples cured 7 and 28 days.

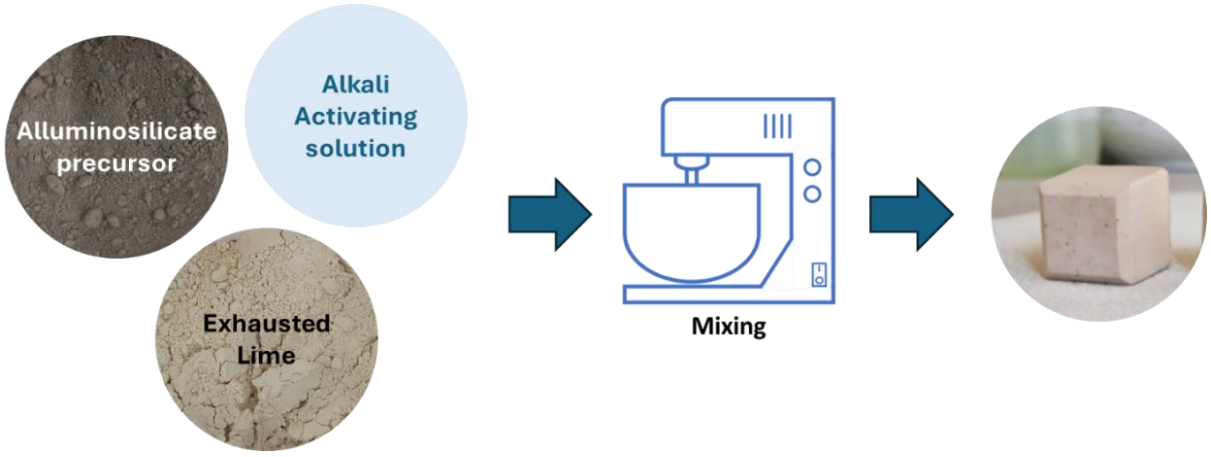

Figure 1. Alkali activated material preparation.

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"ECOSYSTEM FOR SUSTAINABLE TRANSITION IN EMILIA-ROMAGNA" cod. Progetto ECS_00000033 – CUP E93C22001100001 - PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 "Istruzione Ricerca" COMPONENTE 2, "Dalla ricerca all'impresa" INVESTIMENTO 1.5, "Creazione e rafforzamento di "Ecosistemi dell'innovazione" costruzione di "leader territoriali di R&S", finanziato dall'Unione europea – NextGenerationEU - rif. Avviso MUR 3277/2021.

PO2

Through-Plane Ionic Conductivity Measurements of Commercial Membranes and Separators Toward Industrial Nonaqueous Redox Flow Batteries

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Nonaqueous redox flow batteries (NARFBs) are interesting electrochemical devices for energy storage, mainly in the field of stationary applications. These devices offer a unique possibility to combine the decoupled sizing of their energy content and power output intrinsic to all flow batteries with wider electrochemical windows exploitable through organic solvents, resulting in increased energy densities[1]. Major research efforts have so far been focused on the redox-active species (both organometallic materials and fully organic molecules) and on the electrolytes for a tuning of the resulting electrochemical performance. On the other hand, relatively little attention[2,3] has so far been paid to membranes, crucial for avoiding short circuits and crossover of redox-active species while allowing ions of supporting electrolyte to pass through during cell operation.

Here, as part of the work carried out in the R&D division of Eni S.p.A. for the development of a proprietary technology in the field of NARFBs, a preliminary evaluation of the macroscopic chemical compatibility of commercial Fumasep ion exchange membranes (FAPQ-330, FAP-450, F-1850 and FAA-3-30) and Celgard microporous separators (2325, 2340, 2400 and 4560) fully soaked in solutions based on interesting organic solvents (acetonitrile, propylene carbonate, 3-methoxypropionitrile and dimethyl sulfoxide) and a reference salt (tetrabutylammonium tetrafluoroborate) is proposed. Rigorous through-plane ionic conductivity measurements are then provided through Electrochemical Impedance Spectroscopy and a previously reported methodology[4–6] based on stacking 1-4 samples per membrane, in order to select and use them more rationally (*Figure 1*). Preliminary full-cell results from laboratory-scale tests involving these membranes and solutions are also reported, highlighting interesting prospects for the technology.

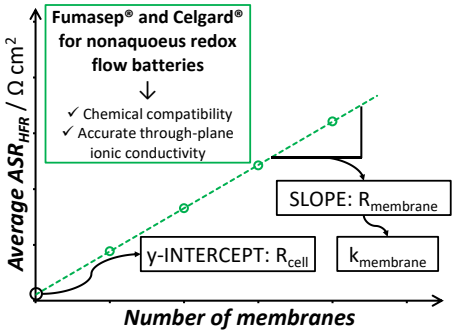

Figure 1. Conceptual scheme for accurate through-plane ionic conductivity measurements of membranes and separators for nonaqueous redox flow batteries.

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PO3

Innovative composite materials based on biochar and salt hydrate for thermochemical heat storage

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The worldwide growth of renewable energy calls for the development of new efficient and reliable energy storage systems, to face the intermittent and variable nature of renewables themselves. In this scenario, thermochemical heat storage (TCS) offers a highly promising solution due to its superior energy density and potential for long-term and seasonal thermal storage[1,2]. Whitin the framework of the Horizon Europe Pathfinder project "*CharCool"* (Grant Agreement No. 101162196.), which focuses on the development of an innovative and sustainable heat-driven cooling system, a new composite material based on biochar and hydrated salts has been developed to integrate sustainability, energy efficiency and circular economy principles. The biochar, produced from agricultural residues via gasification, acts as a porous matrix enabling uniform distribution of hydrated salts, thereby improving thermal exchange. Its mesoporous structure enhances vapor adsorption and diffusion, optimizing heat transfer and limitng crystal growth that can lead to material agglomeration and consequential performance degradation[3,4].

Multiple biochar–hydrated salt composites are being investigated through thermogravimetric analysis and differential scanning calorimetry (TGA/DSC) for assessing their heat storage/release capacity, as well as dynamic vapor sorption (DVS) measurements to determine their thermochemical performance, moisture uptake and material durability. The ongoing activity includes inorganic salts (Calcium chloride - Magnesium chloride) or organic salts (Sodium polyacrylate, di-Sodium succinate), combined with three types of biochar derived from pistachio, almond, and hazelnut shells. Preliminary results underline the potential of biochar–hydrated salt composites for sustainable TCS applications, offering the dual benefit of enhancing thermal storage performances and enabling the energy-oriented reuse of agricultural by-products.

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PO4

Photocatalytic CO_2 reduction

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The increasing concentration of atmospheric carbon dioxide (CO_2) has intensified the global search for sustainable methods to convert it into valuable fuels and chemicals. Solar powered CO_2 reduction inspired by natural photosynthesis emerges as a promising strategy to overcome this challenge by converting CO_2 into energy rich products by utilizing abundant solar energy. Various approaches, including photocatalysis, photoelectrocatalysis, and hybrid processes, have been explored to increase the efficiency and selectivity of CO_2 conversion.[1] Recent advances highlight the importance of semiconductor materials with suitable band gaps and valence and conduction bands energy levels (Figure 1), efficient charge separation mechanisms, and tailored surface properties for an efficient photocatalytic performance.[3]

At this aim, different TiO_2, TiO_2-based and alternative photocatalysts were prepared and optimized for CO_2 photocatalytic reduction in batch gas-solid reactors under simulated solar light irradiation. CO and CH_4 were the main formed compounds and their amount varied by using the different photocatalysts.

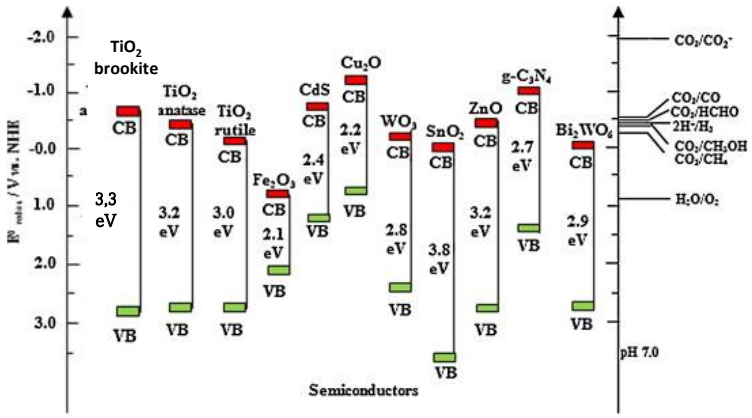

Figure 1. Reduction potentials for different products and corresponding reduction/oxidation potentials from several photocatalysts.

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PO5

Eco-sustainable recycling of red gypsum waste in road pavements

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The present study aims to apply the principles of circular economy through the eco-sustainable reuse of red gypsum waste from a TiO_2 plant in Tuscany, Italy, as an additive in road pavement formulations. It is estimated that to produce one ton of TiO_2, approximately six tons of waste red gypsum sludge are produced. The TiO_2 production process involves the reaction of titanium-rich mineral with excess sulfuric acid to form titanium sulfate, which, upon heat treatment, produces TiO_2. The remaining sulfuric acid mixture is neutralised with a sludge, mainly containing calcium carbonate, which determines the formation of calcium sulfate. A sample of red gypsum sludge was dried at 100°C and used as an additive for a 70/100 penetration grade bitumen. Bitumen blends containing 0, 10, 15, 20 and 30 wt% of waste gypsum were prepared, using a high shear mixer, at 150°C, 5000 rpm for 30 min. The blends were thoroughly characterised by thermogravimetric analysis (TGA), infrared spectroscopy in attenuated total reflectance mode (ATR-FTIR), penetration and softening point temperature determination, Brookfield viscometry, rheological characterisation using the bending beam rheometer (BBD) and the dynamic shear rheometer (DSR). The blends were also artificially aged by rolling thin-film oven test (RTFOT) and pressure ageing vessel (PAV), then analysed to evaluate the effect of gypsum addition on the in-service period. The addition of an increasing amount of red gypsum waste to the bituminous base resulted in improved resistance to permanent deformation at high temperatures (rutting), enhanced thermal stability and better adhesion between bitumen and aggregates in asphalt mixtures. However, it also led to an increase in stiffness at intermediate and low temperatures, which may promote fatigue and thermal cracking. Finally, the red gypsum addition did not significantly affect the ageing behaviour of the bituminous base.

Acknowledgements
This research was funded by the Italian Ministry of Ecological Transition under the 2021 Call for the co-financing of research projects aimed at developing technologies for the prevention, recovery, recycling, and treatment of waste not covered by existing extended producer responsibility schemes, as well as for product eco-design and proper waste management; Project ECOGESSTRA — *Eco-Sustainable Use of Red Gypsum in Construction and Maintenance of Road Superstructures* (CUP: I59I22000530001).

PO6

Fabrication of a novel cellulose-based bio-adsorbent functionalized with Mn-doped Fe_3O_4 for Congo Red removal

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Synthetic dyes pose a serious environmental pollution problem[1]. Among the various technologies used to remove these pollutants from water, adsorption is among the most efficient[2]. This work reports the production of an innovative pulp cellulose-based adsorbent functionalised with manganese-doped magnetite (PC/Fe_3O_4@Mn) for the removal of Congo Red from wastewaters. The adsorbent was prepared through the precipitation method. The adsorbent was characterized by SEM, EDS, FTIR, and XRD. Magnetic properties were evaluated, showing a ferromagnetic behaviour of the adsorbent. The adsorption capacity of PC/Fe_3O_4@Mn was compared with raw cellulose pulp (PC) and pulp doped with magnetite (PC/Fe_3O_4). Parameters such as contact time, pH (5-12), dye concentration (25-200 ppm), adsorbent dosage (0.5-3 g/L), and temperature (25-80°C) were varied to evaluate their effect on CR recovery. The data show that the adsorption capacity of the PC/Fe_3O_4@Mn sample is about four times higher than PC and PC/Fe_3O_4 systems. Among all, the Langmuir model and the Redlich-Peterson model fit the experimental data well, showing that adsorption is characterized by single-layer formation. The maximum adsorption capacity, evaluated by applying the Langmuir model, was 70.6 mg/g. Then, the Response Surface Method was used to analyze the influence of the main operating parameters on the adsorption process. The Design Expert software allowed the evaluation of the set of optimal process parameters that can maximize the recovery of CR. Finally, the magnetic properties conferred by magnetite allow the adsorbent to be removed and regenerated easily. So, the efficiency and economic feasibility of the novel bio-adsorbent were demonstrated by performing reusability cycles.

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PO7

Physico-chemical and Cytotoxicity Study of Silica/Sodium Alginate Hybrid Biomaterials

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Sodium alginate is a biocompatible, non-toxic, and non-immunogenic polymer widely utilized in biomedical and pharmaceutical fields. Its exceptional biological compatibility makes it an ideal candidate for drug delivery systems and tissue engineering, as it does not induce adverse immune responses[1]. If integrated into silica-based materials, sodium alginate can form a hybrid system that effectively combines the chemical versatility and biocompatibility of the polymer with the bioactivity and precisely controllable porosity of a silica matrix[2], thereby enhancing the material functionality in therapeutic and regenerative medicine applications.

In this context, the aim of this study was to synthesize silica-based hybrid biomaterials by incorporating increasing amounts of sodium alginate (2, 5, and 8 wt%). Comprehensive physicochemical characterization was performed using Fourier-transform infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA), along with cytotoxicity assessments on Human immortalized epidermal (HaCaT) cells, to evaluate the properties of synthesized biomaterials and lay the groundwork for their potential use in biomedical applications. FTIR analysis confirmed the successful formation of hybrids, with stabilization occurring through hydrogen bonding. Thermogravimetric analysis (TGA) showed that the presence of the silica matrix increases the thermal stability of the hybrids, thereby enhancing the thermal properties of the sodium alginate pure. Furthermore, cytotoxicity assays showed that the hybrid containing the highest amount of sodium alginate (8%) induced a maximum cell viability inhibition of 40%, indicating that even at higher polymer content, the material exhibits only moderate cytotoxicity. These results underscore the promising potential of silica/sodium alginate systems for advanced biomedical applications, thanks to their enhanced thermal stability, well-defined structure, and favorable biocompatibility. These hybrid materials provide a solid foundation for further research into the development of functional biomaterials for biomedical applications.

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PO8

Photodegradation vs. Adsorption Activity in Dye Removal by Surface-Modified TiO_2 Nanorods

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TiO_2 nanoparticles are among the most studied inorganic materials thanks to their versatile properties that enable a wide range of photocatalytic applications.[1] In this communication we present an investigation on surface-modified TiO_2 nanorods for dye removal, comparing their performance in photocatalytic degradation and in adsorption processes. TiO_2 nanorods (NRs) were synthesized by a solvothermal route in the presence of oleic acid (OA), yielding ligand-capped nanostructures (NR-OA). Ligand exchange with catechol (Cat) yielded surface-modified nanorods (NR-Cat) that maintain their original rod-like shape while bearing a strongly bound aromatic chelator on their surface as confirmed by TGA and XPS. UV–Vis DRS revealed a pronounced band gap narrowing from 2.75 eV (NR-OA) to 1.72 eV (NR-Cat), consistent with enhanced visible-light harvesting. Photocatalytic assays under visible-light irradiation demonstrated that NR-OA effectively degrades a range of xanthene dyes (Eosin B, rhodamine B, Rose Bengal) and methylene blue (MB), achieving almost complete MB removal within 60'. Scavenger experiments indicated that both OH and h^+ radicals contribute to dye breakdown. In contrast, NR-Cat exhibited reduced photocatalytic activity, attributable to its shifted conduction-band potential which favors only OH generation. However, NR-Cat displayed superior adsorption-driven removal of cationic dyes, capturing MB and rhodamine B from aqueous solution. Zeta-potential measurements (–31 mV) support this enhanced electrostatic affinity. This work is part of the PNRR NEST-Network 4 Energy Sustainable Transition project (PE0000021–Next Generation EU).

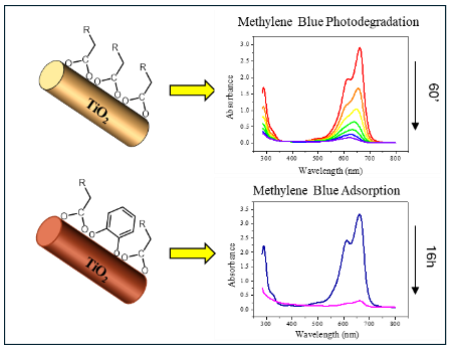

Figure 1. Comparison between TiO_2 nanorods NR-OA (top) and NR-Cat (bottom) and UV–Vis monitoring of MB decay, showing MB removal via photocatalysis (NR-OA) and adsorption (NR-Cat).

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PO9

Waste cooking oil valorization in the field of sustainable mobility

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Preparing biolubricants[1] from waste cooking oil (WCO) is a sustainable and innovative approach that addresses both environmental and economic concerns. This research highlights the multifaceted benefits of converting WCO into value-added lubricants, emphasizing its role in promoting a circular economy and reducing the environmental impact of both lubricant use and waste oil disposal. Waste cooking oil is a widely available by-product of food processing and household cooking. Improper disposal of WCO poses serious environmental hazards, while traditional lubricants derived from petroleum contribute to pollution and resource depletion. Transforming WCO into biolubricants offers a promising alternative aligned with sustainability goals. This presentation deals with the synthesis of novel biolubricants starting from waste cooking oil (WCO). Five new WCO biolubricants were prepared for testing in the automotive sector: 1) the filtered and dried WCO, 2) the WCO subjected to transesterification in methanol and subsequent partial hydrogenation (H-FAMEs), 3) the WCO subjected to partial hydrogenation, 4) the WCO subjected to selective hydrogenation towards C18:1 chains, 5) the estolide.

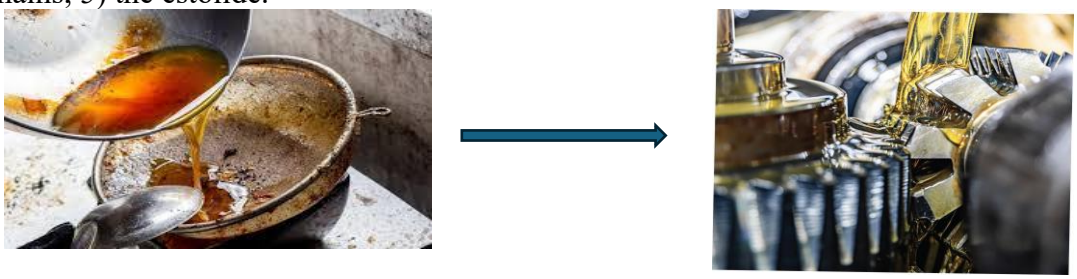

Figure 1. conversion of WCO into biolubricants.

The preparation of biolubricants from WCO represents a strategic approach to waste management, resource sustainability, and green chemistry. It offers tangible benefits in terms of environmental protection, economic viability, and industrial performance. Continued research and development in this field can further enhance the feasibility and scalability of WCO-based biolubricant production.

Acknowledgements: PNRR– NextGenerationEU Award Number: CN MOST, Concession Decree No. 1033 of June 17, 2022, adopted by the Italian Ministery of University and Research, CUP: D93C22000410001, "COmmunicating Sustainability: innovations in MAterial Recycling and new production Technologies for the automotive sector" CO-SMART" and "Reusing Exhausted vegetable Oils for lubricating Bolts and Threaded joints in the Automotive Industry" REOBTAIN" projects, Spoke 11 and Spoke 14 are acknowledged for financial support.

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PO10

Improving the properties of Poly(ethylene-co-methacrylic acid) (EMAA) using carbon nanotubes and expanded graphite

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This paper compares the effects of carbon nanotubes (CNT) and expanded graphite (EG) on the thermal, mechanical, morphological, electrical, and piezoresistive properties of poly(ethylene-co-methacrylic acid) (EMAA) nanocomposites. Various amounts of fillers (5, 10, 15 wt% of CNT and 10, 15, 30 wt% of EG) were added to the EMAA matrix. The electrical percolation threshold (EPT) was established to identify the nanofiller percentages for achieving a continuous conductive network. Thermogravimetric analysis (TGA) suggests the conductive network provides a protective barrier against thermal-oxidative degradation, while differential scanning calorimetry (DSC) shows that carbon nanoparticles influence the EMAA matrix's crystallinity. Mechanical tests indicated enhancements in stresses and moduli due to fillers, with EG offering better improvements. Notably, Tunnelling Atomic Force Microscopy (TUNA) analysis explored filler-polymer interactions. Figure 1 shows TUNA morphology of EMAA 10% CNT and EMAA 15% EG. The study focused on EMAA 10% CNT and EMAA 15% EG for piezoresistive response, revealing significant differences in the Gauge Factor (G.F.), recorded at 0.5 for CNT and 165 for EG, highlighting the effect of filler type on the self-sensing performance.

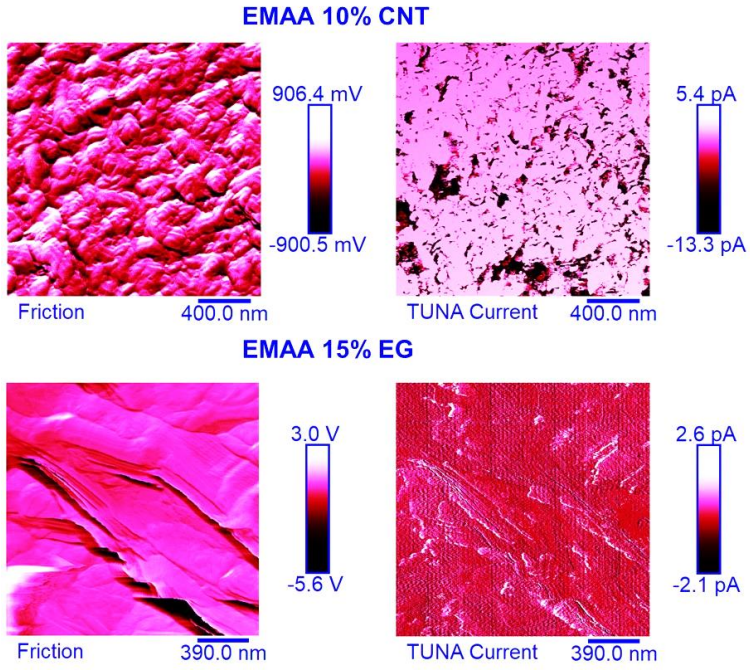

Figure 1. TUNA morphology of EMAA 10% CNT and EMAA 15% EG.

PO11

Sustainable Conversion of Plastic Waste into Valuable Liquid Fuels via Mild Catalytic Processes

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The growing accumulation of plastic waste presents a significant environmental concern, calling for innovative approaches to limit its ecological footprint 1. As global plastic production rises, a considerable portion ends up either in landfills or polluting natural ecosystems. Projections indicate that by 2050, packaging plastics alone could reach more than 300 MT, four times the current amount 2. Conventional waste management methods have proven insufficient, emphasizing the urgent need for more effective and sustainable alternatives 3. This work explores the catalytic upcycling of post-consumer plastic waste using a ruthenium-based catalyst, enabling its transformation into liquid fuels through a solvent-assisted depolymerisation process. By fine- tuning the reaction parameters, a sustainable strategy was developed to efficiently convert plastic materials into valuable hydrocarbons such as gasoline-range (C5–C12) and jet-fuel-range (C12- C20) products, while minimizing the formation of waxes (>C20) and other undesired by-products. The choice of solvent played a key role in boosting conversion efficiency and improving product distribution. These findings underline the potential of catalytic processes in converting plastic waste into high-value outputs, supporting the shift toward a circular economy and addressing the pressing issue of plastic pollution.

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PO12

Life cycle assessment of non-thermal technologies for fruit and vegetable: Cold Plasma (CP) and High Hydrostatic Pressure (HHP)

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The aim of this work, object of the TECH4PATH project (PRIN2022), is to establish whether innovative non-thermal food preservation technologies[1] can provide significant reductions in energy consumption and corresponding greenhouse gas (GHG) emissions, while ensuring the same microbiological preservation, nutritional and organoleptic quality of conventional processes. Two new non-thermal food preservation technologies[2] such as Cold Plasma (CP) and High Hydrostatic Pressure (HHP), were chosen in the study. The comparison between traditional and new technologies was carried out through the LCA methodology in order to provide environmental criteria in the selection of food preservation methods, to develop more efficient and sustainable food products throughout their life cycle.

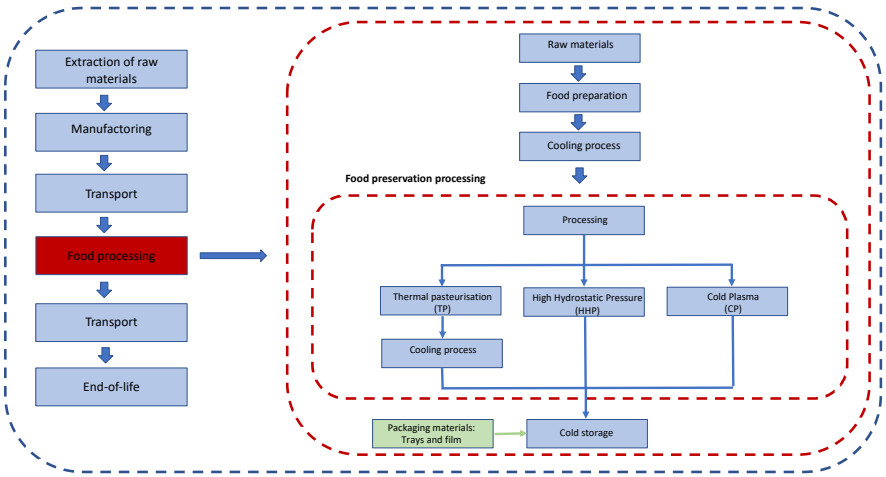

Figure 1. System boundaries of the evaluated preservation technologies.

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The project "TECH4PATH - Non-thermal TECHnologies FOR the inactivation of emerging viral, bacterial and protozoan PATHogens on fruit and vegetable products" is founded by MUR - Ministero dell'Università e della Ricerca - PRIN: Progetti di Ricerca di Rilevante Interesse Nazionale, Bando 2022 (cod. 2022YB8ABM; CUP E53D23011070006) (D.D. 104 del 02/02/2022 - PNRR per la Missione 4, Componente 2, Investimento 1.1)

PO13

Sol-Gel Synthesis and Characterization of Biomaterials with Ferulic Acid

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The integration of biomedical devices into the human body can elicit adverse responses, including infections and inflammation, potentially leading to implant failure. Natural products have emerged as a key source of novel pharmaceutical molecules capable of counteracting these effects. The Sol-Gel technique is a method that has been utilized for the synthesis of a wide range of materials, including biomaterials and involves the formation of a sol, defined as a colloidal dispersion of solid particles in a liquid, which is subsequently transformed into a gel, a cross-linked three-dimensional solid structure, through polymerization or cross-linking processes[1]. In the context of biomaterials, the sol-gel technique has been utilized to generate materials with particular characteristics that are well-suited for diverse biomedical applications, including tissue regeneration, drug delivery, and tissue engineering. The aim of this work is to utilize the Sol-Gel synthesis technique to develop biomedical implants that possess antioxidant and antibacterial properties. In this study, ferulic acid (FA) was incorporated into a silica matrix (SiO_2) at varying weight percentages (5, 10, 15, 20 wt%). Ferulic acid, otherwise known as hydroxycinnamic acid, is a phenolic compound that is found in several plants, including *ferulia* (from which it takes its name), but especially in oats, rice, corn, citrus fruits and bran. The substance has been demonstrated to possess antioxidant and antimicrobial properties[2]. Physical, chemical and biological characterization was carried out on all the synthesized materials[3]. These properties contribute to its versatility in various contexts, including natural medicine and cosmetics. The present study investigated the interactions between different organic and inorganic phases in the hybrid materials using Fourier transform infrared spectroscopy (FTIR). The controlled release was monitored at different time intervals through the use of UV-vis spectroscopy. The antioxidant activity was evaluated using the FRAP method, the antibacterial properties were tested on *gram*$^-$ and *gram*$^+$ and biocompatibility was identified on a cell line.

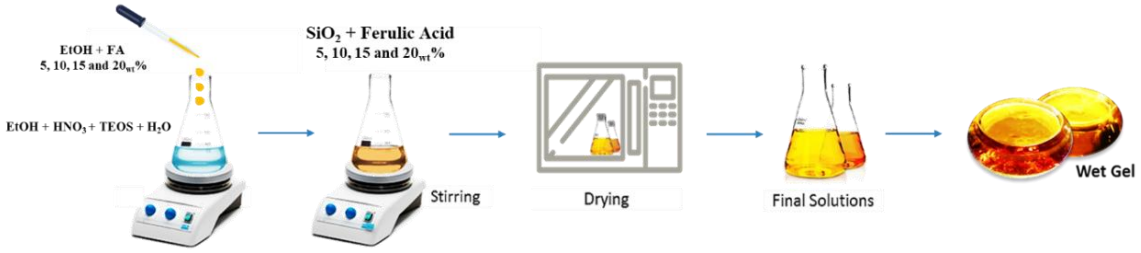

Figure 1. Sol-Gel procedure used to obtain hybrid materials under study.

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PO14

Sodium Iron Phosphate: Cathode Material for Large Scale Batteries

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The rapid development of human society has led to a proportional increase in energy demand that has been met by fossil fuels. [1] Due to global warming, interest in renewable energy and highly efficient energy storage technologies is increasingly greater. The main storage technology on the market is represented by lithium-ion batteries (LIBs). However, the continuous price increases and the difficulty of supplying lithium has pushed many researchers to study alternative storage systems such as sodium-ion batteries (SIBs), technologies based on sodium, a much more abundant and economical element. Many researchers in the past have studied NaFePO4, discovering that it is present in crystalline form as maricite, electrochemically inactive, highlighting however how an amorphous structure can potentially overcome this problem. [2] Our work is based on the development of a synthetic route that, starting from ferrous ammonium phosphate (FAP) leads to the formation of NaFePO4 through a metathesis reaction. The reaction is carried out both thermally using sodium acetate or sodium hydroxide, and mechanically (ball milling) with sodium hydroxide. The resulting materials will be characterized by thermal (TGA and DTA), crystallographic (XRD), morphological (SEM) and electrochemical analysis. The electrochemical characterization will be conducted by first making electrodes with a variable composition of NaFePO4 KJB carbon, as a conductive agent, and Teflon as a binder, which were then inserted into coin cells and tested galvanostatically at C/10 speed.

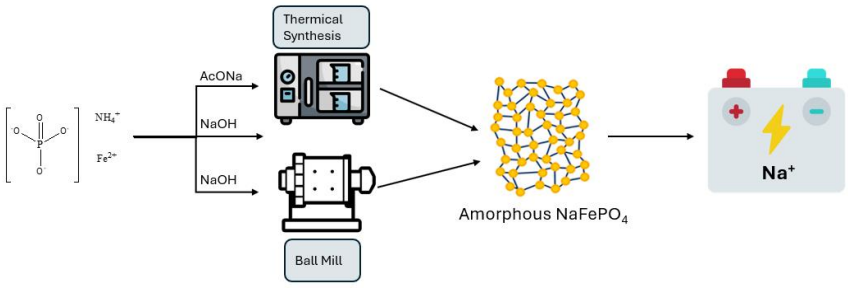

Figure 1. Synthesis of amorphous $NaFePO_4$

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PO15

Physicochemical Characterization of LDPE greenhouse films treated with agrochemicals

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Polyethylene (PE) is durable, and has low stiffness, but has high toughness and impact resistance as well as low friction. Low-density polyethylene (LDPE) has more branches (about 2% of carbon atoms) than high-density polyethylene (HDPE), so its intermolecular forces (bipolar-bipolar attraction) are weak, its tension is lower, and its resistance is higher. Thus, since its molecules are not tightly packed and less crystalline due to lateral branches, its density is lower.

LDPE is suitable for thermoplastic mold processing and good mold making capabilities, its main uses are in packaging (bags, films, seismic screens, bottles, etc.) [1,2]. In the last twenty years, the wide distribution of protected cultivation has increased the production and marketing of a large variety of greenhouse covering materials, among LDPE films plays a dominant role in the sector [3].

In this study, LDPE films for agricultural applications were sprayed with pesticides and their thermomechanical performance was evaluated, compared to uncontaminated samples, through techniques such as thermogravimetry, differential scanning calorimetry and dynamic mechanical analysis.

It was observed how the pesticide treatment affected the thermal properties, such as the glass transition temperature, the melting temperature and the initial decomposition temperature

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PO16

Thermal Conductivity Measurements: a Combined Instrumental Approach

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Thermal conductivity refers to the intrinsic ability of a material to transfer or conduct heat. It is defined as the amount of heat per unit of time and unit area that can be conducted through a plate of a given material with a unit of thickness when the difference of temperatures between the opposite surfaces is one unit of temperature [1]. Enhancing of thermal conductivity of thermoset resins for various applications, namely, circuit board in power electronics, measuring of thermal conductivity for heat dissipators as well as the thermal management in general are always current operations and in strong growth in demand in all phases of device manufacturing. The accurate calculation of thermal conductivity is based on the following relationship:

$$k = \alpha \cdot \rho \cdot C_p$$

where α is the thermal diffusivity, ρ the density, and Cp the specific heat capacity, thus involving different typologies of measurements with different instrumental techniques: the Laser Flash Analysis (LFA) method, the Archimedes' method and Differential Scanning Calorimetry (DSC).

Figure. Laser Flash Analysis (LFA) method, the Archimedes' method and Differential Scanning Calorimetry (DSC).

This work describes the procedure to best combine these techniques in order to obtain accurate and reproducible results.

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PO17

Novel hybrid nanocellulose-porphyrins based optical chemical sensors for heavy metal ions detection

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Two porphyrinoid ligands, the novel zinc complex of [5,10,15,20-tetraphenylporphyrinato-2,3-(1′,3′-bis(imino-dibenzo-18-crown-6))] (ZnPC) synthesised and fully characterised in our laboratories[1] and the free-base 5,10,15,20-tetraphenylporphyrin, TPP, were tested for heavy metal ions (HMIs), assessment of complex media and real water samples. The ZnPC and TPP ligands were uploaded on nanocellulose fibers (CNF) support and tested as all-solid-state colorimetric optodes. The sensing spots prepared with TPP@CNF0.3% were capable of recognizing Ni^{2+}, Co^{2+}, Cu^{2+}, and Zn^{2+} ions in their individual aqueous solutions, while ZnPC@CNF0.3% was sensitive mainly to Pb^{2+} and Cd^{2+} ions, thus confirming their potential for HMIs detection. Further, the performance of both TPP@CNF0.3% and ZnPC@CNF0.3% optodes was tested in several multicomponent HMIs solutions. The results obtained supported the efficiency of developed optodes, demonstrating that they could identify Cd^{2+} and Pb^{2+} ions according to the non-linear PLS1 model. The estimated LDLs (0.0018 mg/L and 0.0033 mg/L, for Cd^{2+} and Pb^{2+} respectively) were lower than the WHO provisional guideline values for natural waters.

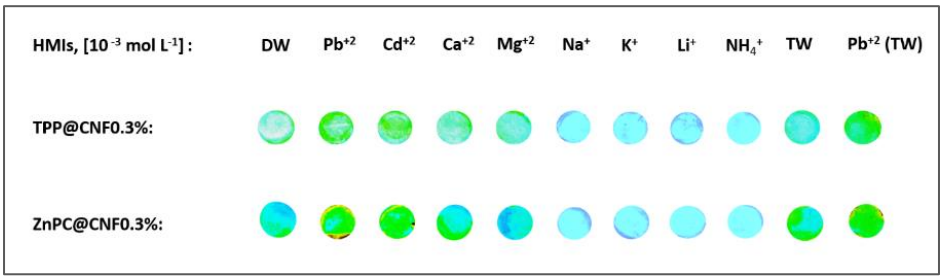

Figure 1. Optical responses of TPP@CNF0.3% and ZnPC@CNF0.3% to interfering cations (Pb^{2+}, Cd^{2+}, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Li^{+}, and NH_4^{+}) at the concentration of 10^{-3} mol L^{-1} in distilled water (DW), as well as to tap water (TW) and to Pb^{+2} (10^{-3} mol L^{-1}) in tap water.

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PO18

Amphiphiles-functionalized colloidal F/ZnO quantum dots as biocompatible fluorescent nanoprobes.

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Semiconductor quantum dots (QDs) have emerged as promising materials for biotechnological applications.[1] Among them ZnO-QDs are highly favourable owing to their ability to dissolve slowly under physiological pH conditions, leading to minor alterations in extracellular zinc concentrations, thereby mitigating cytotoxicity concerns. Uncoated QDs cannot be directly utilized in biological applications due to challenges like colloidal instability and low biocompatibility. In this context, the surface modification with amphiphilic molecules can lead to biocompatible and stable QDs-based formulations for biotechnological applications.

Here, we synthesized via wet-precipitation fluorine-doped ZnO-QDs, named F/ZnO-QDs, which were functionalized by using oleic acid and synthetic glyceroglycolipids exploiting hydrophobic interactions to produce amphiphilic nano-formulations.[2] A combined analysis based on Transmission Electron Microscopy (TEM), Light/X-Ray Scattering, FT Infra-Red, UV-visible and Fluorescence spectroscopy lead to define the physicochemical features of such engineered amphiphiles-functionalized F/ZnO-QDs, which showed a high colloidal stability and a broad emission peak at 550 nm. Biological assays and cytofluorimetric analysis confirmed a greater biocompatibility together with a high ability in ROS regulation and cells uptake, opening to their use as fluorescent nanoprobes for molecular recognition and biomedical detection.

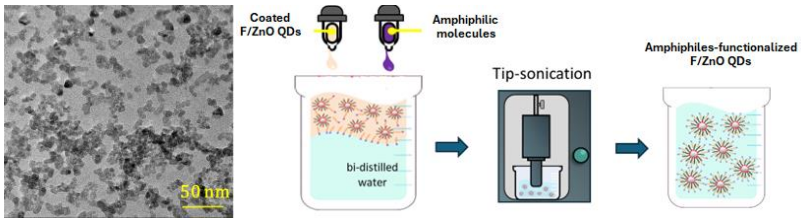

Figure 1. Schematic representation of amphiphiles-functionalization of F/ZnO quantum dots.

Acknowledgments and fundings – This study was supported by National Recovery and Resilience Plan (NRRP) funded by the European Union – NextGenerationEU, Project PRIN2022 "Glycolipids-coated colloidal quantum dots as optical biosensing platform for selective molecular recognition (GLYBIOSENS)" code:2022PJP24F, CUP: E53D23009450006 and by Cascade Call Project "Nanoprobes for the retinal diagnosis of neurodegenerative diseases (NANOEYE)", funded under the Tuscany Health Ecosystem (ECS_00000017), CUP: E67G24000380006.

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PO19

Application of a natural zeolite for the recovery of neodymium

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Rare earth elements (REEs) are critical raw materials (CRMs) in high demand across numerous strategic industrial sectors. Notably, neodymium (Nd) is essential for producing neodymium-iron-boron (NdFeB) magnets, used in wind turbines, traction motors, and robotics.[1] The REEs high cost, limited recycling, and reliance on foreign sources make their recovery increasingly important.[1] Hydrometallurgical processes are advantageous for recovering REEs from waste magnets, offering efficient metal separation, low emissions, and reduced energy use. Solid-phase extraction using zeolites can be employed in metal separation due to their cation selectivity, large surface area, high ion exchange capacity, and stable pore structure.[2] They are also low-cost, abundant, and chemically and thermally stable, allowing reuse across multiple cycles.[3]
This study investigates the extraction of Nd^{3+} and Pr^{3+} using natural clinoptilolite-type zeolite in batch mode. Maximum sorption was achieved at pH 6, 2 $g \cdot L^{-1}$ sorbent dose, and 90 minutes contact time. The pseudo-second-order Ho model[4] best described the kinetics, indicating chemisorption via ion exchange. The Langmuir isotherm fit best, indicating monolayer adsorption on a homogeneous surface. Temperature had limited effect on sorption capacity, which reached 8.8 and 14.8 $mg \cdot g^{-1}$ for Nd^{3+} and Pr^{3+}, respectively.

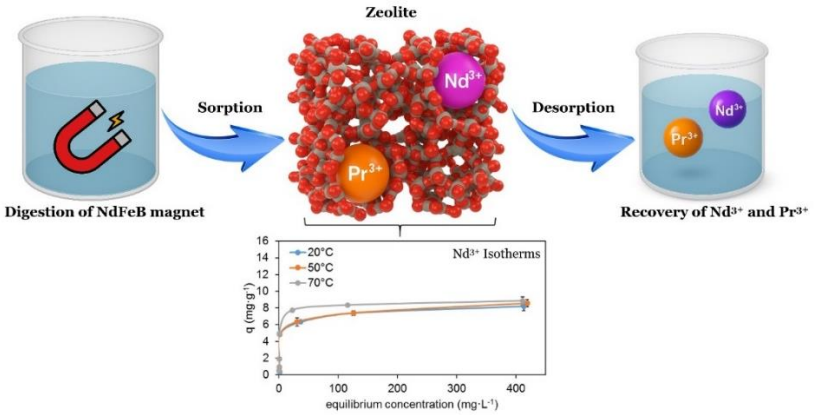

Figure 1. Leaching, adsorption and desorption process

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PO20

A new push-pull dye for semi-transparent p-type DSSCs

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In recent decades, interest in photovoltaic technologies has achieved a significant increase. Among the different technologies, Dye-Sensitized Solar Cells (DSSCs), a photoelectrochemical cell consisting of a dye capable of sensitizing a *n*-type semiconductor (TiO_2) proposed for the first time by Grätzel in 1991[1], has recently revamped thanks to their highly tuneable wave-selectivity, semi-transparent fashion and the possibility of delivering high efficiency under diffuse and indoor illumination[2]. During the last 30 years, in terms of photo-conversion efficiency, *n*-type DSSCs (*n*-DSSCs) have achieved significant progress, reaching certified efficiency as high as 15.2% in 2022[3]. In contrast to *n*-DSSC, where the current is generated by the transfer of an electron from the photo-excited dye to the *n*-type semiconductor conduction band, in *p*-DSSC there is a hole injection from the HOMO of the photo-excited dye to the valence band of the *p*-type semiconductor[4,5].

In this work, we report on the synthesis of two new dyes to be employed as sensitizers in *p*-type DSSCs[6]. The design of the two new molecules has been inspired by the state-of-art dye **PMI-6T-TPA**. In particular, a specific engineering of the thiophene-based central core favours structural planarity between an oligothiophenic p-spacer and the acceptor and donor units made by peryleneimide (PMI) and triphenylamine (TPA) moieties, respectively. This leads to a wide absorption in the NIR with stabilization of the HOMO energy level in the resulting dyes, as supported by TD-DFT simulations and spectroscopic characterization. When tested in NiO_x-based *p*-type DSSCs, **A6D** outperforms P1, a benchmark dye in the field, also showing a quite remarkable value of stabilized efficiency as high as 0.15% when I^-/I_3^- is employed as redox couple. Notwithstanding the panchromatic feature of the sensitizer, **A6D**-based devices show an average visible transmittance (AVT) of 8%. Such a result paves the way toward the application of these types of multifunctional dyes in semi-transparent solar cells.

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PO21

Porous geopolymers for thermal insulation: insights from a Life Cycle Assessment study

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Geopolymers have been widely studied for their potential as a sustainable alternative in the construction sector, particularly due to their ability to incorporate industrial waste streams as functional components. Evaluating these systems through Life Cycle Assessment (LCA) is essential to identify environmental trade-offs and guide the development of greener manufacturing practices. This study applies the LCA methodology to an experimental system for producing a porous, metakaolin-based geopolymer paste incorporating ashes derived from the combustion of both vegetal and animal biomasses. The resulting blocks were designed for thermal insulation applications in the construction sector, serving as potential substitutes for traditional inorganic insulation materials, such as autoclaved aerated concrete (AAC). The life cycle inventories (LCI), initially developed for laboratory scale production, were also scaled up to industrial level using established frameworks and modeling approaches for large-scale LCAs[1]. The environmental performance of the scaled-up porous geopolymer was then compared to that of a conventional AAC block, adopting a cradle-to-grave approach with a functional unit that ensures equivalent thermal insulation performance. In line with previous LCA studies, the potassium-based alkaline activator was identified as the main contributor to the overall environmental impact, followed by metakaolin production. Despite process optimizations that eliminate high-temperature treatments, additional impacts arise from energy use during mixing, drying, and consolidation. Partial substitution of metakaolin with biomass ashes was shown to reduce the overall environmental footprint of the geopolymer blocks. However, a direct comparison with AAC highlights the need for further impact reductions to make geopolymers a truly competitive alternative from an environmental perspective. The findings of this LCA study can support the adoption of more sustainable practices in geopolymer production, while also highlighting the potential benefits of incorporating industrial waste streams into value-added building materials.

This study was funded under the National Recovery and Resilience Plan (NRRP), Mission 04 Component 2 Investment 1.5 – NextGenerationEU (Call for tender n. 3277 dated 30/12/2021 - Award Number: 0001052 dated 23/06/2022). CUP E93C22001100001, spoke 5.

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PO22

Waste Ceramic Capacitors as Efficient and Recyclable Catalyst for the Reduction of Nitroarenes into Anilines in Water at Room Temperature

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This study deals with the use of ceramic capacitors (commercial, **CC**, or extracted from waste printed circuit boards, **WC**) as pre-catalysts for the reduction of nitroarenes into anilines using $NaBH_4$ as reducing agent. Capacitors are frequently found in electronic waste (e-waste), since they are key components of mother boards. E-waste contain potentially toxic and polluting substances, which pose a threat to human health and the environment[1]. On the other hand, if properly managed, they become valuable resources thanks to their high content of critical raw materials[2]. In this procedure, after grinding and calcination, the magnetic fractions of **CC** and **WC** (*i.e.* **MCC** and **MWC**, respectively) were tested as catalysts in the reduction of nitroarenes to their corresponding amines, carried out under environmentally friendly conditions, using water as the solvent at room temperature. **MCC** and **MWC** were active and selective due to the presence of CuO. In addition, their magnetic properties allowed an easy removal from the reaction medium by means of an external magnet, permitting easy recycling of the catalyst for subsequent runs.

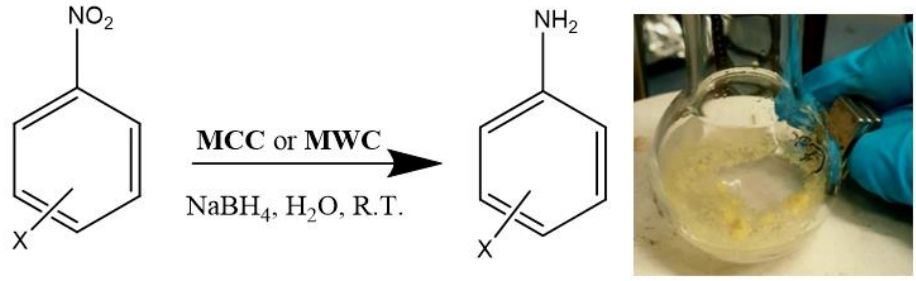

Figure 1. Reduction of nitroarenes catalysed by **MCC** and **MWC** and magnetic separation of the catalyst from reaction mixture

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PO23

Hybrid nanomaterials from biowastes for sustainable agriculture

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Nano-fertilizers can heavily support transition towards a more sustainable farming system, by exploring eco compatible materials able to enhance nutritional efficiency, biotic and abiotic stress tolerance, and/or crop quality. At the same time, BWs are emerging as a cheap and abundant source of chemical and biological richness, in view of their multiple properties including metal ion chelating, as well as intrinsic red-ox behaviour involving antioxidant and antimicrobial activity. Among BWs, lignin and humic acids exhibit great efficacy in improving plant growth and nutrition[1]. Furthermore, molecular combination of BWs with an inorganic nanostructured phase can address the issues related to high heterogeneity, provide stability and boost intrinsic bioactive features[2]. In this context, hydroxyapatite (HA), is an ideal component for forming hybrids with lignin (L), expanding its applications. Moreover, encapsulation of hybrid nanostructures into electrospun fibers can provide with 2D and 3D constructs mimicking soil structure. Herein, it is highlighted the bio-stimulant potential of hybrid nanomaterials derived from BW valorization. Notably, hybrid BW-apatite (HA-L) nanostructures have been designed and encapsulated into electrospun polylactic acid (PLA) fibers (Figure 1). Obtained nanostructured materials exhibit marked antioxidant activity as well as widespread potent biocide action towards phytopathogenic bacteria and fungi. Furthermore, they promote proliferation of microorganisms beneficial to the soil microbiome. Following a holistic approach to sustainability, this study provides with organo-mineral systems with multifunctional activity and boosted efficacy.

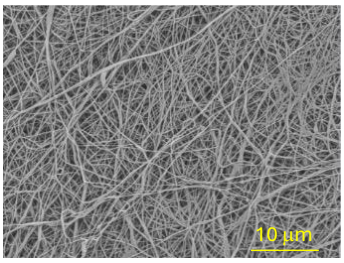

Figure 1. SEM micrography of PLA-HA-L mats

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PO24

Synthesis of nonlinear optical materials for quantum sources

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The development of nanostructured nonlinear optical (NLO) materials plays a key role in photonics due to the advanced functionalities these materials can provide, including single photons, entangled-photon pairs, and quadrature-squeezed states[1]. Sol-gel NLO materials are a remarkable alternative to traditional ones due to the intrinsic versatility of this synthetic technique that is easily integrable with other technologies.

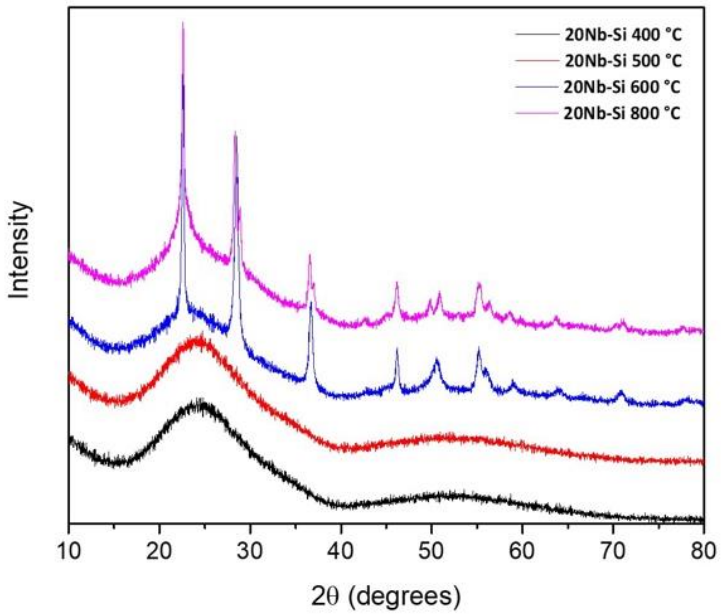

Figure 1. XRD patterns of 20Nb ($20Nb_2O_5 \cdot 80SiO_2$) powdered samples heat-treated for 1 h at 400, 500, 600 and 800°C.

Sol-gel nanomaterials belonging to Nb_2O_5-SiO_2 and ZrO_2-SiO_2 binary oxide systems have been obtained in the frame of the research activity of this NLOQS PRIN PNRR project. These materials will be subjected to proper drying and heat treatment programs to give film/gel-derived materials with amorphous and/or crystalline nanostructuring.

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PO25

Comparative Study of Adsorption and Mechanical Characteristics of Composite Coatings using Zeolite 13X, SAPO-34, and Silica gel for sorption technologies

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Electric vehicles are advancing in the shift to renewable energy. A key hurdle is their reduced driving distance, especially in cold weather, where energy is required for cabin heating [1]. A promising approach to address this challenge involves using a thermal storage system based on sorption materials, allowing for efficient air heating and dehumidification while saving a high energy amount. The effectiveness of the system is proven, but more research is needed to confirm that the adsorbent materials can withstand the mechanical stresses involved in non-stationary conditions to allow its industrial applicability[2]. In this context, the present study is dedicated to development and comparison of innovative composite coating using zeolite 13X, SAPO-34 and silica gel, based on a sulfonated pentablock terpolymer (Nexar) as the binding material. A series of composite coatings incorporating varying amount of fillers (80-95wt%) were developed. The coatings were deposited onto aluminium substrates and evaluated for their mechanical strength, surface morphology, thermal stability, and adsorption performance. The results demonstrate that all composites exhibit a consistent trend: as filler content increases a progressive reduction in mechanical performance was observed. Compared to other fillers, zeolite 13X exhibits slightly improved stability in impact and scratch tests, along with a slightly reduced adhesion (0.82MPa) to the substrate. Water vapor sorption measurements demonstrated that the polymer matrix did not hinder the adsorption/desorption process in the solid sorbents. All coatings exhibited a sorption capacity consistent with the amount of active filler added. As expected, the highest sorption capacity was observed in the coating formulation with the highest filler content (95 wt%). All compounds showed enhanced thermal stability compared to the neat polymer and exhibited good adsorption/desorption reversibility, making each one suitable for this application based on their specific operating conditions.

Acknowledgments

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PO26

Carbon-Based Materials in Combined Processes for Removal and Functional Application of Indigo Dye

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This study evaluates the effectiveness of removal and functional application of indigo dye, specifically potassium indigotrisulfonate (ITS), using different carbon-based materials: activated carbon (AC), multi-walled carbon nanotubes (MWCNT), graphitic carbon nitride[1] (*g*-C_3N_4), thermally etched carbon nitride nanosheets[1] (C_3N_4-TE) as well as chitosan-based films (CTS).
This work is motivated by the need to treat dye-laden industrial wastewater. Catalytic ozonation experiments carried out by using AC, MWCT, (g-C_3N_4), and (C_3N_4-TE) demonstrated that all catalysts achieved rapid decolorization, with over 99% dye removal within just 120 seconds of reaction time. This high efficiency under short contact conditions highlights the potential of the process for practical, high-throughput wastewater treatment. Beyond performance assessment, the study explores the mechanisms underpinning catalytic ozonation, focusing on the interactions among ozone, dye molecules, and catalyst surfaces. Key process parameters, such as the point of zero charge (PZC), the pKa of the dye and the pH of the solution can influence the ozonation efficiency.[2] These factors govern ozone decomposition, radical generation, and dye-catalyst affinity, thereby shaping the overall treatment outcome. Complementary adsorption studies were conducted to decouple adsorption effects from catalytic activity. Among the materials tested, MWCNT showed the highest dye adsorption capacity (43.4% removal in 60 s), followed by AC and C_3N_4-TE (21.4%), the latter performing notably well despite its significantly lower surface area.[3] To the best of our knowledge, this is among the first studies to systematically evaluate catalytic ozonation of indigo dye under short contact times. CTS films have developed as eco-friendly adsorbents for ITS removal (>99% from 16 mg/ml secondary treated wastewater solution) and the dye was completely decoloured by simple UV-vis exposure. ITS dye itself in combination with carbon-based materials can play an important role in promoting photocatalytic processes concerned with the water splitting for H_2 production. In a typical experiment, 25 mg of g-C_3N_4 catalyst were dispersed in a 57 mL sealed glass reactor containing 20 mg of glucose dissolved in 30 mL of water. The photoreaction started when 2 mL of ITS ($1.3\ 10^{-3}$ M) were added into the reactor exposed to the sunlight. Under these experimental conditions 2955 ppm (29.34 mmol $g^{-1}\ h^{-1}$) of H_2 were produced and detected by using a gas sensor.
All the studied processes can be considered as effective strategies for ITS dye removal from water matrices, contributing to the development of scalable, sustainable solutions for industrial wastewater treatment.

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PO27

Chemical characterization of heavy metals and anions encapsulated in geopolymers with reducing and chelating agents

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Geopolymers are a class of inorganic polymers ($M_n[-Si-O_2]_z[-Al-O]_n \bullet wH_2O$) synthesized through the alkaline activation of aluminosilicate precursor. Their three-dimensional network, formed by Si-O-Al bonds, makes them suitable for a wide range of applications, including the remediation of contaminants[1].

In this study, galvanic sludge (DE) was incorporated into a geopolymeric matrix with the aim of immobilizing and stabilizing the heavy metals contained in this industrial waste. Considering the extremely high concentrations of metals present, particularly chromium and nickel, at 40.01 %wt as Cr_2O_3 and 18.06 %wt as NiO respectively in dried waste, various stabilizing agents, acting through chelation or redox mechanisms, were evaluated and incorporated to improve the immobilization performance. Leachable contaminants were assessed by ICP analysis (UNI EN 12457), while the reticulation of the geopolymer was investigated by integrity test in water, ionic conductivity and pH measurement on the eluates, FT-IR and XRD on the solids.

The results show promising immobilization efficiencies, positioning these formulations as potential solutions for environmental remediation and waste management.

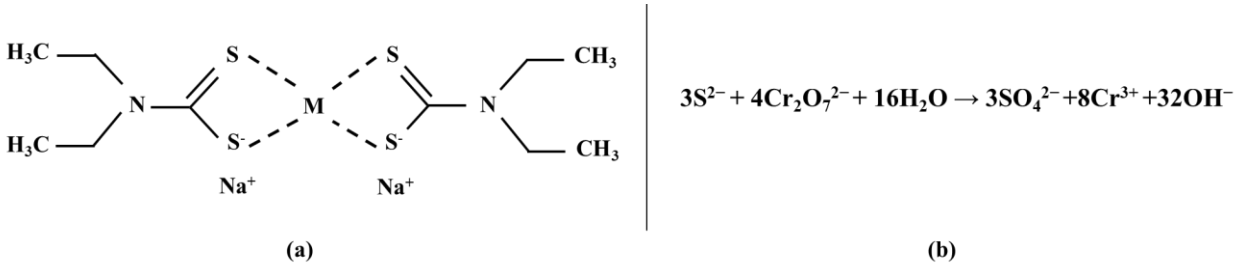

Figure 1. Chelation via dithiocarbamate DTC (a) and reduction of chromium (VI) using sulphide (b).

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Acknowledgments

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PO28

Nanocellulose from Industrial By-Products as a Renewable Platform for Advanced Materials

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The replacement of synthetic polymers with renewable, low-impact materials is a critical priority in materials and chemical engineering. In this context, this work focuses on bacterial nanocellulose derived from industrial fermentative by-products. The purified material exhibited a porous nanostructured architecture, high crystallinity and purity, excellent water retention capacity, and mechanical resistance and viscoelasticity suitable for engineering applications. The nanocellulose was employed as a hydrogel in various cultural heritage conservation applications, ensuring effective surface contact and sustained moisture retention on complex substrates. When combined with active agents such as chelators, organic solvents, or ozone, it served as a controllable delivery system for surface cleaning, demonstrating outstanding performance on porous materials. These results highlight the potential of nanocellulose sourced from waste streams as a sustainable platform for the development of advanced bio-based materials.

PO29

Preliminary Characterization of Synthetic Fibers from Fast Fashion Textiles: A Step Toward Sustainable Recycling Strategies

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The fast fashion industry is one of the leading sources of textile waste globally, often inadequately recovered or recycled, with a significant environmental impact due to the high content of synthetic fibers derived from fossil sources.[1] A further complication to recycling is the widespread presence of blended fibers and synthetic dyes, which makes recycling processes more challenging due to the need for separation and purification steps to achieve high-quality recycled products.[2] This study represents a preliminary phase in the development of innovative recycling methods for synthetic fibers. The work focused on FT-IR and thermogravimetric analysis to characterize fabrics selected from commercial products distributed by fast fashion retailers, with the aim of identifying their polymer composition. The obtained data enable a preliminary classification of the materials based on their chemical composition, offering valuable insights for the development of selective and targeted recovery strategies for synthetic fibers, in accordance with circular economy principles.

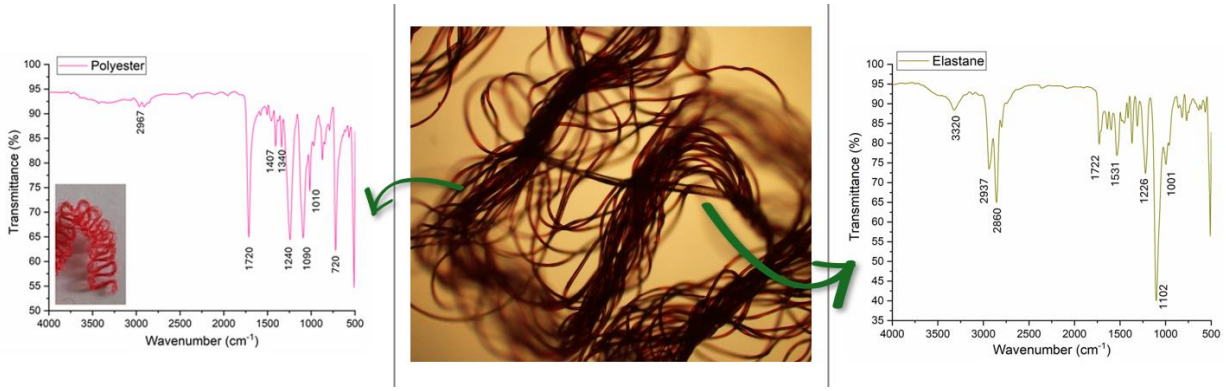

Figure 1. Optical microscopy image of an elastane filament woven with polyester fibers, alongside the corresponding IR spectra of each fiber type.

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PO30

Microfluidic-assisted synthesis of bioactive glass nanoparticles

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Silica bioactive glass nanoparticles (BG NPs) represent the latest advancements in sol–gel-derived nanomaterials, offering large surface areas and porosity. These nanomaterials can be doped with a wide range of biologically active ions, making them promising candidates for soft and hard tissue repair and engineering[1,2]. Microfluidics has emerged as a potential tool for the in-flow production of NPs, providing platforms for controlled and highly reproducible syntheses[3]. The aim of the present work is the design of silica-based bioactive glass NPs, through the optimization of an in-flow process. In particular, the synthesis was performed in a PDMS-based microfluidic platform (Figure 1), conceived as sol-gel reaction device for the production of SiO_2 (100), SiO_2-CaO (70:30) and SiO_2-CaO-ZnO (70:20:10) BG NPs. The resulting NPs were physically and chemically characterized by Transmission and Scanning Electron Microscopy, Dynamic Light Scattering and Inductively Coupled Plasma Optical Emission Spectroscopy.

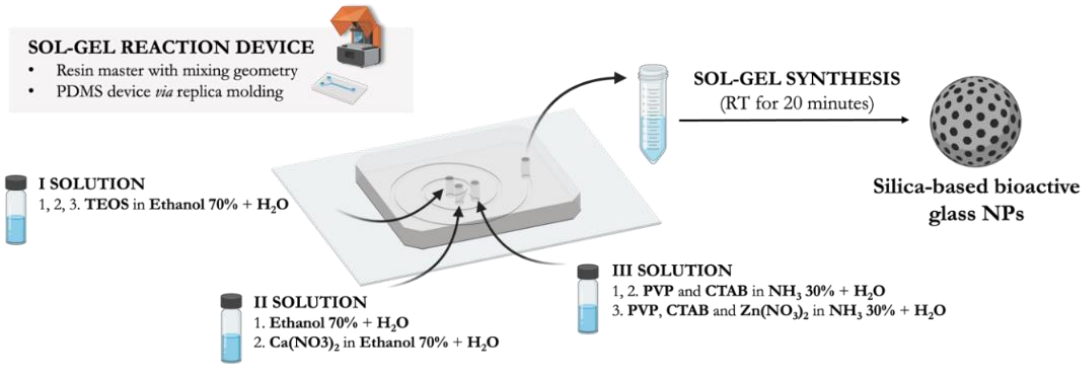

Figure 1. Experimental setup for the in-flow synthesis of BG NPs.

The evaluated process has successfully enabled the production of BG NPs with optimal characteristics, particularly in terms of size, polydispersity index and composition. Therefore, the optimization of the synthesis by combining the sol-gel microfluidic approach with the ability to incorporate various biologically active ions, such as calcium and zinc, has the potential to facilitate the design of nanomaterials with tailored functions, ultimately improving NPs performance in a variety of clinical applications.

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PO31

In vitro models of marine ecotoxicology

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The common bottlenose dolphin (*Tursiops truncatus*) represents a sentinel for marine pollution as it is at the top of the food chain and it lives in coastal area, which are more exposed to anthropic factors. Dolphin skin represents a major barrier to exogenous substances and a potential bioaccumulation site for pollutants. Among these, per- and polyfluoroalkyl substances (PFASs) can well testify the enormous impact of anthropic activities on the marine ecosystem. PFASs have long been used in materials formulations for their chemical stability and water resistance. This aspect, however, has made them a class of persistent organic pollutants ("forever chemicals"), raising major concerns for their toxicity to man and animals[1], which persists long after their progressive industrial abandonment in the 21st century.
By combining organ-on-chip technology, automated microscopy and AI-based image analysis, we developed a high content screening platform for the evaluation of the phenotypic changes associated to the exposure of dolphin fibroblasts to perfluorooctanoic acid (PFOA).
SV40-immortalized skin-derived fibroblasts[2], obtained according to a methodology patented by the Univ. of Padova (Sea Sentinel System) starting from primary fibroblasts harvested and isolated from stranding events (already available at the Univ. of Padova, cryopreserved cell repository - Mediterranean Marine Mammals Tissue Bank, CITES nr. IT020) were used for the generation of 3D spheroids. Spheroid generation was achieved in agarose microwell arrays, produced as replicas of PDMS molds. PFOA-treated spheroids were analyzed by fluorescence-based assays and compared to untreated controls. Micrographs were quantitatively analyzed using a Deep Learning segmentation tool (ZEISS Arivis).
Overall, our results show that the proposed in vitro model is successful in quantifying the phenotypic changes in *Tursiops truncatus* dermal fibroblasts following exposure to marine pollutants. This innovation could help to better understand the hurdles posed by anthropic factors to marine mammals, therefore providing the scientific community with new tools to contrast biodiversity decline, which may also encompass more informed planning of human maritime activities.

Acknowledgements
Funded under the National Recovery and Resilience Plan (NRRP), M4 C2 I1.1, call for proposals PRIN 2022 PNRR, funded by the EU – Next Generation EU. Project P2022WENKB "In vitro models of marine ecotoxicology (INVENT)", CUP C53D23008300001.

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PO32

Bifunctional nickel-based compounds as electrocatalysts for green hydrogen production via alkaline water electrolysis

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Hydrogen, as a clean and sustainable energy carrier, represents a promising alternative to fossil fuels and will play a key role in the energy transition to achieve the goal of zero-carbon society by 2050. It is produced by different technologies with different environmental impact. Among them, alkaline water electrolysis (AWE) powered by renewable sources is one of the least expensive and environmentally friendly methods for producing high-purity hydrogen[1]. The design and fabrication of low-cost, high performance, non-PGM bifunctional electrocatalysts for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) is a very important challenge.

This contribution focuses on the synthesis and characterization of nanostructured NiCo and NiFe electrocatalysts and their testing as electrode materials in an alkaline electrolyzer employing a polymeric anion exchange membrane (AEM) as electrolyte.

NiCo and NiFe based oxides with different Ni contents are synthesized by sol-gel method, followed by calcination in air at two different temperatures. The as-prepared and reduced (in 5% H_2/Ar atmosphere) binary oxides are used as electrocatalysts to fabricate the anode and cathode, respectively. The electrodes are assembled in a zero-gap AEM-based AWE full cell, in combination with a commercial polymeric anion exchange membrane (Fumatech® FAA3-50) and a commercial ionomer (ION FAA-3-SOLUTION). The effect of the preparation conditions on the microstructure, morphology and crystalline phase purity of the produced materials is analyzed by using complementary characterization techniques.

The physicochemical results indicate that the catalysts exhibit significantly different morphology and average crystal size, depending on the metal pair and their molar fraction. These differences are reflected in their electrochemical performance. Promising performance and stability have been recorded using the bifunctional sample NiCo (85:15 at.%) calcined at 400 °C.

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PO33

Direct recovery of spent lithium-ion battery for catalytic hydrogenation reaction

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The global generation of spent lithium-ion batteries (s-LIBs) amounts to millions of tons annually. While conventional recycling methods primarily aim to recover valuable metals such as Ni, Co, and Li, they often suffer from low selectivity, high energy consumption, and costly by-product management. This has sparked growing interest in alternative strategies for the direct reuse of s-LIBs [1] (Figure 1).
Spent lithium cobalt oxide (LCO)-based batteries represent a secondary yet strategically valuable source of transition metals, particularly cobalt. In this study, we demonstrate a sustainable and environmentally friendly method for the direct reuse of spent LCO as a heterogeneous catalyst, without any mechano-thermal treatments beyond a simple calcination step to remove binder residues. This minimal processing makes the resulting Co-based material a greener, more sustainable and readily available catalyst for lignocellulosic biomass hydrogenation.

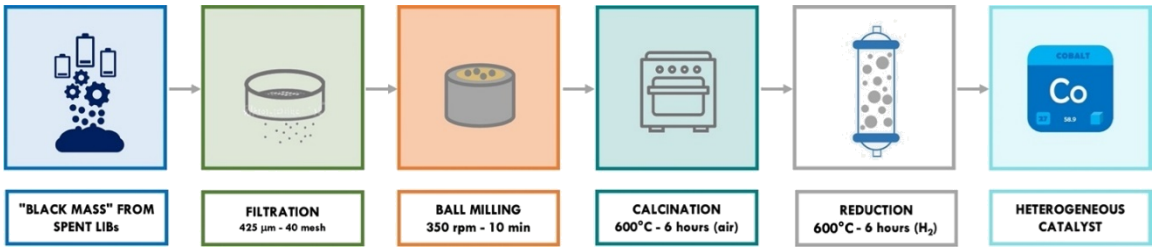

Figure 1. *Development of heterogeneous cobalt catalyst from spent Lithium ion batteries*

The catalytic performance of the spent LCO was evaluated in the selective hydrogenation of furfural (FUR) using 2-propanol as both solvent and hydrogen donor under reductive conditions. The catalyst exhibited notable activity, achieving over 50% conversion to furfuryl alcohol (FAL) under optimized conditions (10 bar H_2, 180 °C, 180 min), with complete conversion observed upon extended reaction time. Further enhancement in conversion and selectivity (up to 90%) was achieved at higher temperatures (210 °C). Notably, no by-products were detected under any reaction condition, highlighting the high selectivity and stability of the catalyst.
This work presents a novel green and sustainable approach to valorize electronic waste by directly reusing spent LCO batteries as efficient and selective Co-based catalysts for the reductive upgrading of lignocellulosic biomass-derived molecules.

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PO34

Tunable antioxidant properties of mixed lipid-PLGA matrix encapsulating polyphenols

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The development of formulations with antioxidant activity is nowadays a crucial aspect given the urban exposure to highly oxidative agents. On the other hand, the use of different stabilizers can lead to an instability of the formulations, causing a drastic decrease in terms of efficacy and the possible onset of systemic toxicity processes during *in vivo* metabolization[1].

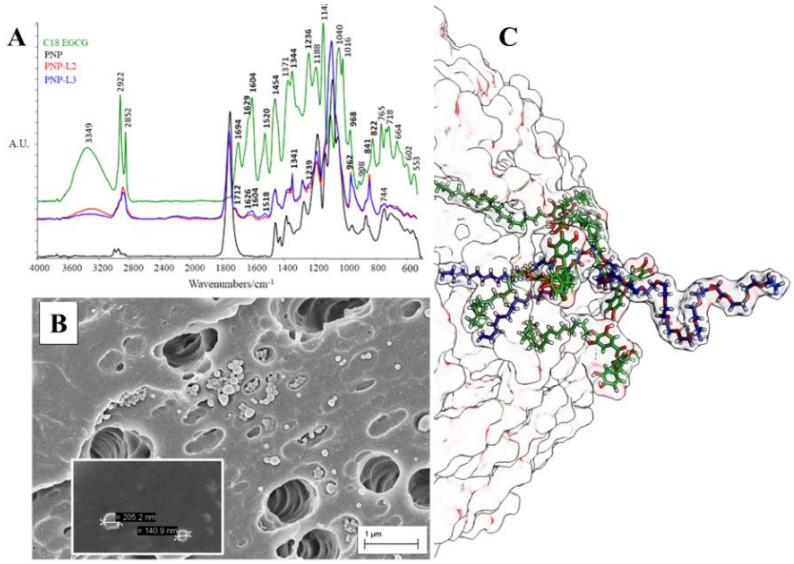

Figure 1. IR spectra of PNP- based systems compared to the alone EGCG-C18 spectrum (A) SEM images of PLGA NPs in presence of PVA and DSPE-PEG_{2000} after 24 h from preparation (B) Representative structure of EGCG-C18 molecules surrounding DSPE-PEG_{2000} (C)

In this work we use a combined *in silico-in vitro* approach to develop efficient PLGA-based nanoformulations to deliver a chemically modified Epigallocatechin 3 gallate molecule with antioxidant activity[2]. We will investigate the effect of a lipid stabilizer as DSPE-PEG_{2000} on the size, antioxidant capacity, and colloidal stability of the systems (Figure 1). The use of different experimental characterization methods and molecular dynamics simulations allowed to chart the course for an optimal and efficient formulation design.

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PO35

Recovery of cobalt from lithium-ion batteries by extraction with zeolite modified with ionic liquids

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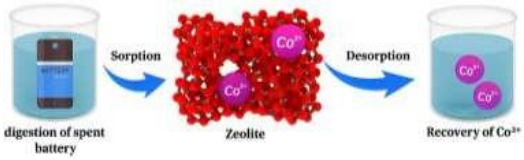
Cobalt is one of the critical raw materials (CRMs) in high demand today, due to its use in the manufacture of electronic devices, particularly in lithium ion batteries[1]. Due to their high cost, low recycling rates and high dependence on other foreign markets, the recovery of these CRMs is of great importance[2]. In order to recovery cobalt from spent batteries, hydrometallurgical process shows advantages, involving methods such as leaching, chemical precipitation, liquid-liquid extraction and solid-phase extraction[3]. Zeolites have been also used in the separation of metals due to their good selectivity for the exchange of different cations, large contact surfaces and a suitable tetrahedral pore structure[4]. Modification of zeolites with ionic liquids has also improved their sorption capacity[5]. In this work, the extraction of cobalt is proposed using a natural zeolite in combination with the ionic liquids trihexyltetradecylphosphonium chloride ($[P_{66614}][Cl]$) and trihexyltetradecylphosphonium decanoate ($[P_{66614}][Dec]$), obtaining new materials in the form of sorbents and membranes. The characterization of the materials was based on the pH at the point of zero charge and Scanning Electron Microscopy. The optimal separation of cobalt in the zeolite modified with $[P_{66614}][Cl]$ was obtained in 8 M HCl medium and the kinetic model shows that chemisorption processes are at play during the extraction with the sorbents, reaching a maximum cobalt sorption capacity in about 30 minutes of contact. The experimental results were fitted by using Langmuir and Freundlich models. The increase in temperature did not cause significant increase in the sorption capacity. The separation of cobalt with the membrane based on the ionic liquid $[P_{66614}][Dec]$ reached more than 70% retention after 24 hours.



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PO36

Chemical modification of potatoes by-products for the realization of PLA-based bioactive and smart packaging

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Valorization of agricultural and food wastes, such as potatoes by-products largely present in European countries, is a challenging objective in the perspective of a circular economy.
Potato derived compounds can be used for the realization of bioactive and smart packaging.
In the present study lignin has been chemically modified and combined with a widely produced and used polyester, polylactic acid (PLA)[1] with the aim of improving its thermal and mechanical response as well as imparting it smart properties.
More in detail, lignin functional groups were converted into primary hydroxyls (-CH_2OH)[2] to which oligomeric PLA branches were subsequently linked (Figure 1). These chemical modifications are supposed to improve lignin/PLA matrix dispersability/miscibility. The reaction with lactide was also carried out on pristine lignin.
Chemical modification was corroborated by NMR, FTIR, DSC and TGA analyses. Antioxidant activity was measured on both neat lignin and modified ones.
Starch/lignin/PLA films were prepared and subjected to molecular, thermal, mechanical, and functional characterization to test their suitability in the envisioned application.
An alternative pathway has also been implemented to enhance biomolecules/polymer miscibility. An A-B-A triblock copolymer was synthesized as compatibilizer, being A polylactic acid segments and B an *ad hoc* oligomer with a chemical structure resembling the lignin one.

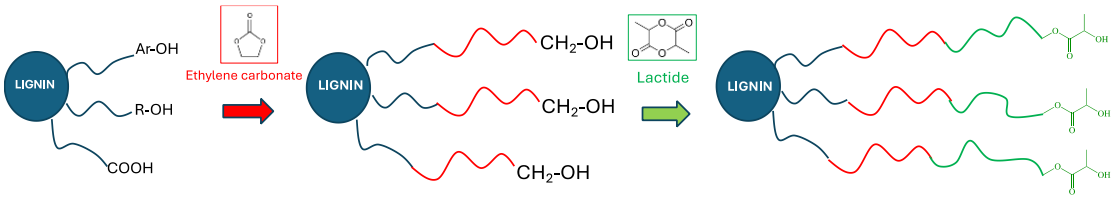

Figure 1. Scheme of lignin chemical modification.

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PO37

Hybrid nanostructured polyethylene sulfone sulfonate membranes for water remediation based on adsorption and photocatalytic degradation of organic

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Synthetic dyes represent a major environmental concern for their toxicity, persistence and resistance to biodegradation. [1,2] Among these, methylene blue (MB)[3] is widely used and known to pose significant risk to both human health and aquatic ecosystems.[4] This study focuses on the preparation and application of polyethylene sulfone sulfonate (sPES)[5] based composite membranes incorporating nanoparticles[6] – titania (TiO_2), multiwalled carbon nanotubes (MWCNTs) and oxidized MWCNTs (OXMWCNTs) – for the removal of MB from contaminated water. The membranes were characterized by FT-IR spectroscopy and thermogravimetric analysis (TGA) to investigate their chemical functionality and thermal stability. Batch experiments were performed to evaluate both adsorption performance and photocatalytic degradation efficiency under UV light, using MB as a model ionic dye. The results demonstrate that the incorporation of nanofillers significantly enhances dye removal efficiency compared to pristine sPES membranes, showing improved removal adsorption kinetic and adsorption capacity (up to 1300 mg/g). The adsorbed MB can be degraded by photocatalytic activation of the membrane upon exposure to low power (18 W) 365 nm UV radiation. In this way, the membranes can be regenerated and reused for several adsorption/photocatalytic degradation cycles, making them suitable candidates for sustainable wastewater treatment applications (Figure 1).

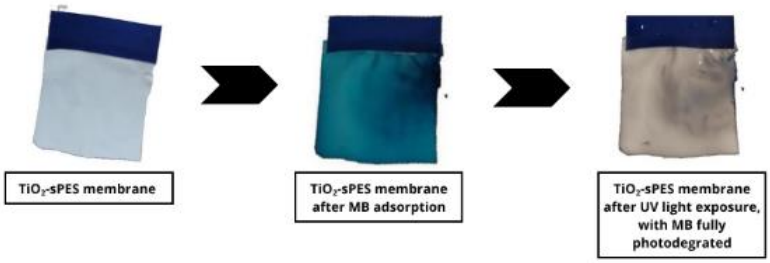

Figure 1 - Demonstration of the Methylene Blue adsorption/photodegradation cycle using the TiO_2-sPES membrane.

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PO38

Strain and damage monitoring of expanded graphite /nylon composites

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In the last decade, significant developments of flexible and stretchable force sensors have been witnessed to satisfy the demand of several applications in robotics, prosthetics, wearables, and structural health monitoring, bringing decisive advantages due to their manifold customizability, easy integration, and outstanding performance in terms of sensor properties and low-cost realization[1]. Nanoparticle-based structures with different architectures and dimensions have been intensely investigated, proving their potential applicability as sensors for piezoresistive strain detection [2,3]. In this scenario, the following research work arises: The resistive behavior of expanded graphite (EG)/nylon 6 is tested in axial tension under mechanical cycles and at different levels of applied strain. The electrical behavior shows the typical increase in conductivity predicted by the percolation theory up to a maximum value of 42 S/m, obtained for a filler concentration of 40% by weight. The electrical percolation threshold is attested for a value $x_c < 10\%$ by weight. The strain sensitivity, in the range between 40 and 60, may be specifically modified by controlling the EG loading; in fact, the sensor sensitivity decreases with increasing graphite amount. Microscale damages are directly related to the resistance changes and hence easily detectable in a non-destructive way through electrical measurements. In the fatigue tests, the damage is expressed through the presence of a residual resistivity, which increases with the amount of plastic strain accumulated in the matrix.

Acknowledgements

The authors gratefully acknowledge the Prin 2022 project "Alternative Manufacturing Approach to Recycling Fiber-Reinforced Composites (AMORFIC)" (grant number: P20227NYXH), founded by the Italian Ministry of University and Research, for financial support.

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PO39

Dinuclear semi-rigid Zn(salen-type) complex: role of spacer flexibility on aggregation and selectivity properties and potential application as chemosensor of ditopic amines

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Recently, we have demonstrated that dinuclear Zn(salen-type) complexes having a flexible spacer, are chromogenic and fluorogenic chemosensors for biogenic amines,[1] performing as *molecular tweezers* toward ditopic Lewis bases in non-coordinating solvents.[2,3] Considering that spacer flexibility could limit the selectivity of the chemosensor,[4] here we present the synthesis and characterization of a new dinuclear Zn(salen-type) complex **1**, having a semi-rigid spacer, in order to study the role of spacer flexibility on aggregation and selectivity properties and the potential application as chemosensors for ditopic Lewis bases.

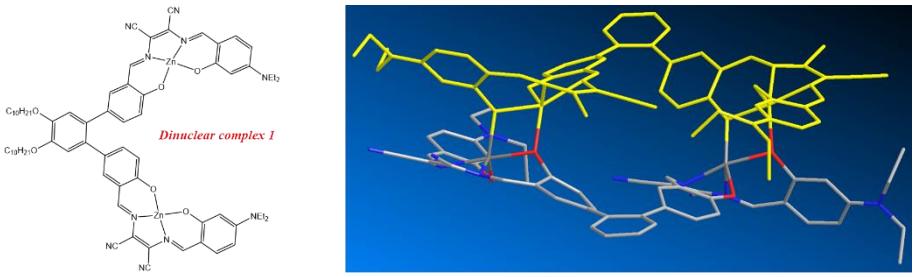

Figure 1. (Left) Molecular structure of complex **1**. (Right) Chem3D representation of dimeric structure of complex **1**.

In non-coordinating solvents, the presence of a semi-rigid spacer promotes the formation of dimeric aggregates through intermolecular Zn···O interactions for dinuclear complex 1, as demonstrated by ^{1}H NMR and ^{1}H DOSY NMR spectroscopy. This is in contrast with the behaviour of dinuclear complexes containing flexible spacers, which, under the same conditions, are stable as intramolecular aggregates.[2,3] This distinct aggregation mode significantly influences the sensing properties of dinuclear complex **1**.

This work was supported by the University of Catania, PIACERI 2024/2026, Linee di Intervento 1, and partially funded by European Union (NextGeneration EU), through the MUR-PNRR project SAMOTHRACE (ECS00000022).

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PO40

Efficient Capture and Dynamic Solvent-Exchange of Volatile Organic Compounds (VOCs) via Copper (II)-Bispidine Coordination Polymers

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Volatile organic compounds (VOCs) are hazardous airborne pollutants that require efficient capture strategies. Low-dimensional coordination polymers (CPs), like those incorporating bispidine scaffolds, offer significant promise due to their dynamic and reversible VOC adsorption capabilities.[1] In this context, we examined the coordination behavior of the bispidine ligand "L1" (**Figure 1**) with Cu(II) ions employing rapid and slow crystallization approaches that yielded distinct products: a non-solvated amorphous phase (**1-Amorph^{Pwd}**) and solvent-templated monocrystalline phases, **1-TCM^{SC}** (with chloroform) and **1-MeCN^{SC}** (with acetonitrile).[2] Structural analysis revealed a 1D ribbon-like topology for **1-TCM^{SC}** and a 2D extended network for **1-MeCN^{SC}**, respectively. Notably, **1-Amorph^{Pwd}** exhibited a broad VOC adsorption profile and selective MeCN uptake in binary mixtures, while **1-TCM^{SC}** underwent solvent-induced structural transformations, forming new 1D and 2D networks (**1-H$_2$O^{SC}** and **1-MeCN^{SC}**), **Fig.1**.[3]

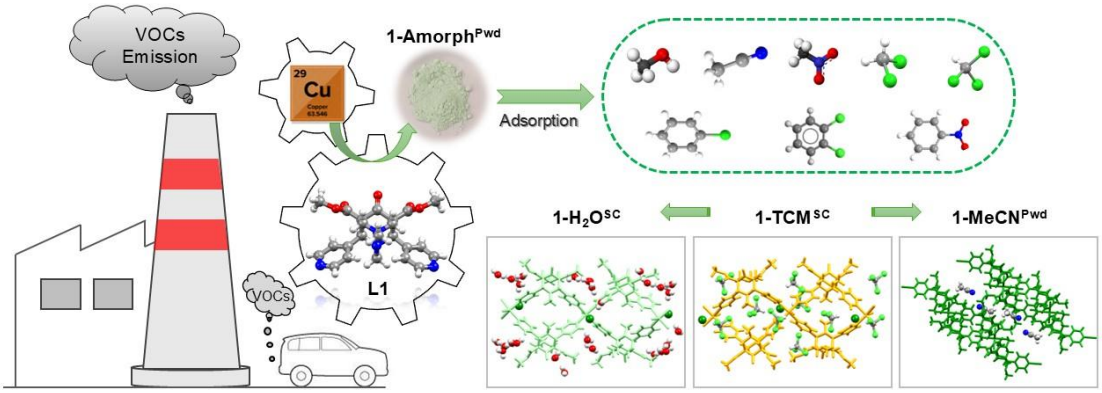

Figure 1. VOCs adsorption and solvent-exchange on low-dimensional Cu(II)-bispidine CPs.

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PO41

Engineering of biomass: bioplastic films from proteins

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Organic waste and byproducts of the food and agricultural chains represent promising feedstocks for biopolymers. Proteins, in particular, are a promising category of biopolymers, that exhibit high versatility, adaptability, the capacity to fulfil a broad range of functions and the ability to self-assemble into functional complexes. Moreover, protein-based bioplastics are alternatives to petroleum-based plastics and have the chance to be biodegradable or compostable.[1]

In the frame of our research on the engineering of protein based materials[2], proteins from different sources were compared for the preparation of biofilms. The protein extracts were: bovine serum albumin (BSA), black soldier fly protein extract (BSF), soy protein isolates (SPI), and sericin (SER). The protein content and the molecular mass were determined by means of BCA assay and SDS-PAGE, respectively. The water solubility was assessed as a function of temperature and pH, investigating the proteins denaturation. The film-forming ability was evaluated (**Figure 1**).

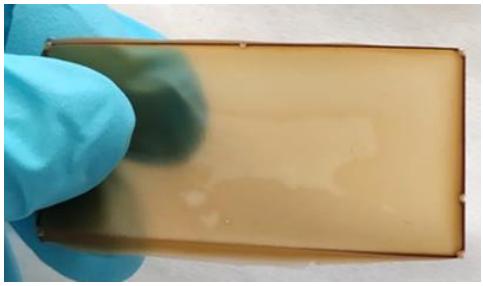

Figure 1. BSF-based film.

Structure-property correlation was studied, by using techniques such as ATR-FTIR, swelling tests, ThT assay, TEM microscopy, TGA-DSC. Biodegradability tests (biological oxygen demand, BOD) were carried out.

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Acknowledgments

This project has received funding from the European Union's Horizon Europe research and innovation program under grant agreement No 101070167. We acknowledge the Circular Economy Lab for Life Sciences-CELLS within the MUSA –Multilayered Uban Sustainability Action –project, funded by the European Union –NextGenerationEU, under the National Recovery and Resilience Plan (NRRP) Mission 4 Component 2 Investment Line 1.5: Strengthening of research structures and creation of R&D "innovation ecosystems", set up of "territorial leaders in R&D".

PO42

A circular approach to flexible electronics: biobased chain extenders for the close-loop recycling of PET substrates

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The growing desire for continuous data collection, real-time information, and connectivity has resulted in increased demand for electronic devices. These consumer electronics are regularly replaced or thrown away, and this seriously contaminates the environment. The production of e-waste is expected to reach about 75 million tons by 2030. The printed circuit boards based on thermoset resins are a relevant part of the electronic waste. Printed electronics (PE) can be based on flexible polymer substrates, in particular poly(ethylene terephthalate) (PET).

The aim of our research was to develop circular materials for electronics. The research was part of the European ECOTRON project, and was focused on end-of-life polymers used as substrates for flexible PE. In the frame of our research on materials from biosources[1], chain extension of a recycled PET grade was performed with a biobased dianhydride, mellophanic dianhydride (MEDA), obtained from a C6 biobased building block[2]. MEDA was employed in substitution of the oil-based pyromellitic dianhydride, traditionally used. Degradation of the polymer was avoided and the macrostructure of PET was controlled. The chain-extended PET was extruded in foils and screen printed. The research performed is summarized in the infographic in Figure 1.

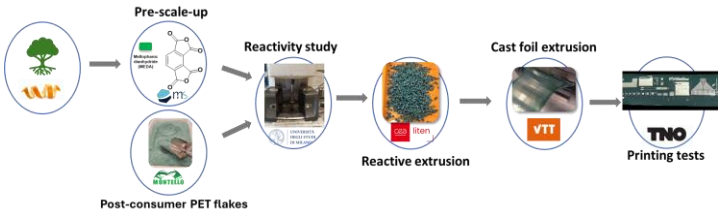

Figure 1. From and of life PET to screen printed foils for flexible electronics.

This work demonstrated that a cellulosic derivative, such as MEDA, can promote the circularity of materials for electronics.

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PO43

Green gold nanoparticles for pollutants removal from water

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In the field of nanosciences, gold nanoparticles play an important role receiving a tremendous attention from the scientific community in the last decades for their interesting catalytic, optical and electronic properties.[1] Amongst the different applications such as in biomedicine, materials science, electronics fields, the catalytic properties of gold nanoparticles make them interesting also in the environmental field for the degradation of organic pollutants which represent a great concern of the modern society.
Recently, several works have been focused on the development of green gold nanoparticles by using natural extracts that allow a green synthetic approach in terms of reducing agents, stabilizers and solvent. In addition, the use of natural extracts derived from agricultural or industrial wastes respect also the principles of the circular economy.[2]
In the present work *Aloe vera* wastes were used to prepare gold nanoparticles. *Aloe vera* fresh leaf contains fibers, proteins, organic acids, vitamins, minerals, monosaccharaides, and polysaccharides, which partially remain in the leaf wastes providing the reducing sugars for gold reduction and others organic components for nanoparticles stabilization.
We report here the green synthesis of gold nanoparticles through a hydrothermal approach evaluating some experimental factors that affect the nanoparticles properties. Gold nanoparticles were characterized by using TEM, FTIR, DLS analyses. Finally, a preliminary photocatalytic activity of gold nanoparticles for pollutants degradation in water was also evaluated.

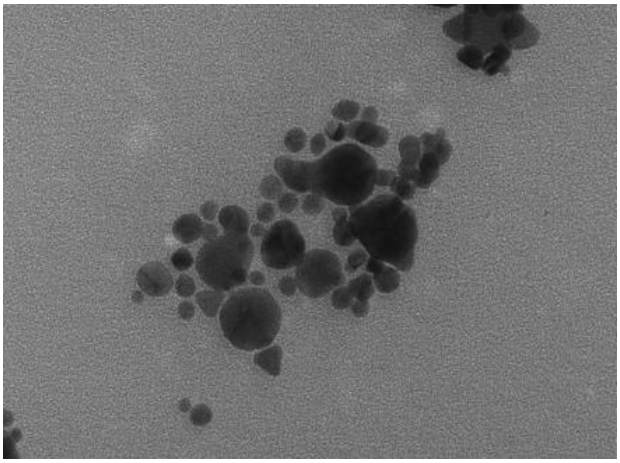

Figure 1. TEM of Au-NPs synthesized from *Aloe vera* wastes.

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PO44

An integrated electrochemical system for the purification of polluted water

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Water available to humans is increasingly contaminated by both microorganisms and harmful organic and inorganic residues. Ozone-based treatments are often used in current practice to treat such contaminated water.

Treatment with ozone directly generated in situ is often effective in treating microorganisms but, despite the high redox potential of ozone, a low degradation rate and negligible mineralization of organic compounds are often observed. To improve the performance of this process, the combination with electrochemical methods, in particular with carbon-based electrodes, has recently been proposed. In this way, high-power oxidizing species are generated in situ without the need to add additional reagents. However, the development of the procedure is partly slowed down by the poor resistance of commercial electrodes which, although exposed to relatively low current densities, operate under extremely difficult conditions.

This work aims to identify the most suitable materials for optimizing the performance and long-term stability of the EAO (Electrochemically Assisted Ozonation) process. The study will evaluate five metals—Pt, Pd, Cu, Ti, and Ag. Comparative electrochemical characterization will assess their electroactivity and stability, with the most promising candidates being tested as cathodes in EAO systems for paracetamol mineralization from aqueous solutions.

Preliminary experiments identified Ag and Ti as the most effective cathodes for EAO treatments aimed at paracetamol (PA) mineralization. After a 3-hour treatment, at 40 mA cm^{-2}, the electrodes ranked as follows: Ag>Ti>Pd>Cu>>Pt.

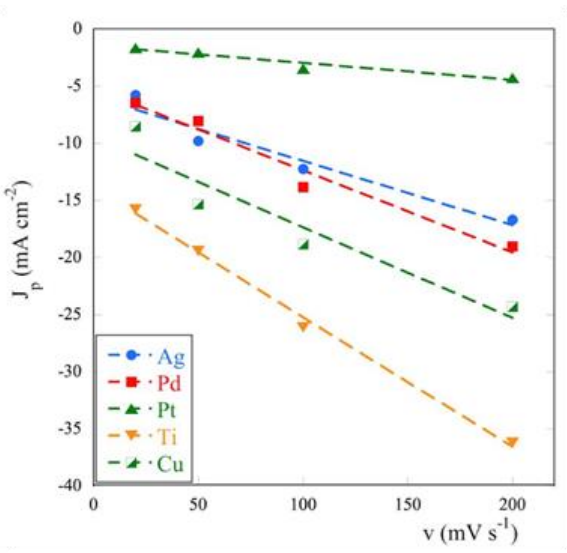

Figure 1: O_3 current density peak versus scan rate.

PO45

Advanced Plasmonic-based PoCTs for Attomolar-Level Cytokine Detection

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The precise quantification of cytokines at ultra-trace levels remains a pivotal objective in the context of inflammatory pathologies, oncogenesis, and immunomodulatory therapies. In this contribution, two different plasmonic biosensing paradigms were reported, both engineered to achieve attomolar-level detection of interleukin IL-17A, IL-1β, and IL-18, thereby extending the frontiers of molecular diagnostics. The first bioinspired device leverages the hierarchical nanostructure of pollen, coated with a gold film and functionalized with specific antibodies (e.g. anti-IL-17A) to excite hybrid plasmonic modes with exceptional field confinement and spectral sensitivity.[1] Another sensing approach is based on a novel point-of-care configuration employing plastic optical fibers (POFs) integrated with microcuvette structures and D-shaped SPR probes arranged in cascade. This configuration facilitates real-time monitoring of antigen–antibody interactions free in solution (e.g. for the detection of IL-17A, IL-1β, and IL-18), entirely avoiding traditional surface functionalization protocols.[2]

Both systems demonstrate rapid analyte recognition kinetics (≤5 min), sub-attomolar limits of detection (<5 aM), and pronounced selectivity, even in the presence of structurally homologous interferents. These attributes underscore their potential for integration into next-generation point-of-care diagnostics.

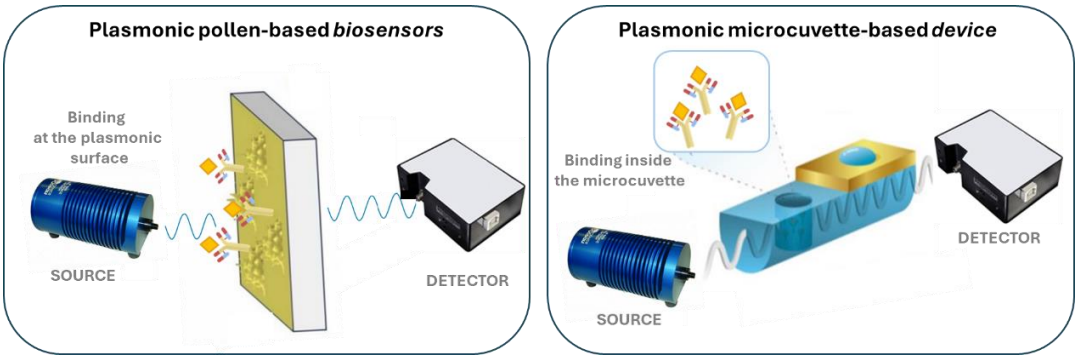

Figure 1. Outline of optical sensors in cytokine monitoring

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PO46

Hydrochar from orange peel waste and Black Mass from Spent Li-batteries as co-catalyts of C_3N_4 for H_2 generation form aqueous solutions of organics

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Sustainability has become a guiding principle for modern society, arising from the awareness that anthropogenic waste can be a valuable resource. Waste materials can be seen as a resource. In this context, the valorization of spent lithium-ion batteries (s-LiBs) is an urgent issue[1] and the use of waste biomass to obtain valuable materials an interesting strategy for environmental sustainability[2]. In the current work a set of composites based on graphitic carbon nitride (g-C_3N_4) has been prepared for the photoreforming of organics in aqueous suspensions of an irradiated photocatalysts. This technology aims to obtain H_2 from water and simultaneously oxidize organic molecules into higher value-added substances in the presence of semiconductors such as g-C_3N_4[3]. In this work g-C_3N_4 was enriched with a metal-based co-catalyst obtained from the cathodic part of s-LiBs, the black mass (BM) and also with hydrochar (HC) obtained via hydrothermal combustion of orange peel waste. A set of composites have been prepared by different strategies to obtain various g-C_3N_4/BM/HC photocatalysts. The amount of BM and HC, both bare or activated by different strategies, with respect to the precursor of C_3N_4 (melamine, thiourea or dycianamide) was fixed in the range 0.5 to 2 % w/w. The composites were tested for H_2 production by photo reforming of organic aqueous solutions irradiated under UV LED 365 nm and solar light. Aqueous solutions of organics as ethanol, glycerol, triethanolamine or aqueous solutions obtained from the distillation of orange peel or during the preparation of the hydrochar from the biomass waste, were used as hole scavengers in the photoreforming process. The presence of BM enhanced the g-C_3N_4 activity for H_2 obtainment and the presence of small amounts of HC furtherly improved the H_2 productivity. In particular, the best result was obtained in the presence of g-C_3N_4 with 0.5 % w/w of BM (previously reduced in H_2) and 1% of hydrochar activated by NaOH for the photoreforming of an aqueous solution of ethanol 0.39 M. The amount of H_2 obtained was ca. 20,000 μmol h^{-1} g^{-1} and it was ca. 6 times higher with respect to that observed for bare g-C_3N_4. Further experiments are underway in order to optimise the photocatalyst composite composition to boost H_2 productivity using real solutions of biomass derivatives.

Acknowledgements
Authors acknowledge financial support from the NATIONAL RECOVERY AND RESILIENCE PLAN (NRRP) PNRR-2022-Italia Tomorrow. Project PRJ-1611 " PHOTOLION ".

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PO47

Sustainable materials from industrial waste for applications in beyond lithium energy storage devices

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Using added-value materials obtained from recycling of waste for energy application, the two-fold aim of favouring a circular economy and a green transition can be pursued. Within this context, the activity of our group has been recently focused on the exploitation of industrial and agricultural waste to obtain electrode materials for Li-ion and beyond Li-ion energy storage devices.[1-3] Mn-based oxides represent a valid choice for beyond Li-ion energy storage devices for their eco-compatibility and variety of crystalline and morphological structures. However, being Mn a Critical Raw Material since 2023, finding new supply sources becomes a major necessity, and mining residues may represent a precious alternative. Moving from a previously developed strategy to recover Mn and synthesize different oxides from mining tailings from Brazilian Amazon Rainforest,[4] we are now focusing on δ-MnOx and α-MnOx, respectively characterized by a layered and a tunnelled structure. The abovementioned materials have been used for Na-ion and Zinc-ion batteries. Here we show our preliminary results obtained by tuning electrode preparations, cycling conditions, and cell design.

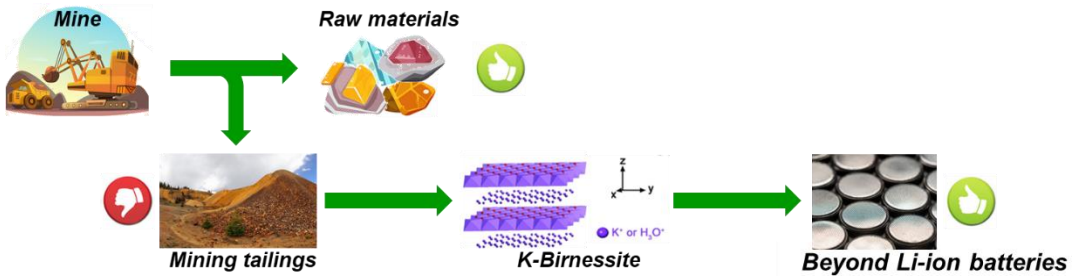

Figure 1. Graphical overview: synthesis of MnOx from mining tailings for beyond Li-ion batteries.

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PO48

Photoreforming of glucose via noble metals free BiOX (X=Cl,Br,I)-TiO_2 composites

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Photoreforming of biomass derivatives involves the simultaneous production of valuable chemicals and H_2, represents a promising strategy to counteract the negative effects resulting from excessive consumption of fossil fuels[1-3]. Glucose is an abundant carbohydrate derived from cellulose that can be converted into valuable platform chemicals such as gluconic, levulinic and formic acids and 5-hydroxymethylfurfural[4-6]. In this context, this study explores the aerobic and anaerobic heterogeneous photocatalytic partial oxidation of glucose in aqueous medium under both UV and simulated solar irradiation, using bismuth oxyhalide-based photocatalysts BiOX (X = Cl, Br, I). The noble metal-free BiOX-TiO_2 (P25) composites were prepared through a simple ball milling procedure. Both the formation of partial oxidation compounds, namely arabinose and formic acid in solution, and the production of CO_2 and H_2 in the gas phase were monitored. Pure BiOBr and BiOCl proved to be more effective than bare TiO_2 P25 (one of the most widely used and studied photocatalysts), providing higher selectivity towards high value-added products, while the composite samples exhibited high glucose conversion values. Particularly noteworthy was the performance of BiOCl-P25 and BiOBr-P25 samples containing 5 and 7 wt% of BiOCl or BiOBr relative to P25, which also promoted H_2 formation under simulated sunlight irradiation without the presence of noble metal species such as Pt.

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PO49

Green solution for ceramic glazes using vitreous fibers waste as resource

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In response to the current need to produce ceramic tiles through processes that minimize environmental impact and the increasing difficulty in supplying natural raw materials, the ceramic sector has focused its efforts on optimising resources. The solution can be found in a circular economy model, which minimises the use of virgin raw materials by recycling materials that would otherwise end up as waste in landfills. The ceramic factories already reintegrate the majority of production residues back into their manufacturing cycle. The next step for the sector must be to adopt a circular economy model that uses "*extra-muro* waste", which corresponds to waste from other production chains. In this line, we have developed a ceramic glaze using the product of rock wool's (a category of man-made vitreous fibres (MMVF))[1] thermal inertization. The thermal treatment destroys the fibrous habit of the wool and produces an inert, non-hazardous solid glass[2]. Many formulations were tested (containing between 40-50 wt% of MMVF) replacing commercial frits and after the optimization process, the final samples show a good aesthetic quality, good stain resistance and a surface with no defects. Moreover, the realized glazes resulted to be stable under chemical attack and in good dilatometric agreement with the supports they are supposed to glazed. The most promising formulation contains 44 wt% of waste, resulting in a glossy, dark ceramic glaze (Figure 1). This result underlines the suitability of this waste material as a valuable secondary raw material for the production of traditional ceramic glazes for porcelain stoneware.

Figure 1. Fired glazed tile with the best glaze formulations containing MMVF.

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PO50

Utilization of Lignin-Rich Biorefinery Residues to Produce Biofuels and Value-Added Chemicals

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This work deals with the hydrogenation of lignin-rich residue[1] (LRS) obtained after steam explosion pretreatment and enzymatic hydrolysis of wheat straw in a biorefinery pilot plant of ENEA in Trisaia (Italy), without any further pre-treatment.[2] Commercial Raney Nickel was used as the catalyst, and several reaction conditions (such as catalyst loading, hydrogen pressure, reaction temperature, solvent type, and reaction time) were varied (Figure 1). The final reaction mixture was characterized by gas chromatography-mass spectrometry (GC-MS), suggesting that the higher the catalyst loading the higher the conversion efficiency and selectivity towards some products, such as 4-ethyl-2-methoxy phenol and eicosane. Statistical analysis using a fractional factorial design was applied to gain insight into the role of temperature, hydrogen pressure, and solvent type on the product distribution obtainable by LRS hydrogenation.

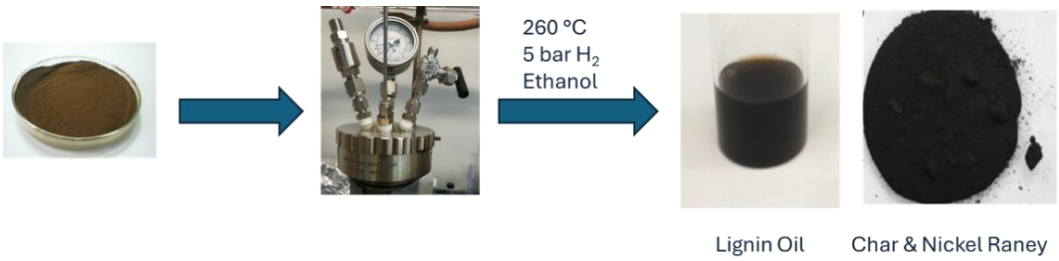

Figure 1. Visual representation of the process and products involved in lignin valorization. (a) Raw lignin residue before catalytic treatment. (b) An autoclave reactor was used for the catalytic conversion of lignin. (c) Reaction products obtained after treatment showed separated lignin oil, solid char, and Raney Nickel catalyst.

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PO51

Palladium-catalyzed Suzuki-Miyaura coupling reactions in confined pockets of soy-protein cryogels

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The Suzuki-Miyaura coupling reaction is one of the most versatile tools in organic synthesis for the formation of carbon-carbon bonds, with applications ranging from pharmaceuticals to materials science.[1-2] In the frame of our research aimed at the engineering of biomasses,[3] soy protein-derived cryogels have been developed as biobased and porous supports for transition metal catalysts. The cryogels provide a confined microenvironment that promotes dispersion and stabilization of the metal atoms. Palladium was successfully immobilized with a concentration of 2 mmol %. Preliminary tests and recyclability studies confirmed the structural integrity of the catalytic system and its potential for multiple reuse cycles, because the coupling efficiency slightly decreases after the 10th cycle. The cryogel matrix modulates reactivity through spatial confinement effects and enables catalyst recovery. In this work, a library of substituted biphenyls was synthesised by coupling reactions between aryl halides and boronic acids, conducted under mild conditions, at 80°C under air, with sodium carbonate as the base, in alcoholic and aqueous media, with excellent yields and good selectivity. These results suggest that soy-protein cryogels represent a promising support for heterogeneous palladium catalysis in cross-coupling chemistry, aligning with the principles of green chemistry and circular economy. Future work will extend this methodology to other coupling reactions and explore further proteins derived from waste.

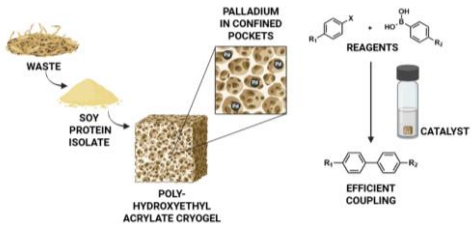

Figure 1. The poly-HEA/soy protein cryogel with Pd atoms in a confined pocket; catalyst for the Suzuki-Miyaura coupling reaction.

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PO52

Palladium decorated carbon nanostructures for sustainable catalysis

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Homogeneous catalysis possesses intrinsic advantages due to the well-defined coordination geometry of catalysts and high efficiency. However, it also presents several problems related to catalyst recovery and leaching. Heterogeneous catalysis effectively faces these problems but renounces selectivity and efficiency. One possible solution is anchoring metal complexes or particles on solid supports, creating organometallic centers on the substrate surface, building a bridge between traditional homogeneous and heterogeneous catalysis [1]. The focus of this work lies in the exploitation of pyrrole methodology[2], which is a simple, versatile, and sustainable method, to covalently graft sp^2 carbon allotrope supports with Janus molecules (pyrrole compounds) via domino reactions, which subsequently allows the loading of metal atoms onto the solid support [2, 3]. The obtained systems of metal-loaded carbon allotropes are deployed to complete catalytic reactions in mild conditions and reduced reaction times.

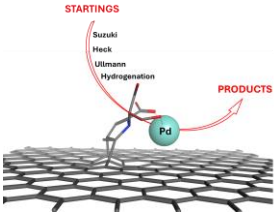

Figure 1. Chemical reactions catalyzed by Pd-decorated carbon allotropes.

In particular, High Surface Area Graphite (HSAG) is grafted with serinol pyrrole (SP) via domino reaction [3]. The modified HSAG is then loaded with Pd atoms, either in the Pd^0 or Pd^2 forms. A small amount of catalyst (Pd amount 2 mmol% with respect to substrates) is used to perform Suzuki-Miyaura coupling, Heck, Ullmann, and hydrogenation reactions [4]. The catalyst can be recovered by centrifugation, maintaining the catalytic performance over reaction cycles, paving the way to an efficient and sustainable heterogeneous catalysis approach.

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We acknowledge the Circular Economy Lab for Life Sciences-CELLS within the MUSA –Multilayered Urban Sustainability Action –project, funded by the European Union –NextGeneration EU, under the National Recovery and Resilience Plan (NRRP) Mission 4 Component 2 Investment Line 1.5: Strenghtening of research structures and creation of R&D "innovation ecosystems", set up of "territorial leaders in R&D"This research was funded by Made in Italy–Circular and Sustainable (MICS) Extended Partnership funded by the European Union Next-Generation EU (Piano Nazionale di Ripresa e Resilienza (PNRR)–Missione 4, Componente 2, Investimento 1.3–D.D. 1551.11-10-2022, PE00000004) for financial support

PO53

Properties and Conductivity Mechanisms of Hybrid Inorganic Organic Polymer Electrolytes for Na Batteries

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The accelerating demand for energy storage systems - driven by the rise of electric vehicles, smart grids, and portable electronics - is expected to exceed the capabilities of current lithium-ion battery technology. This growing need has sparked intense research into alternative electrochemical storage solutions [1]. Among the most promising candidates are sodium-based secondary batteries (NaBs), which offer advantages such as the widespread availability and low cost of sodium resources, as well as favorable electrochemical properties. Notably, sodium standard reduction potential and its chemical similarity to lithium facilitate its integration into existing battery concepts. However, conventional liquid electrolytes for NaBs typically rely on volatile, flammable organic solvents that pose safety risks, particularly in contact with metallic sodium. As a result, there is a strong impetus to develop safe, efficient solid-state electrolytes capable of conducting Na^+ ions.
Building upon foundational work by Di Noto and collaborators [2-4], this study presents a novel class of hybrid inorganic-organic polymer electrolytes (HIOPEs) tailored for next-generation solid-state NaBs. These materials are synthesized via the sol-gel reaction of zirconium ethoxide with polyethylene glycol (PEG400) and sodium perchlorate, forming a three-dimensional hybrid structure. The resulting network combines inorganic zirconium-based nodes with flexible PEO segments, enabling both mechanical adaptability and ionic transport. The Zr centers, carrying a positive charge, partially coordinate with perchlorate anions, thereby increasing the sodium transference number. To further improve flexibility and conductivity, poly(ethylene glycol) dimethyl ether (PEGDME250) is introduced as a plasticizer, yielding ionic conductivity above 10^{-4} S cm^{-1} at ambient temperature. The thermal stability and structural features of the HIOPEs are thoroughly investigated, with particular attention to interactions between the individual components. In addition, broadband electrical spectroscopy across wide frequency and temperature ranges is employed to clarify the Na^+ conduction mechanism. This study provides critical insights into the design and application of unconventional solid-state materials for advanced sodium battery technologies.

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PO54

Safe and Sustainable Development of Functional Materials for Technical Documentation Systems

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The growing attention towards sustainability in chemical technologies has led to the need to design new materials characterized by better chemical-physical properties together with a lower impact on human health and the environment. To achieve this goal, it is essential to direct research towards the development of new synthetic strategies to produce materials widely used in industrial contexts. Our project aims at the development of synthetic and innovative molecules to be included in composite products, ensuring safer handling for production line operators and improved environmental and user safety for daily consumer. A key focus is to explore materials intended for the production of functional document-related products, with a strong focus on user safety, environmental compatibility, and regulatory compliance. The research activities are centered on the identification, formulation, and optimization of functional compounds capable of interacting with selected substrates to achieve advanced technical performance in terms of visual quality, stability, and industrial processability. Different classes of molecules will be analyzed to identify alternative solutions to those currently in use, prioritizing favorable toxicological profiles, chemical reproducibility, and scalability. During the research activity, particular attention is paid to the principles of eco-design and green chemistry, looking at the ecological and toxicity profile of the reagents and solvents used. The main activities include the synthesis of functional compounds with properties activated under controlled conditions, the evaluation of visual performance and stability on selected substrates, the assessment of environmental and regulatory compatibility and the optimization of industrial processability and rheological behaviour.

The project seeks to find technological alternatives that ensure high safety standards, production efficiency, and environmental sustainability, contributing to the qualitative improvement of document-related products for specific industrial applications. In the present communication, the objectives and the main milestones of the conducted research activities will be described.

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PO55

A Dual-Mode Knudsen/Langmuir Apparatus with QCM Detection for High-Sensitivity Vapor Pressure Measurements

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Understanding the vaporization and sublimation behavior of materials at high temperatures is critical for applications in optoelectronics and thin-film production. While traditional Knudsen and Langmuir methods suffer from sensitivity limitations, quartz crystal microbalances (QCMs) offer a powerful alternative, enabling real-time measurement of minute mass changes through shifts in resonance frequency[1].

We present a novel apparatus that integrates Knudsen effusion and Langmuir vaporization with a QCM for in situ mass flux detection, alongside classical gravimetric validation. The custom-designed system features a high-temperature furnace, vacuum-compatible QCM sensor, and modular sample stage. Although similar configurations have been explored independently in prior works [2,3], this is the first reported dual-mode apparatus capable of studying both ionic liquids and molecular organic compounds across a broad temperature range.

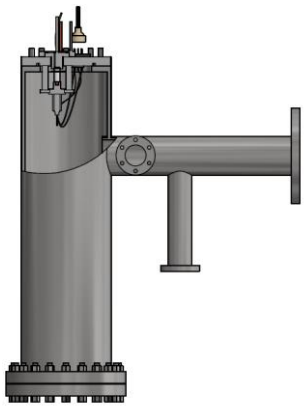

Figure 2. Schematic of the Knudsen Effusion/Langmuir Vaporization QCM apparatus.

Preliminary testing with benchmark ionic liquids and molecular substances demonstrates the system's reliability for phase-change measurements. This communication details the design, construction, and initial validation of the apparatus, highlighting its potential for precise thermodynamic studies of vaporization and sublimation in diverse organic materials.

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PO56

From Regolith to Resilience: Geopolymer Materials for Space Construction Under Vacuum Conditions

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The mechanical behavior and viability of geopolymers derived from simulated lunar and Martian sands was investigated. Artificial-simulated sand consistently yielded higher strength values, especially when powder ratios were optimized. Characterization methods such as thermogravimetric analysis, electron microscopy, and differential scanning calorimetry revealed the influence of moisture reduction, particle size, and phase reactions on performance. Attempts to mimic the dry extraterrestrial environment included using powdered sodium hydroxide without water, demonstrating reaction feasibility but with limited strength outcomes. A series of experimental treatments by varying powder-to-activator ratios, oven aging, and vacuum conditions were applied to evaluate compressive strength under space-relevant constraints. The findings suggest that geopolymer formulations, particularly those strengthened by grinding or aggregate integration, have the potential to be low-resource in no-water conditions with gravity-independent building materials for future planetary homes.

Figure 1. Samples from lunar and Martian sands after the vacuum

PO57

Membrane Scale-Up for Chemical Industries (MEASURED)

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Since the past four decades, the *Chemical Foundations of Technologies* research group at the University of Calabria promotes research activities in the field of membrane engineering for applications in liquid and gas separation. Its collaborations with universities, research centers, and industrial companies include participation in several international projects.
The EU H2020 project MEASURED (https://www.measured-project.eu), started on January 2023, aims at developing and demonstrating advanced membrane materials for Pervaporation (PV), Membrane Distillation (MD) and Gas Separation (GS) technologies applied to acrylic ester production, treatment of wastewaters from polymeric membrane manufacturing plant, and gas separation from a carbon capture & utilization (CCU) stream, respectively.
To reach these objectives, MEASURED is developing a set of flexible cost-effective and environmentally friendly membranes, i.e. polymeric membranes for MD, ceramic membranes for PV, and carbon molecular sieve (CMSM) membranes for GS, setting the basis for future commercialization of greener technological pathways all along the value chain.
MEASURED also includes a thorough multiscale modelling and simulation techniques including a full Life Cycle Assessment and addresses the societal implications to increase the acceptance and further market readiness.
The interdisciplinary MEASURED consortium is composed by 17 participants – 2 SMEs, 7 industries and 8 Universities/Research Centres – which will comprehensively study the development of advanced materials, reactor design and process configuration to identify the most sustainable options from a demonstration, techno-economic and environmental point of view.

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