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Escola Tècnica Superior d'Enginyeria

Departament d´Enginyeria Química

[MaTs MATERIALS TECHNOLOGY SUSTAINABILITY]n

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- Research team
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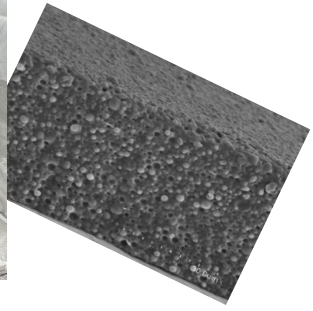

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TEAM AND AIM OF THE GROUP

RESEARCH TEAM

JOSÉ DAVID BADIA VALIENTE, jose.badia@uv.es
Chemical Engineer, Master in Material and Mechanics Engineering
Master Erasmus Mundus in Materials and Sensor Systems for Environmental Technologies.
PhD. Engineering and Industrial Production
Expert in Polymer Science and Technology and Valorisation of Plastic Waste
ORCID: https://orcid.org/0000-0001-8477-1459

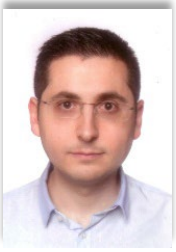
VICENTE MARTÍNEZ SORIA, vmsoria@uv.es
Ph. D. Chemist, Specialization in Industrial and Environmental Engineering
Full Professor
Expert in Heterogeneous Environmental Catalysis, Treatment of gas emissions

AMPARO CHÁFER ORTEGA, amparo.chafer@uv.es
Chemist specialist in Technical Chemistry, PhD. Chemical and Environmental Engineering
Expert in Extraction, Supercritical Fluids, Green Solvents as Ionic Liquids and Deep Eutectic Solvents
ORCID: https://orcid.org/0000-0003-4287-1552

RESEARCH TEAM

MARTA IZQUIERDO SANCHIS, marta.Izquierdo-sanchis@uv.es
Chemical Engineer, Master in Environmental Engineering
PhD. Chemical, Environmental and process engineering
Expert on sustainable technologies for water and air emissions treatment
ORCID: https://orcid.org/0000-0001-7244-2877

ÓSCAR GIL CASTELL, oscar.gil@uv.es
Chemical Engineer, Master in Polymers and Biopolymers
PhD. Engineering and Industrial Production
Expert in (Bio)Polymer Science and Technology: Design-to-Validation
ORCID: https://orcid.org/0000-0001-6293-080X



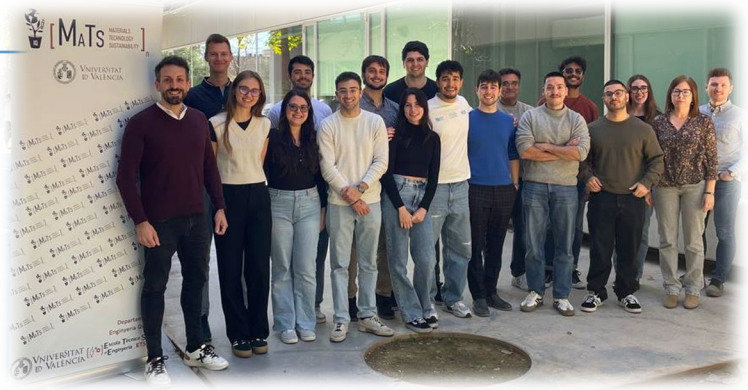
JOSEP PASQUAL CERISUELO I FERRIOLS, josep.cerisuelo@uv.es
Chemical Engineer, PhD. Chemical, Environmental and Process Engineering
Expert in Polymer Science and Technology and Food Packaging
ORCID: https://orcid.org/0000-0001-9780-9604

RESEARCH TEAM

ROSANA MORIANA TORRO, Rosana.moriana@uv.es
Chemical Engineer, Master in Material and Mechanics Engineering
Master Erasmus Mundus in Materials and Sensor Systems for Environmental Technologies.
PhD. Mechanical Engineering and Materials
Expert in (Bio)Polymer Science and Technology and Valorisation of Agricultural and Forestry Biomass
ORCID: https://orcid.org/0000-0002-0252-337X

PhD candidate researchers

Camila Arango
Mireia Fernández Bazán
Karen Gutiérrez Silva
Cristina Martín Poyo
Félix Montero Rocca
Gorka Marco Velasco
Alejandro Pérez Subiela
Rubén HervásMartínez



AIM OF THE GROUP

- Decarbonisation
- Packaging
- Fuel cells
- Biomedicine
- Flat and hollow-fibre

- Environmental impact
- Security and health
- Mild conditions
- Reduction of energy

- Focus on TRL 3-5
- Experimental set-ups for validation

- From cradle to cradle
- Replacement of petroleum-based polymers by bio-based counterparts
- Lignocellulosic biorefinery processes for the recovery of biomolecules

- Mechanical, thermal, chemical and biological valorization
- Polymer and natural waste (agri-food and forestry)

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SKILLS AND EQUIPMENT

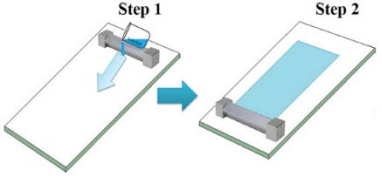
SKILLS AND EQUIPMENT

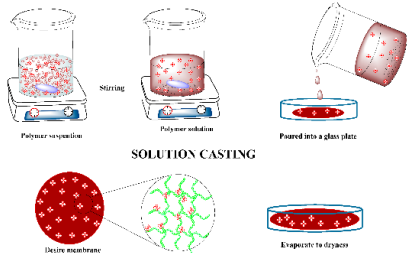
- Preparation and functionalization of polymer membranes, at bulk and surface level.
- Design and synthesis of neoteric solvents (ionic liquids, deep eutectic solvents)
- Degradation and stability of polymers subjected to normalized and accelerated operational conditions
- Characterisation of material properties (DSC, mech test, SEM, WCA, FTIR, …)
- Characterisation of processes (UV-VIS, GC,…)

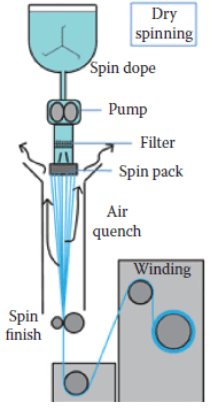
SKILLS AND EQUIPMENT

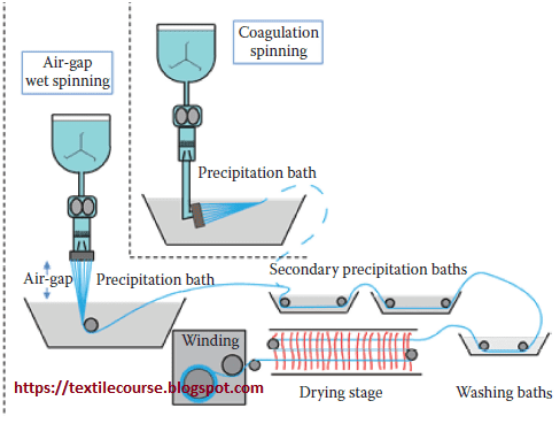
PREPARATION OF POLYMER-BASED MATERIALS, NANOCOMPOSITES AND COMPOSITES

- Preparation of mixtures and formulations
- Solve casting
- Wet-spinning
- Dry-spinning
- Electrospinning
- Spray drying
- Preparation of nanocelluloses and nanocellulose-based composites
- Encapsulation of additives
- Barrier Coatings and films



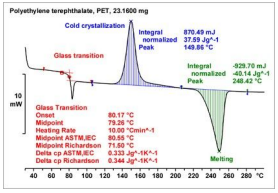


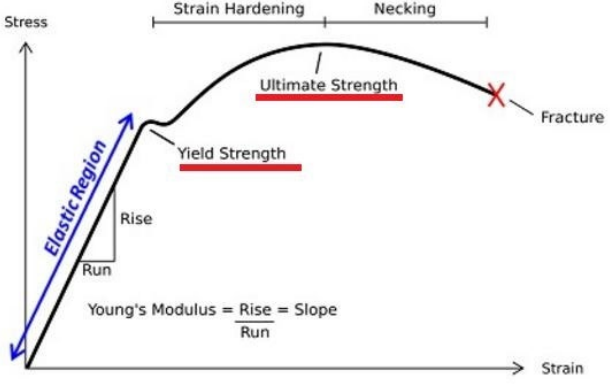


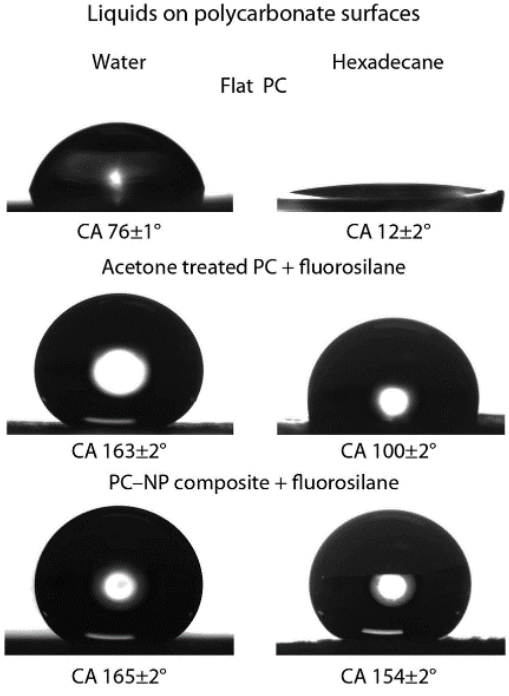


FUNCTIONALISATION OF POLYMER MEMBRANES

- Hydrophilicity / Hydrophobicity
- Thermal endurance
- Mechanical improvement
- Biodegradability
- Antibacterial performance

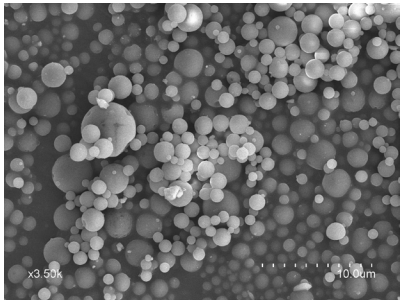






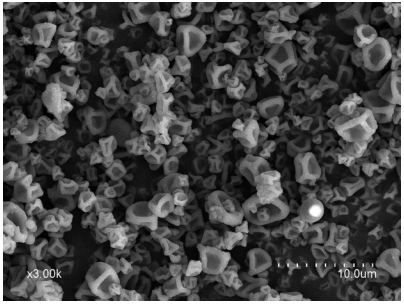
APPLICATIONS OF SPRAY DRYING TECHNIQUE

- Obtain particles of materials at nano and micro-size.
- Encapsulation of biomolecules, enzymes, pigments, drugs.



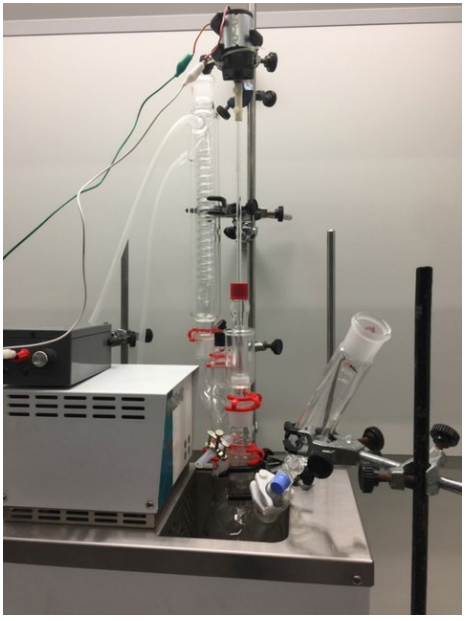
Chitosan: Silica

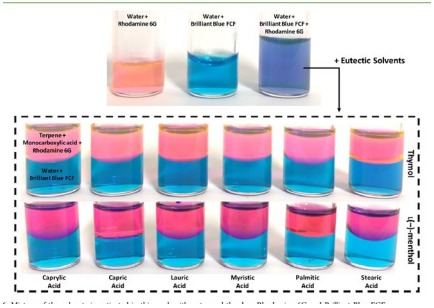
Chitosan: STP: Silica



PREPARATION OF NEOTERIC SOLVENTS

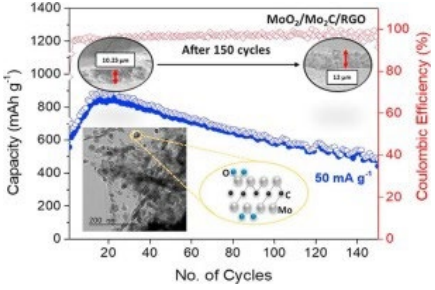
- Synthesis of Ionic Liquids
- Synthesis Deep Eutectic Solvents
- Applications as green extractants
- Applications as Catalysts
- Applications as media for electrodeposition of nanostructures





USE OF SUPERCRITICAL FLUIDS AS EXTRACTION OR REACTION MEDIA

- Extraction of products of interest from natural matrices.
- Reaction at supercritical conditions in CO_2 media.



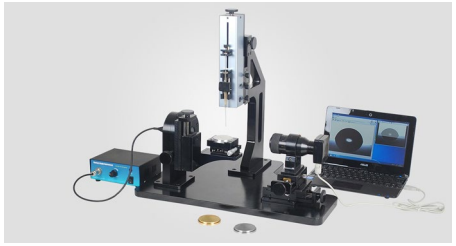
VALIDATION OF STABILITY AND DEGRADATION OF POLYMERS

- Corona degradation
- Plasma degradation
- UV-degradation
- Chemical degradation
- Hydrolytic degradation
- Hydrothermal degradation
- Physiological degradation
- Biological degradation

STANDARDS / ACCELERATED SIMULATION

CHARACTERISATION OF PROPERTIES OF MATERIALS

- **Structural and morphological properties**
  - Microscopy (SEM, TEM, AFM)
  - Spectroscopy (NMR, MS, FTIR, XRD)
- **Thermal properties**
  - DSC, TGA
- **Mechanical properties**
  - Universal testing machine
- **Functional properties**
  - Contact angle
  - Porosity
  - Film-forming capability
  - Water diffusivity, solubility



SKILLS AND EQUIPMENT

CHARACTERISATION OF PROCESSES

- UV- Absorption
- Gas Chromatography
- Titration
- Conductometry

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{ RESEARCH LINES }n

RESEARCH LINES

Membrane technologies

- **Design and validation** of polymer materials and composites for technology of **membranes**
- Membrane technologies for **decarbonization** of liquid streams and atmospheric emissions
- Development of **polymeric and composite** and materials with advanced properties for **packaging** applications

Waste valorisation

- **Valorization of plastic waste** by means of mechanical, chemical, thermal and biological processes
- Establishment of **biorefinery processes for lignocellulosic biomass fractionization** into valuable biomolecules

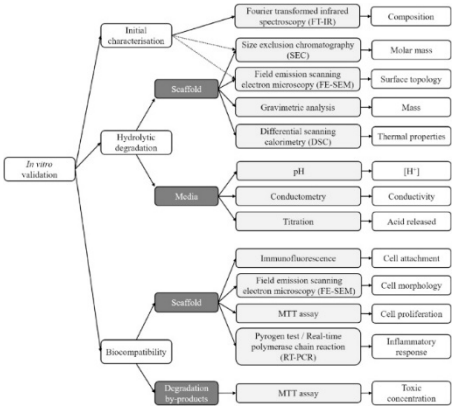
Enabling technologies

- Synthesis and applications of **ionic liquids** and **deep eutectic solvents**
- Use of **supercritical CO_2** in different applications: as extracting or reaction media
- **Modelling and simulation** of property transport in polymeric membranes

Design and validation of polymer materials and composites for technology of membranes

Research leader: José Badia

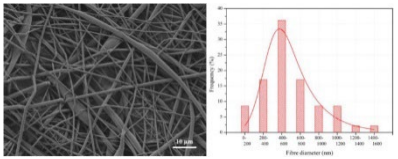
Description: Design, preparation and validation of flat-shaped and hollow-fibre polymer and polymer nano/micro composites, along with bulk or surface functionalisation for their use as membranes. Applications: decarbonisation of liquid efluents in waste-wáter plants, packaging, biomedical scaffolds or electrolytes for low-T fuel cells, among other sectors.



Previous projects/results:

Project: Recovery of methane from anaerobic efluents by means of advanced functionalized membranes (RECH4, ongoing)

Paper: Crosslinked Sulfonated Poly (vinyl alcohol)/Graphene Oxide Electrospun Nanofibers as Polyelectrolytes



Membrane technology for decarbonization of liquid streams

Research leader: Vicente Martínez Soria

Description: Evaluation and optimization of the operating conditions and membrane properties in the recovery of dissolved methane in aqueous effluents from industrial treatment bioreactors or WWTPs.

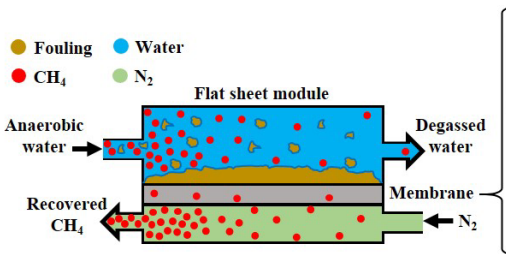
Applications: water decontamination, energy recovery, recovery of industrial effluents and WWTP.

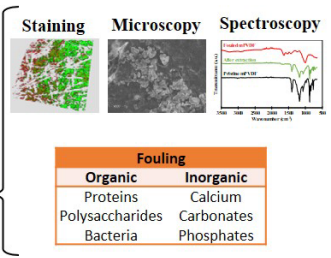
Previous projects/results:

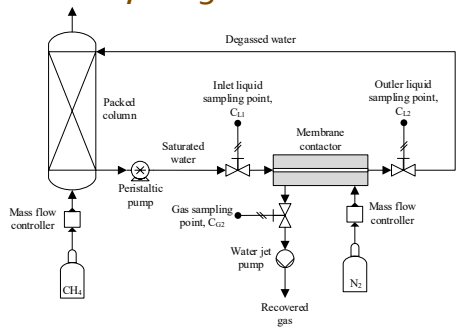
Project: RECH4 - Recovery of methane dissolved in effluents from anaerobic reactors using advanced functionalized membrane technology (GV/2019/149).

Doctoral thesis: (1) M. Henares, 2017. (2) R. Jiménez-Robles, 2023

Papers: 9 scientific papers, 2 doctoral theses



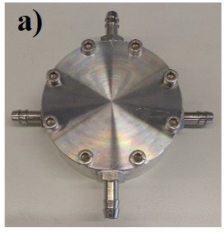




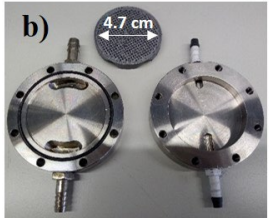
Membrane technology for decarbonization of atmospheric emissions

Research leader: Marta Izquierdo Sanchis

Description: Evaluation and optimization of operating conditions and membrane properties in the operation of carbon dioxide separation from emissions to the atmosphere, especially for biogas upgrading.

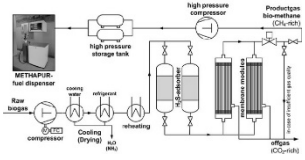


Applications: biogas upgrading from industrial bioreactors and WWTPs.



Previous projects/results:

Project: Research of membrane contactors for the recovery of dissolved methane and biogas upgrading from WWTPs. (MemPro)



Development of polymeric and composite materials with advanced properties for packaging applications

Research leader: Josep Pasqual Cerisuelo

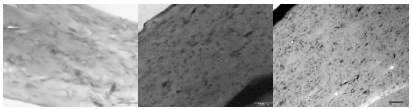
Description: Development and characterization of new polymeric and composite materials with advanced properties: active, intelligent, biodegradable, recyclable, edible, nanocomposites and biocomposites. Applications: preservation systems for food and drug products.

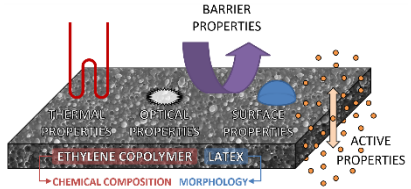
Previous projects/results:

Project: Etiquetas inteligentes con nanopartículas para la detección del deterioro de los alimentos envasados.

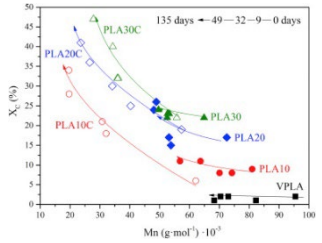
Project: Envasado antimicrobiano de alimentos basado en polímeros dinámicos cuya acción se activa por un estímulo externo.

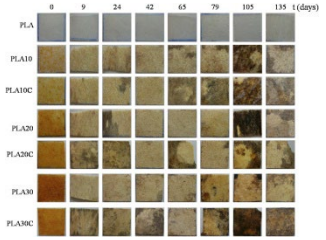
Paper: Antimicrobial-releasing films and coatings for food packaging based on carvacrol and ethylene copolymers.





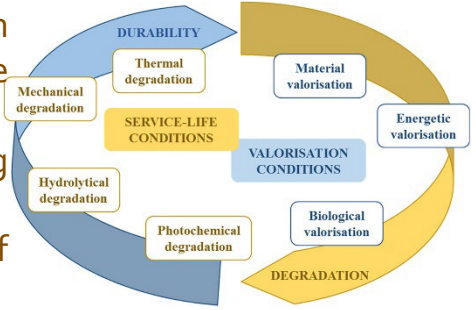
Valorisation of plastic waste by means of mechanical, chemical, thermal and biological processes





Research leader: José Badia / Óscar Gil

Description: Experimental simulation and monitoring of properties of plastic waste subjected to mechanical, chemical, thermal and biological valorisations, and their combinations thereof. Evaluation of eco-design alternatives and impact on aqueous, air and soil media.



Previous projects/results:

Project: Strategies and analytical procedures for a sustainable plastic waste management. An application to poly (ethylene terephthalate) and polylactide in the packaging sector.

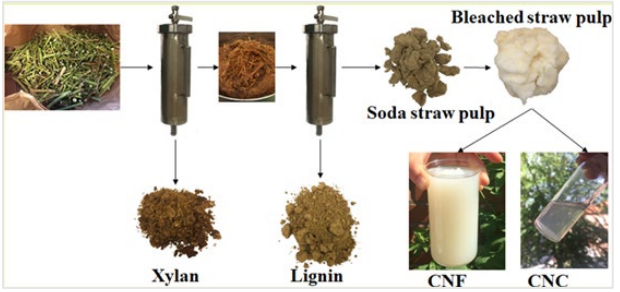
Paper: Mechanical recycling of polylactide, upgrading trends and combination of valorization techniques

Paper: Long-term properties and end-of-life of polymers from renewable resources

Establishment of biorefinery processes for lignocellulosic biomass fractionization into valuable biomolecules

Research leader: Rosana Moriana

Description: Design industrially scalable methods involving resource-efficient and low environmental impact technological approaches to deconstruct biomass allowing its integral fractionization in valuable macromolecules or molecular compounds.



Applications: Valorization of forest residues, agri-food wastes and industrial lignocellulosic side-streams.

Previous results/paper:

RDT line: Cascade extraction of proteins and feruloylated arabinoxylans from wheat bran / Rapseed straw biorefinery

RDT line: Solvent fractionation of softwood and hardwood kraft lignins for more efficient uses: compositional, structural, thermal, antioxidant and sorption properties

RDT line: Pine cone biorefinery: integral valorization of residual biomass into lignocellulose nanofibrils (lcnf) reinforced composites for packaging

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RESEARCH LINES

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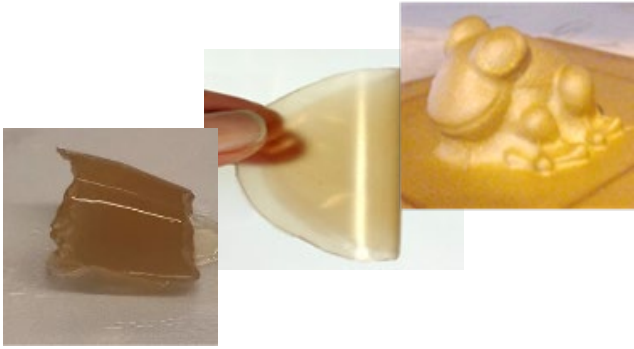
Design biological structures with targeted properties from residual biomass for food applications (packaging and food ingredients)

Research leader: Rosana Moriana

Description: Process and design competitive materials/products by understanding how structural & physicochemical properties of plant compounds link to their supramolecular assemblies and material properties



Applications: Edible films/gels, gas barrier coatings and films, 3D fiber-based moulded products, texturised food, functionalized ingredients / Personalized 3D printed food

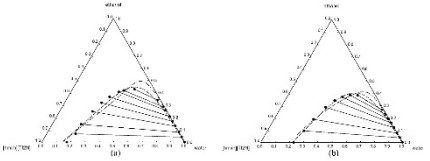
Previous results/paper:

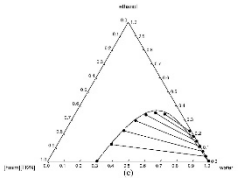
RDT line: Biopolymeric films based on faba bean protein and pine cone lignin for packaging applications

RDT line: Synergetic behaviour of CNF and LCNF in films for food packaging applications

RDT line: Bioinspired composites from cross-linked galactoglucomannan and microfibrillated cellulose: thermal, mechanical and oxygen barrier properties

Synthesis and applications of ionic liquids and deep eutectic solvents for reaction media





Research leader: Amparo Cháfer

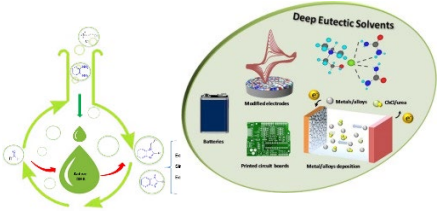
Description: Synthesis of Green solvents and development of new applications in different fields as solvents, catalysts, media of reaction, extractants, modifiers of membranes, media for electrodeposition of nanostructures, etc. Characterization of Green solvents synthetized.

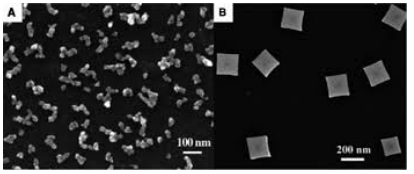
Previous projects/results:

Project: Improved production of bio-buthanol from lignocellulosic waste: advanced process alternatives

Paper: Study of liquid–liquid extraction of ethanol + water azeotropic mixtures using two imidazolium-based ionic liquids

Model of Utility: Quantitative analysis of mixtures of ionic liquids/DES and volatile compounds

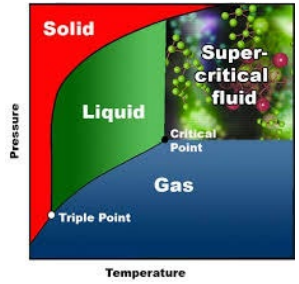


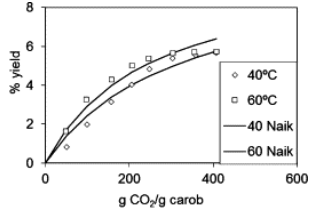


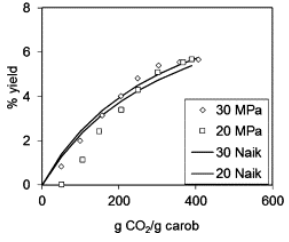
Use of Supercritical CO_2 in different applications: as extracting or reaction media

Research leader: Amparo Cháfer

Description: Determination of phase equilibria in supercritical conditions of standards of interest in CO_2 or CO_2 + polar modifiers. Study of kinetics of extraction from natural matrix of different interesting materials as polyphenols, terpenes, anthocyanins, etc. Direct incorporation into matrix of interest as polymers.
Use of CO_2 in supercritical conditions as reaction media in the synthesis of nanomaterials or polymers.







Previous projects/results:

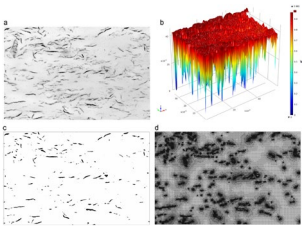
Project: Modelling and optimization of supercritical extraction from dehydratated vegetables at laboratory and pilot scale.

Paper: Study of kinetics of the d-pinithol extraction from carob pods using supercritical CO_2

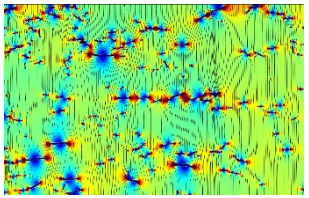
National Patent: Extraction and purification process of d-pinithol or rich extract on it.

Modelling and simulation of property transport in polymeric membranes

Research leader: Josep Pasqual Cerisuelo



Description: Development of FEM models for the study and simulation of mass and heat transport through multilayer polymeric structures under variable operating conditions. Applications: preservation systems for food and drug products, and asymmetric, composite or hybrid membranes for compound separation in liquid effluents.

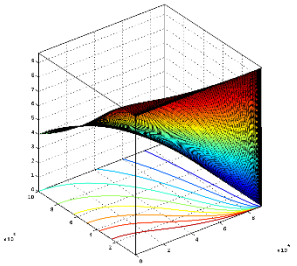


Previous projects/results:

Paper: Describing and modeling the release of an antimicrobial agent from an active PP / EVOH / PP package for salmon.

Paper: Diffusion modeling in polymer–clay nanocomposites for food packaging applications through finite element analysis of TEM images.

Paper: Modelling the evolution of O_2 and CO_2 concentrations in MAP of a fresh product: Application to tomato.



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[MATS MATERIALS TECHNOLOGY SUSTAINABILITY]n

CONTACTO MATS

https://www.uv.es/mats

iqmats@uv.es

@iqmats_uv

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