ARISTOTLE UNIVERSITY OF THESSALONIKI
FACULTY OF SCIENCES
SCHOOL OF CHEMISTRY

Sector of chemical technology and industrial technology
Laboratory of Polymers and Colors Chemistry and Technology

Scientific activities and accomplishments of the Laboratory of Polymers and Colours Chemistry, Chemistry Department AUTH

The **Laboratory of Organic Chemical Technology & Food Chemistry** was founded in 1969 (P.D. 459) and in 1981 was renamed to **Laboratory of Organic Chemical Technology** (OCT) (Government Gazette 126/12-5-81), having as its object teaching and research:

• using Organic Chemistry reactions and its compounds in Industry, such as of paints, surfactants, paper, fuel, Polymer and other oil derivatives

• Lot of activities were to the synthesis, structure characterization and study of physicochemical, thermal and mechanical properties of macromolecular compounds

Since 1979 the Laboratory moved to the **N. Building of Chemistry** School building and has been housed since then on the 7th , 8th and 9th floors of the with staff offices, a classroom and student practice laboratories as well as laboratories for preparing students' research papers.





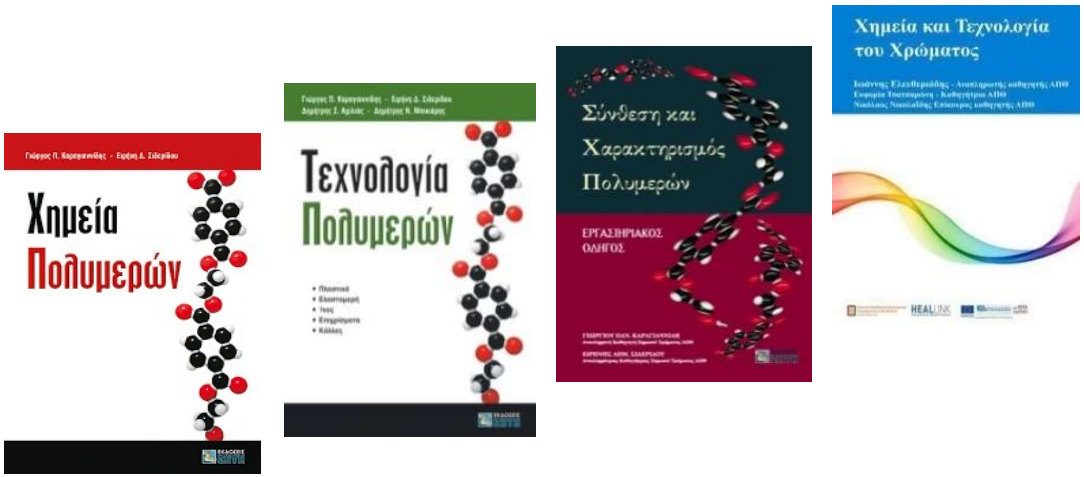
Since 1990, the laboratory of **Organic Chemical technology** focuses on teaching the Chemistry and Technology of various classes of:

polymers and copolymers (polyolefins, polyesters, resins, etc.), emphasizing their fields of application (coatings, packaging materials, plastics, paints, fibers, biomaterials), textiles, dyes and colours as well as cosmetics.

In terms of research, the laboratory synthesizes materials of immediate technological interest, while reinforcing agents are later introduced, producing composite polymeric materials. Gradually, nanoparticles were incorporated as reinforcing agents, thus producing nanocomposite polymeric materials.

In 2016, the Laboratory was renamed the **Laboratory of Chemistry & Technology of Polymers & Colors**, maintaining its activities and contributing to the present to the provision of high academic work within the Department. Chemistry. Today it consists of:

1. D. N. Bikiaris, professor, director
2. D. S. Achilias, Professor
3. N. F. Nikolaidis, Assistant Professor
4. S. Lykidou, laboratory teaching staff
5. E. Lazaridou, laboratory staff



- Teaching 6 different courses
- Lessons in 400 students per year
- 3 Lab Courses (150 Students)
- 15 diploma thesis per year
- 7 Master Students
- 15-20 PhD students

Equipment and laboratory apparatus
















Research activities- Projects

60-70 Published papers per Year

20 International Collaborations

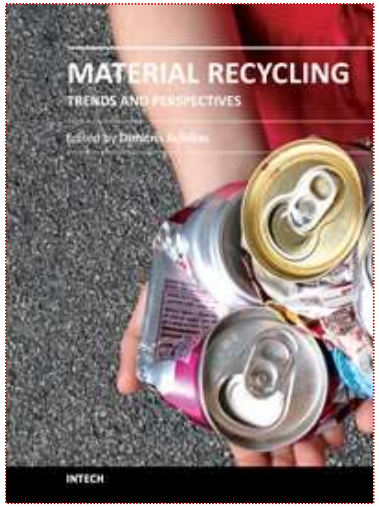
15 Industrial Partners

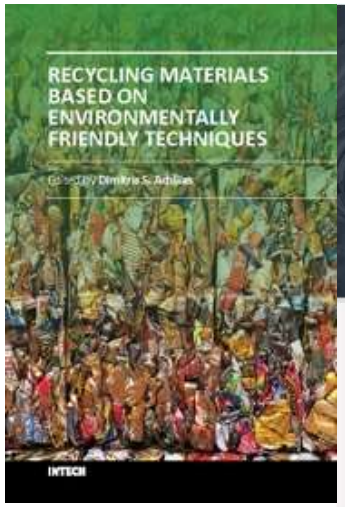
>90 Research Projects (national and international)

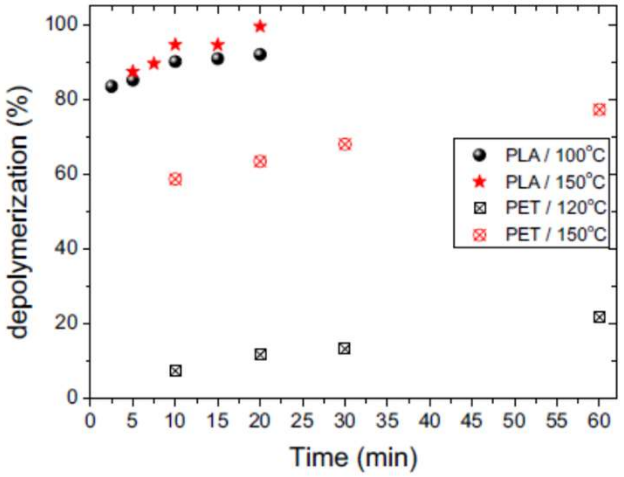
Role in the project: Coordination, Leader in several WPs

Research fields

- **Chemiscal recycling of PET** (hydrolysis, glycolysis, methanolysis, etc.)
- Chemical recycling of PC, PLA
- Thermochemical recycling by pyrolysis of polyolefins, polystyrene, poly(methyl methacrylate).
- Identification and uses of recycling products
- Removal of hazardous additives from polymers during their recycling



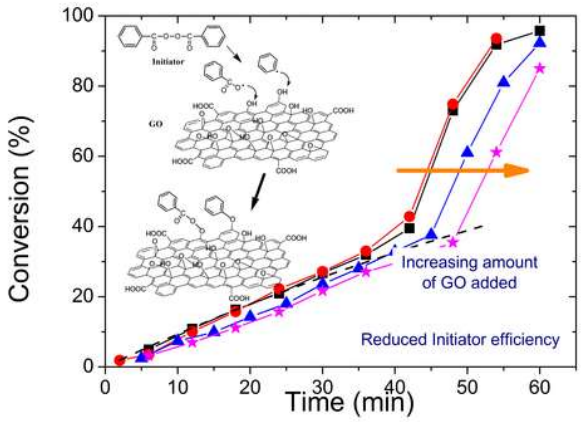


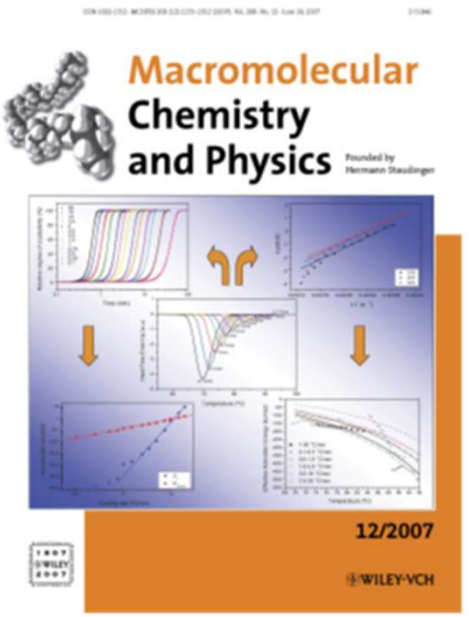


PLA-PET degradation under microwave irradiation

Research fields

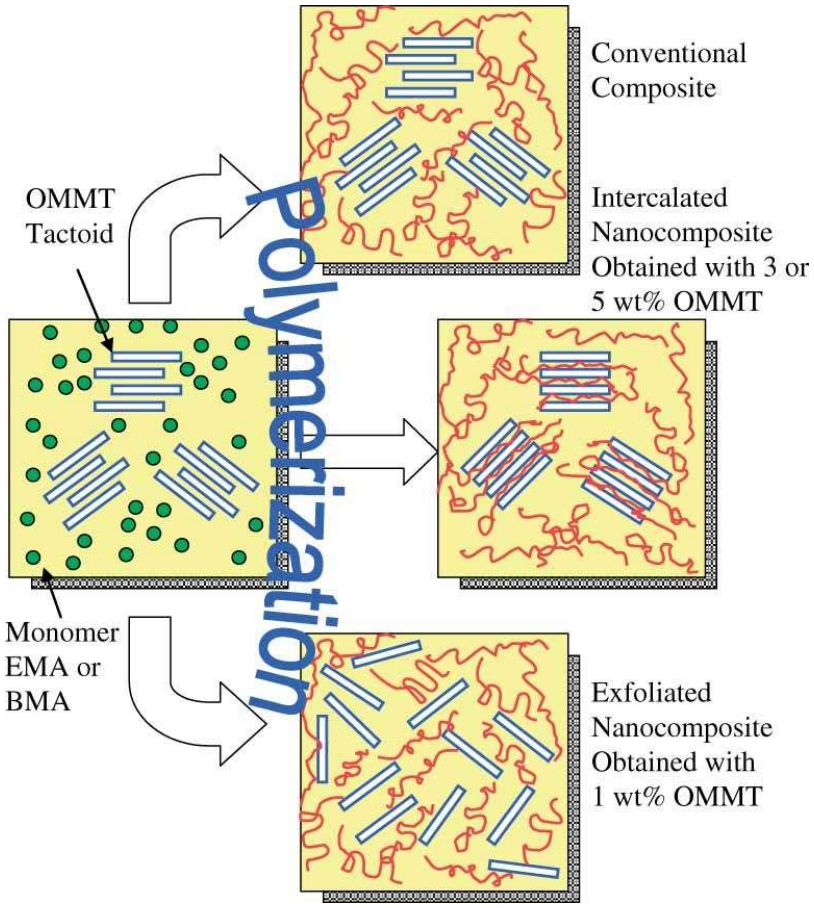
- Kinetics of polymerization reactions
- Development of theoretical models for simulation of free radical polymerization and polycondensation reactions, prediction of the molecular and structural characteristics of the produced polymers.
- Kinetics of thermal degradation of polymers
- Crystallization kinetics of polymers
- Effect of diffusion effects on polymerization and polymer degradation reactions





Research fields

- Synthesis and study of properties of polymers and polymer matrix nanocomposites
- Synthesis and study of properties of nanocomposite dental resin composites.
- Utilization of food industry waste in the preparation of composite polymeric packaging films
- Use of natural products in improving the properties of polymeric composites



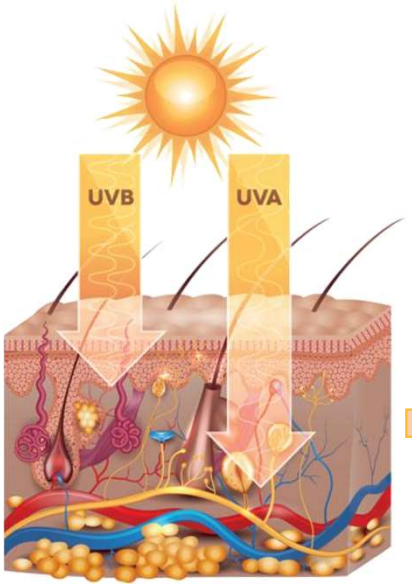
Research fields in Textiles and dyes

- Conventional and digital printing on natural and synthetic fiber fabrics
- Isolation and integration of natural active ingredients for the modification of composite or polymeric materials.
- Preparation of cosmetic emulsions with active ingredients and natural pigments

Research fields in Emulsions

SKIN DAMAGES

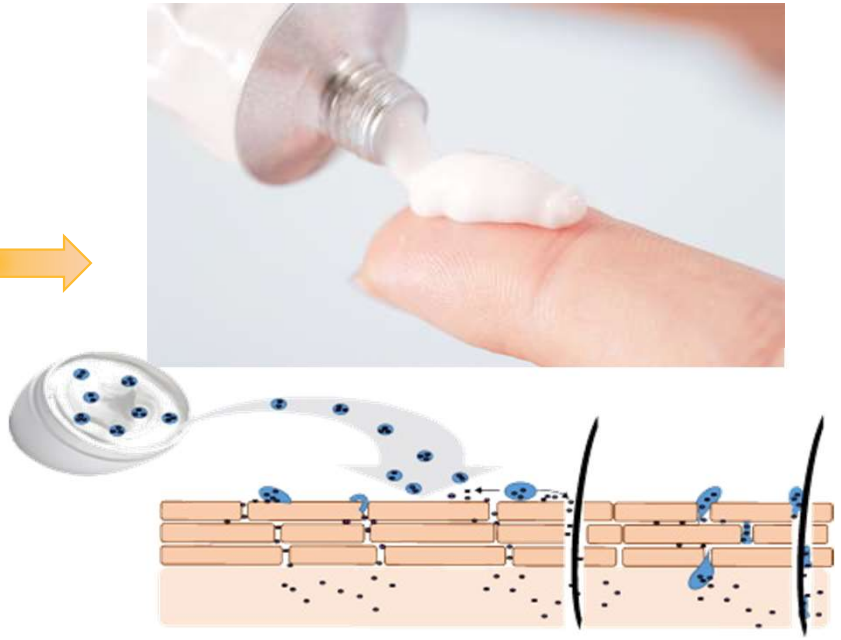
Deleterious skin diseases caused by sun radiation, such as aging, scaling, dryness, mottled pigment and skin cancer



EMULSIONS

Emulsions are widely used as active delivery systems in cosmetic and pharmaceutical formulations for skin protection

Emulsions present excellent solubilizing capacities for lipophilic and hydrophilic active ingredients and application acceptability.

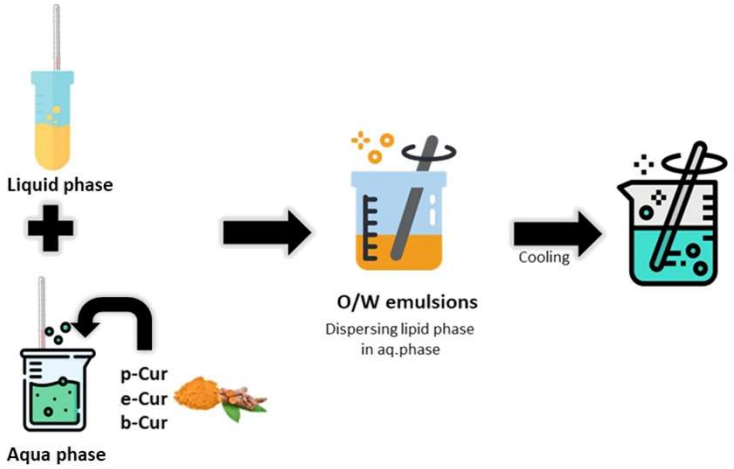


Formulation, Characterization and Evaluation of Innovative O/W Emulsions Containing Curcumin Derivatives with Enhanced Antioxidant Properties

EXPERIMENTALS

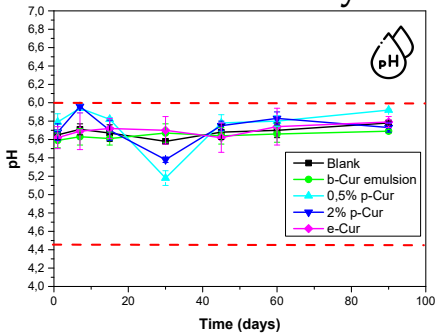
Emulsions with Curcumin (Cur) derivatives:

- Cur powder,
- Cur extract, and
- Cur complexed with β-cyclodextrin

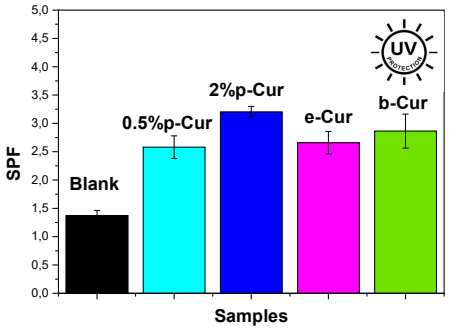


RESULTS

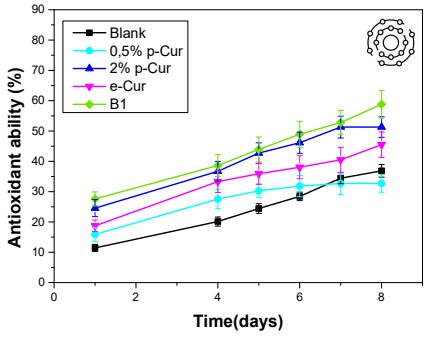
Great stability

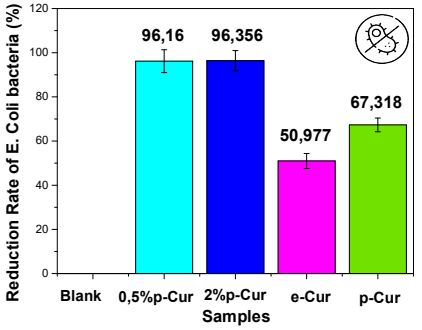


Increased UV protection



Enhanced antioxidant and antimicrobial properties





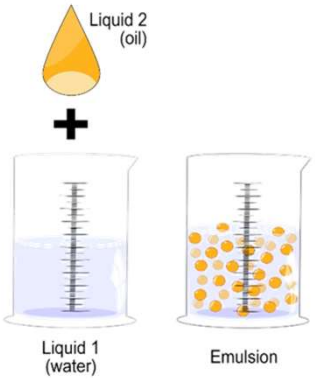
Dalla, E., Koumentakou, I., Bikiaris, N., Balla, E., Lykidou, S., & Nikolaidis, N. (2022). Formulation, Characterization and Evaluation of Innovative O/W Emulsions Containing Curcumin Derivatives with Enhanced Antioxidant Properties. *Antioxidants*, *11*(11), 2271.

Preparation and Investigation of the SPF and Antioxidant Properties of O/W and W/O Emulsions Containing Vitamins A, C and E for Cosmetic Applications

EXPERIMENTALS

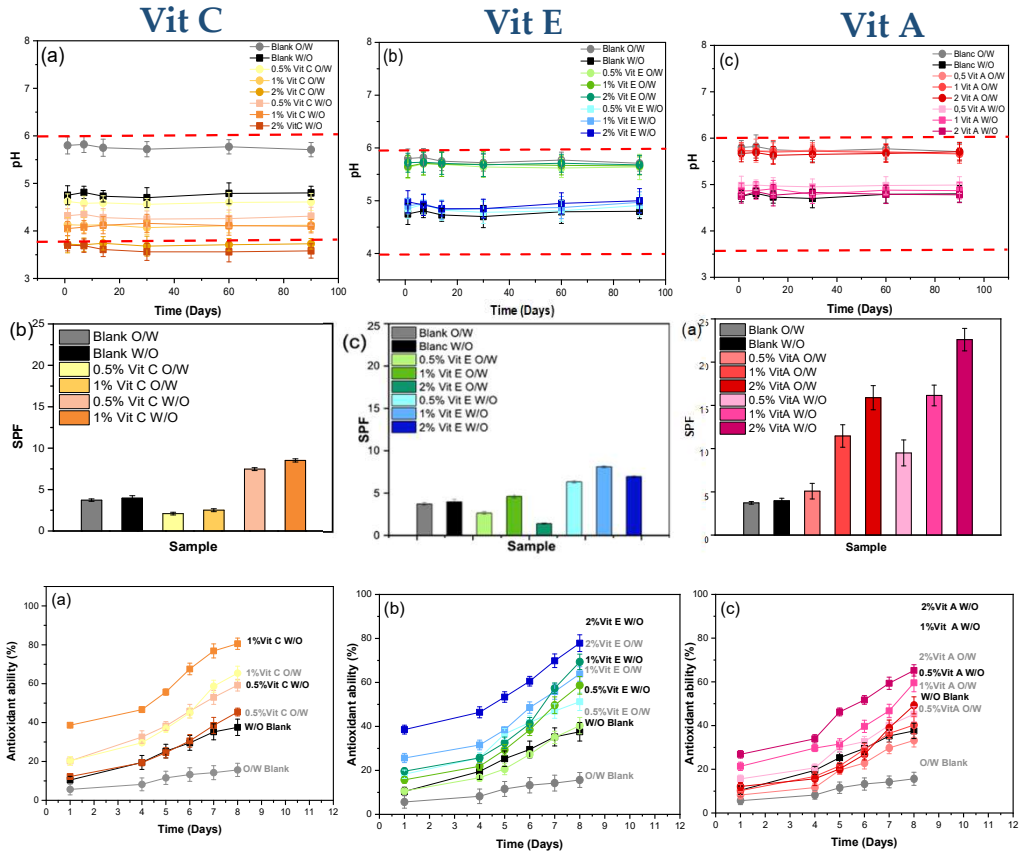
Emulsions with Vitamins:

- Vitamin A,
- Vitamin C, and
- Vitamin E



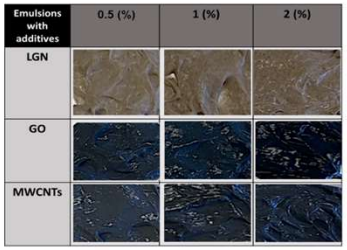
Bikiaris, N. D., Koumentakou, I., Hatzistamatiou, K., Lykidou, S., Barmpalexis, P., & Nikolaidis, N. (2023). Preparation and Investigation of the SPF and Antioxidant Properties of O/W and W/O Emulsions Containing Vitamins A, C and E for Cosmetic Applications. *Cosmetics*, *10*(3), 76.

RESULTS



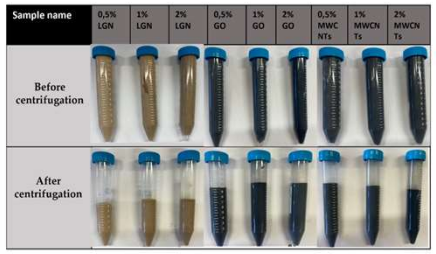
Innovative Skin Product O/W Emulsions Containing Lignin, Multiwall Carbon Nanotubes and Graphene Oxide Nanoadditives with Enhanced Sun Protection Factor and UV Stability Properties

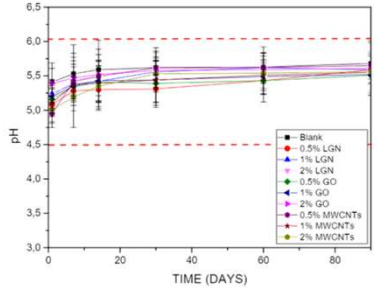
EXPERIMENTALS



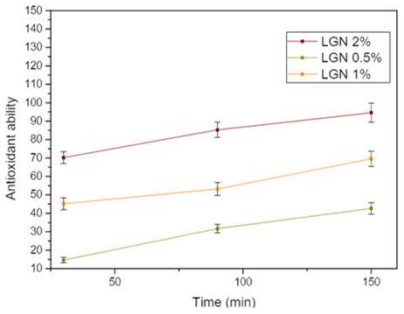
RESULTS

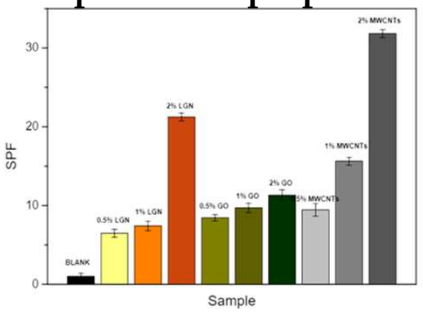
Great storage and pH stability





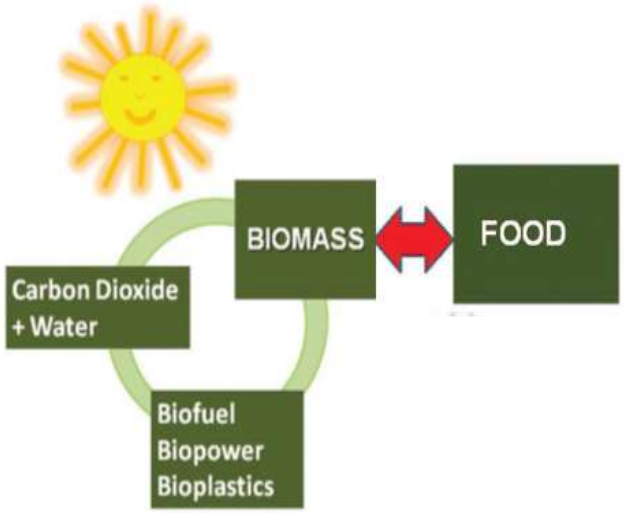
Enhanced antioxidant and sun protection properties





Bikiaris, N. D., Koumentakou, I., Lykidou, S., & Nikolaidis, N. (2022). Innovative skin product O/W emulsions containing lignin, multiwall carbon nanotubes and graphene oxide nanoadditives with enhanced sun protection factor and UV stability properties. *Applied Nano*, *3*(1), 1-15.

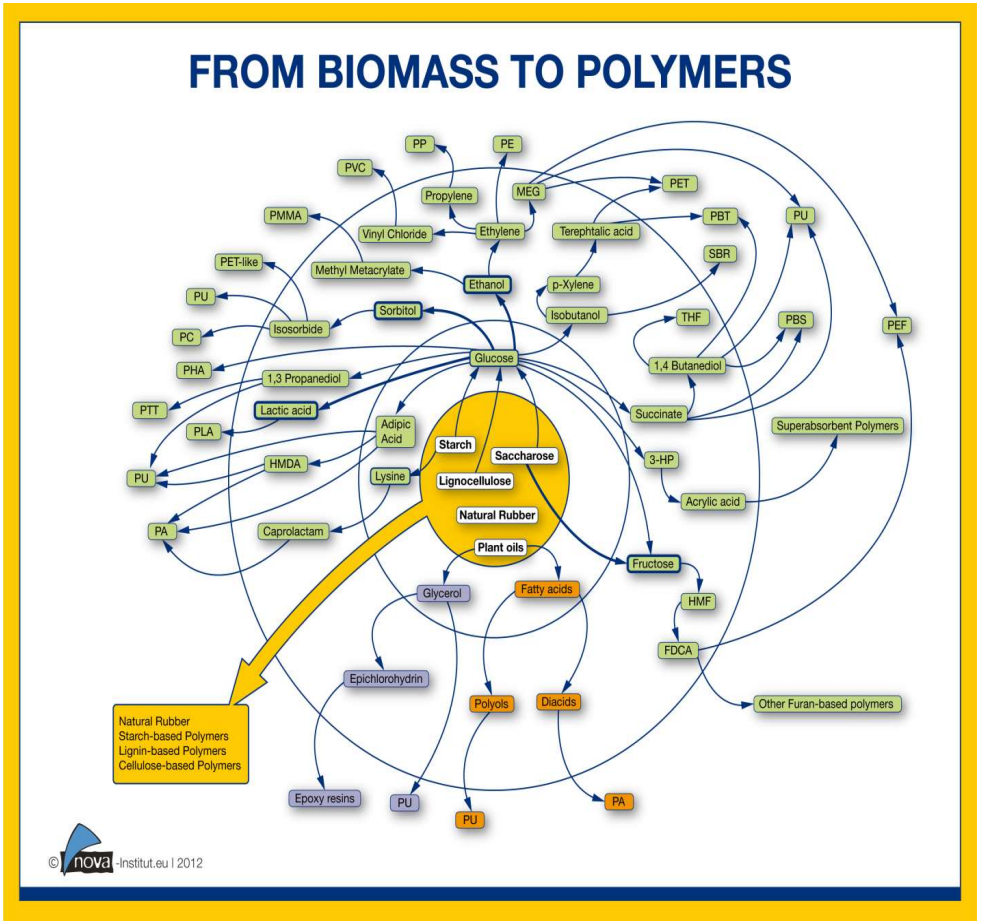
Research fields in Synthesis of Biobased Polymers and additives



From biomass there are 2 different strategies to produce bioplastics.

In strategy (i), biorefining of biomass is employed to produce synthetic crude oil ("renewable oil") and green monomers.

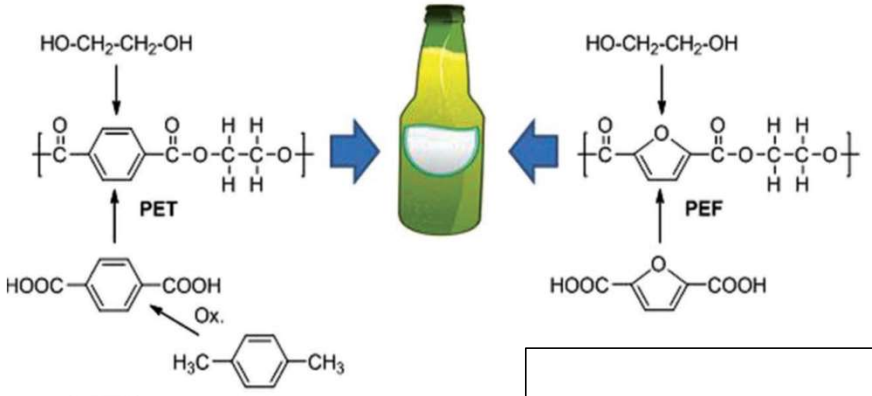
In strategy (ii), these monomers are used for effective polymer manufacturing processes

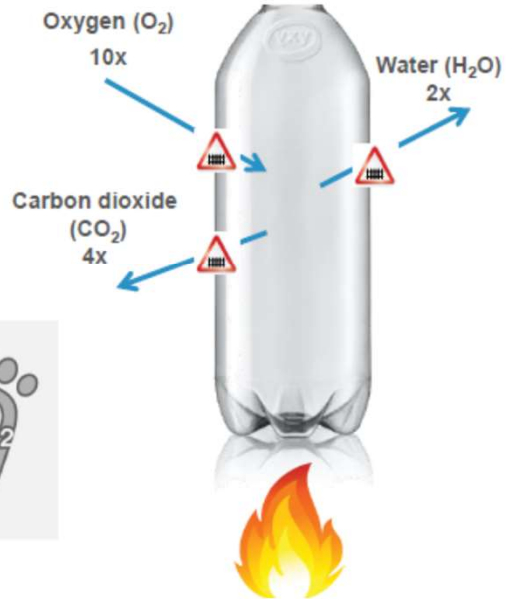


Bio-based polyester for food packaging
Poly(ethylene furanoate) (PEF)

PEF: the Next Generation Polyester

- Superior performance over PET:
  - O_2 barrier: 10x improvement
  - H_2O barrier: 2x improvement
  - CO_2 barrier: 4x improvement
- Improved Thermal Stability
  - Tg: ~88°C → 12°C higher than PET
- Excellent Mechanical Properties:
  - Tensile Modulus PEF : 1.6* PET
- Significant reduction in carbon footprint
  - 70% lower carbon emission
  - 65% lower NREU





- Published more than 60 papers in this area,
- Most active group around the world in furanoate Polyesters

The Project

FoodTraNet

ITN - Marie Skłodowska-Curie

https://www.foodtranet.org

The goal is to train and mobilize **15 early-stage researchers** to develop advanced methods for maintaining food quality, authenticity, and traceability and create radical food production and safety solutions **using advanced materials and technologies.**

Consortium Partners

Jožef Stefan Institute

COORDINATOR

7 ACADEMIC BENEFICIARIES

2 INDUSTRIAL BENEFICIARIES

20 PARTCIPATING ORGANISATIONS

Poly(ethylene furanoate) bottles with active additives to enhance antibacterial properties and to extent food life.

Johan Stanley

ESR 12

The synthesis of smart biopolymer materials with nanostructured surfaces with antimicrobial, biocompatible, anti-adhesive properties

Aristotle University of Thessaloniki

Lorenzo Martello

ESR 8

Synthesis of "smart" polymer nanostructured materials for use in food research

BIOBASED NANOMATERIALS COMMUNITY

A research and industrial community serving the uptake of a revolutionary technology

BIOMAC

35 partners

https://www.biomac-oitb.eu

B I O M A C

Project Coordinator

ARISTOTLE UNIVERSITY OF THESSALONIKI

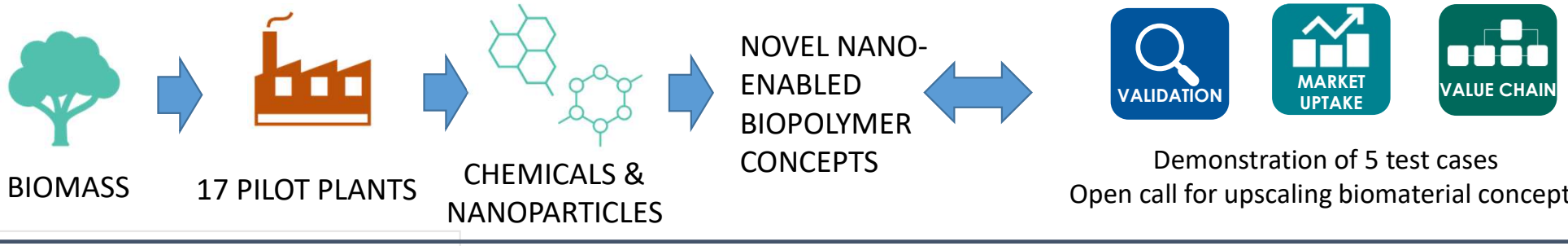
www.biomac-oitb.eu

biomac@chem.auth.gr

Project details

Start date: JANUARY 2021
Duration: 4 YEARS
EU contribution: 16.5 mil €

Open Innovation Test Bed for concept development in the field of nano-enabled bio-based materials and products

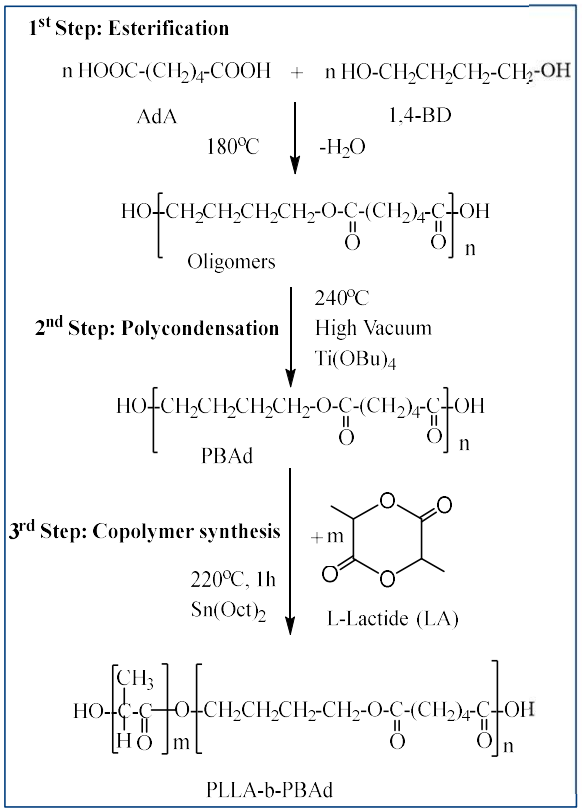


Demonstration of 5 test cases
Open call for upscaling biomaterial concepts

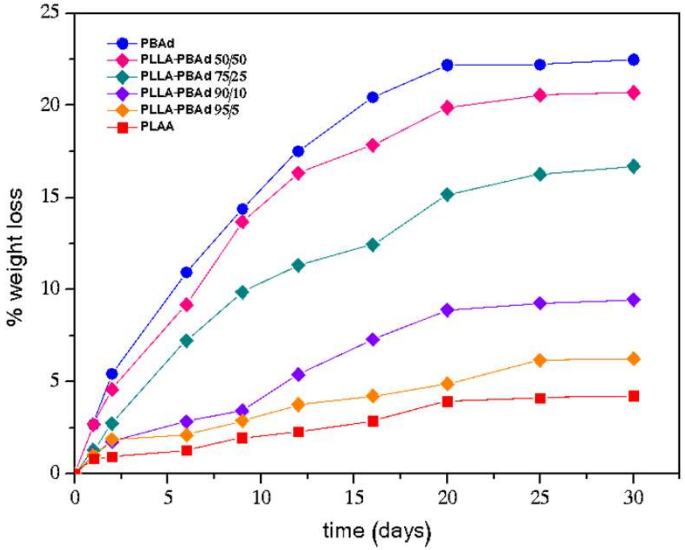
This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 952941

Biodegradable polymers

1. PLA copolymers with high hydrolysable monomers in order to achieve PLA biodegradability at natural environment.

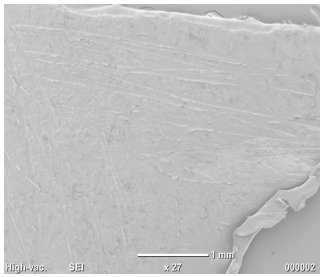


Block copolymers by ROP

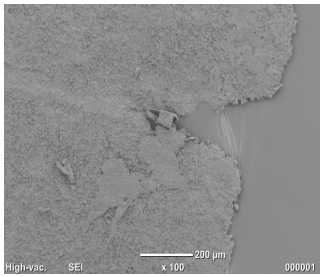


Enzymatic Hydrolysis

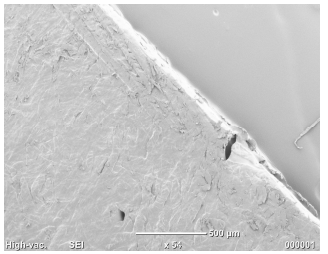
0 Day

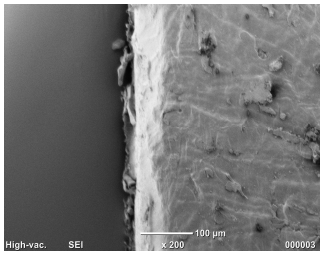


20 days



PBAd





PBAd/PLA 50/50

Poly(lactic Acid): A Versatile Biobased Polymer for the Future with Multifunctional Properties. Second most viewed paper in Polymers with 32707 views.
Polymers **2021**, *13*(11), 1822; https://doi.org/10.3390/polym13111822

PROJECT PARTNERS

TEKNOLOGISK INSTITUT

creative nano · LOMARTOV · ARISTOTLE UNIVERSITY OF THESSALONIKI

AXIA INNOVATION · ITENE · Metrohm DropSens

NanoScientifica · UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH · melsen tech · cpi

11 PARTNERS
6 EUROPEAN COUNTRIES

Funded by the European Union

This project has received funding from the European Union's Horizon Europe (HORIZON) programme under the grant agreement No. 101070556

PROJECT COORDINATOR

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DENMARK

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www.sustainaprint.eu
info@sustainaprint.eu

#SUSTAINAPRINT

SUSTAIN A PRINT

SUSTAINABLE MATERIALS AND PROCESS FOR GREEN PRINTED ELECTRONICS

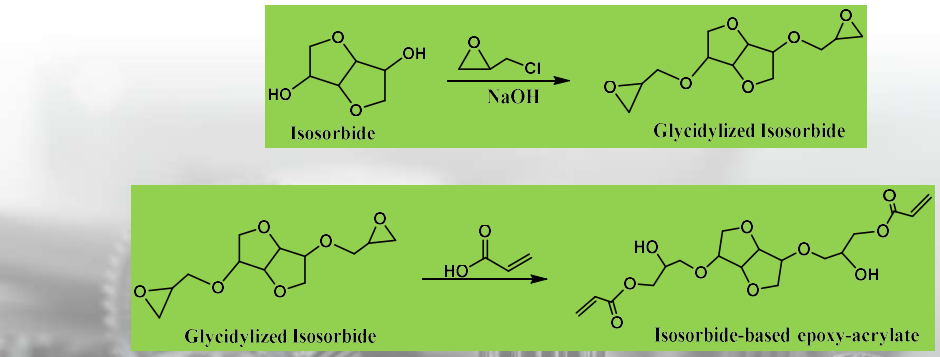
PROJECT DETAILS
START DATE: OCTOBER 2022
DURATION: 36 MONTHS
EU CONTRIBUTION: 4.1M €

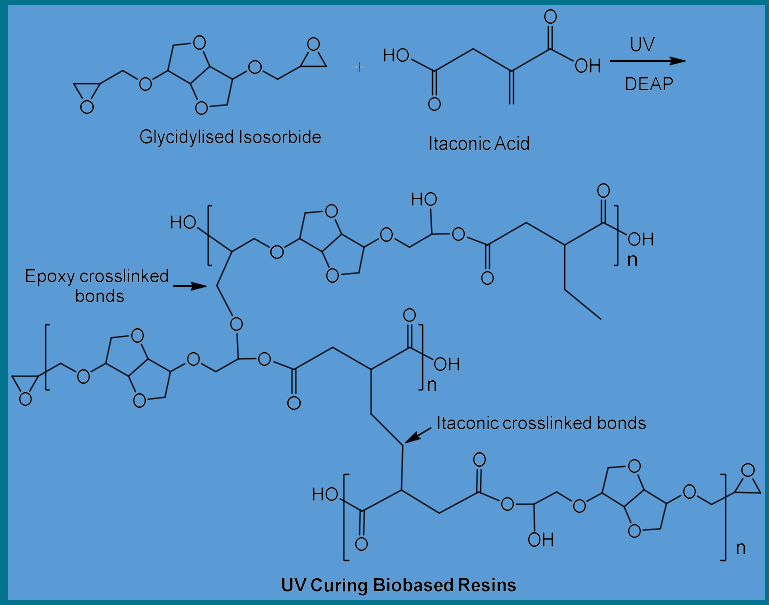
WWW.SUSTAINAPRINT.EU

https://www.sustainaprint.eu/

https://www.freeme-project.eu/

Toxic FREE MEtallization process for plastic surfaces





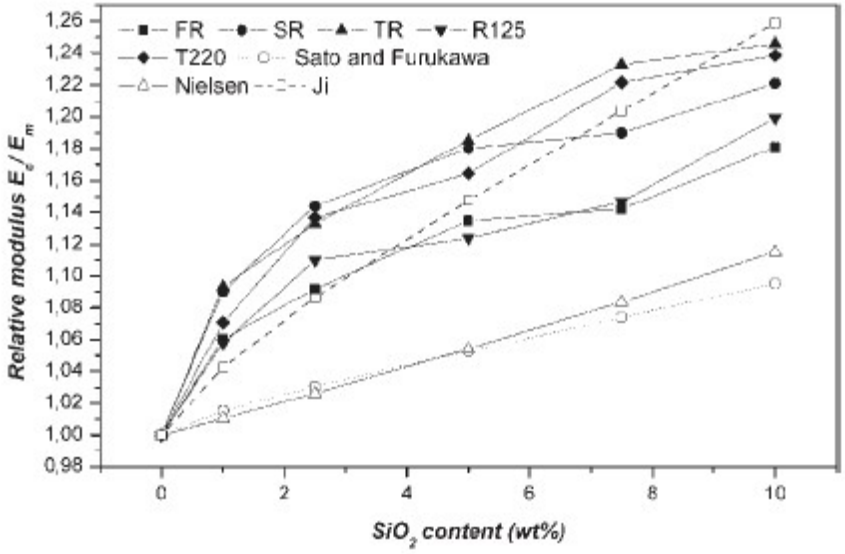
This project has received funding from the European Union's Horizon Europe research and innovation programme under the grant agreement **No 101058699**

Polymer composites and Nano-composites

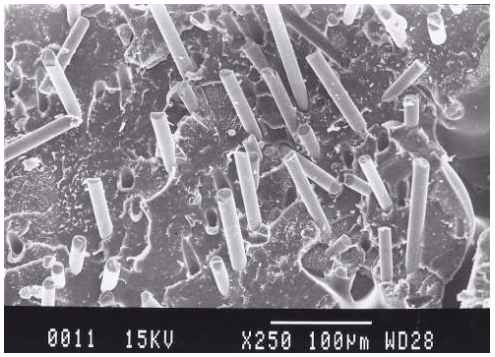
- **PP/HDPE-glass fibers,**
  Surface treatment

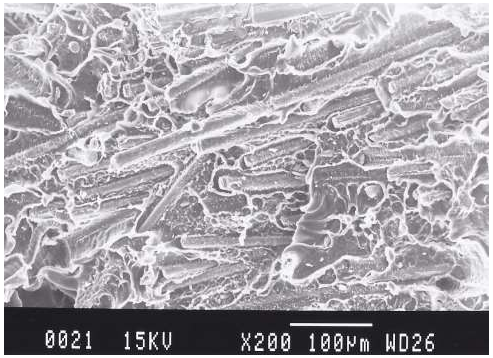
- **PP/$CaCO_3$ - volastonite, talc, $Mg(OH)_2$**

- **PET/PPT/Aliphatic polyesters, PP, HDPE, PS, PVC nanocomposites**
  SiO_2 (surface treatment, aminosilane, etc.)
  Clays
  MWCNTs (oxidation, surface treatment)
  NDs
  TiO_2, Al_2O_3, NanoAg,
  Graphene



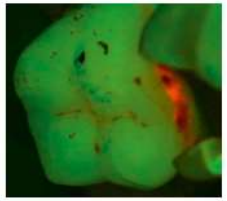
Mechanical properties, thermal stability, crystallization rates, gas permeability, biodegradability, pinking effect, thermal conductivity, UV stability, etc.





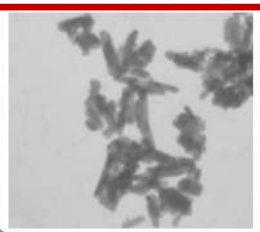
Overall contribution of AUTH to I-SMarD

Photoactive layers for monitoring the healing process.

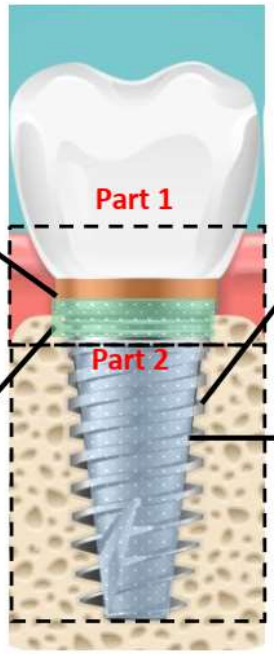


- Rare earth elements
- Light based diagnosis of soft tissue
- Blood oximetry

Release of nanoparticles and minerals from the pores to promote new bone formation.

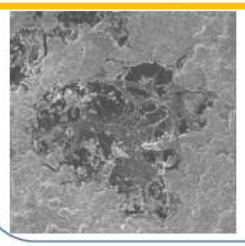


- Slow release of mineral NPs that promote bone formation
- Porosity favors strong implant-bone bond



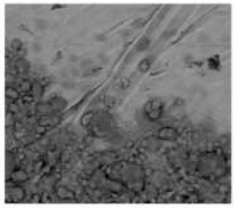
AUTH Chemistry

pH sensitive polymer for "smart" delivery of antibiotics and/or Ce-oxide NPs.



- Increased drug release during infection
- Agents to promote soft tissue attachment

Fluorapatite coatings on the surface to promote implant integration to bone.



- Calcium phosphate layer to promote osseointegration
- Increased resistance to corrosion

Development of the materials (pH sensitive polymers, nanoparticles etc.) that will be loaded to our implant in order to achieve "smart" delivery of antibacterial agents and enhanced antibacterial potential.

https://i-smard.eu/

REVERSIBLY DESIGNED CROSS-LINKED POLYMERS

REDONDO

https://www.redondo-project.eu/en/normal/home

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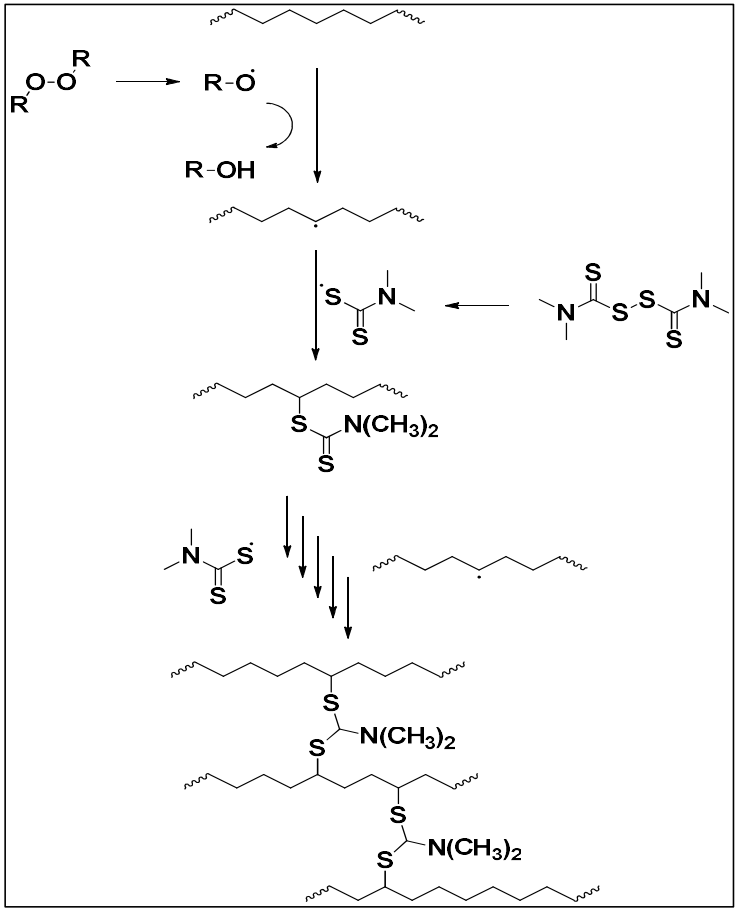


Polymers Used in Pharmaceutical Technology

Natural Polymers

- Starch
- Cellulose
- Chitosan
- Proteins
- Collagen

- **Drug Solid dispersion**
- **Nanoencapsulation**
- **Sustained release formulations**
- **Long acting injectables**
- **Transdermal patches**
- **Hydrogels**
- **Nanocomposites**

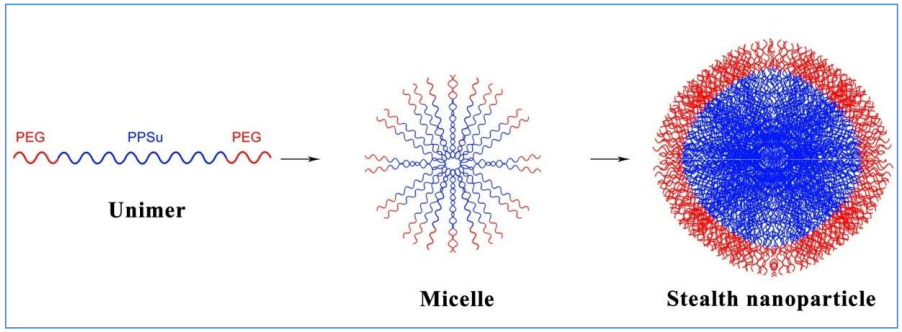
Synthetic polymers

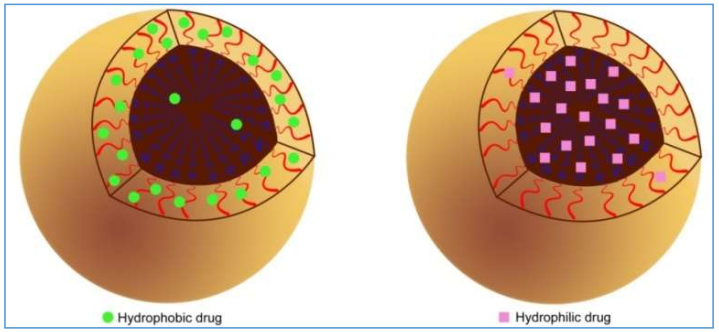
- Polyesters
- Polyurethanes
- Poly(ethylene-co-vinyl acetate)
- Poly(vinyl alcohol)
- Poly(ethylene glycol)
- Poly(ethylene oxide)
- Poly(vinyl pyrrolidone)

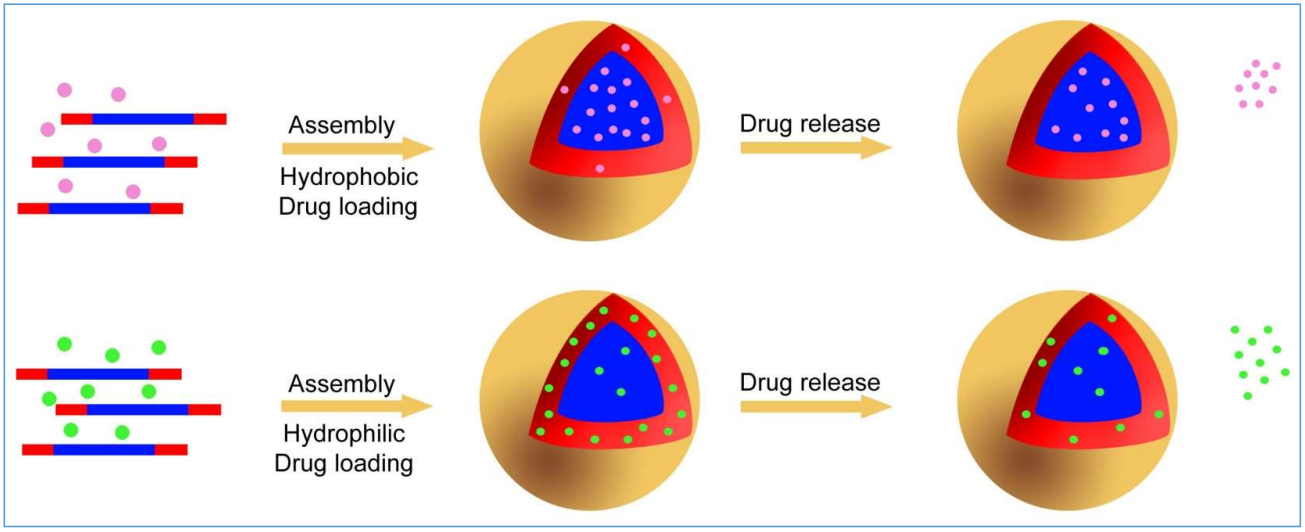
- **Drug bioavailability enhancement**
- **Ocular release formulation**
- **Anticancer drug applications**
- **Antibacterial drugs**
- **Transdermal formulations**
- **3D – printing**
- **Tissue engineering applications**

PEGylated PPSu copolymers can form core-shell nanoparticles

- Hydrophobic PPSu creates the core while hydrophilic PEG shell
- Hydrophilic drugs are encapsulated in core while hydrophilic in shell

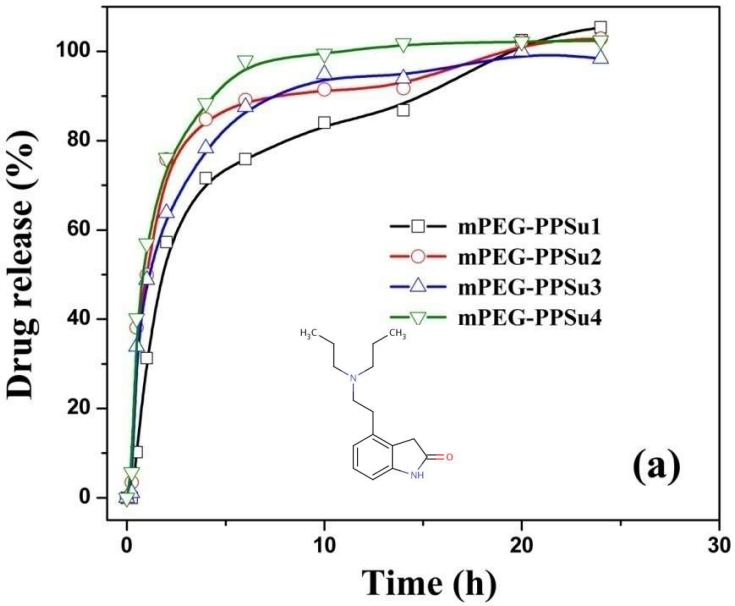




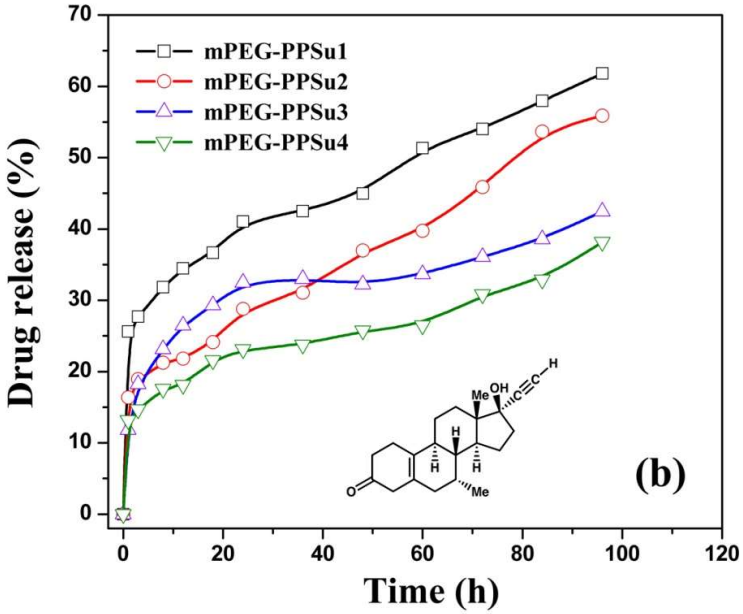


Drug release from PPSu-PEG core-shell nanoparticles

Ropinirole is a non-ergoline dopamine agonist

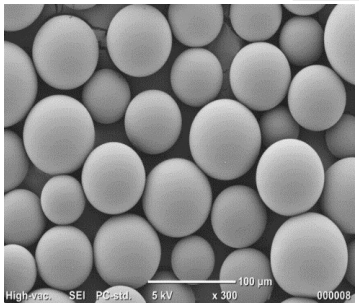


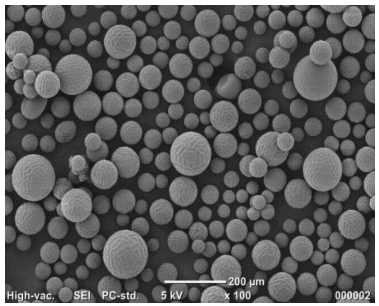
Tibolone is a synthetic steroid hormone drug

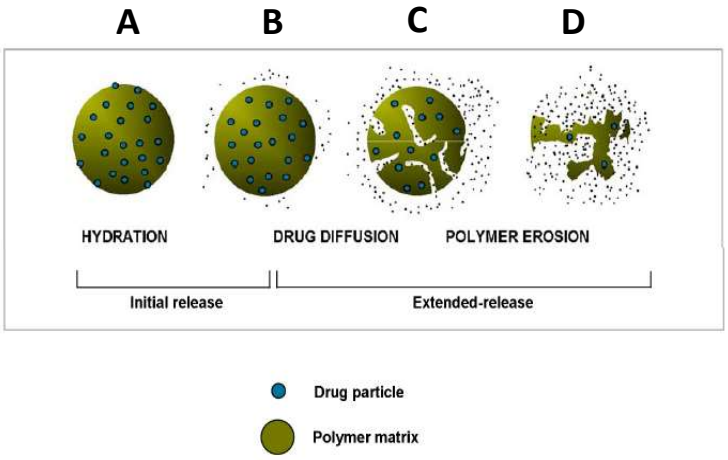


•A.A. Vassiliou, et al. J. Controlled Rel 148, 388–395 (2010).

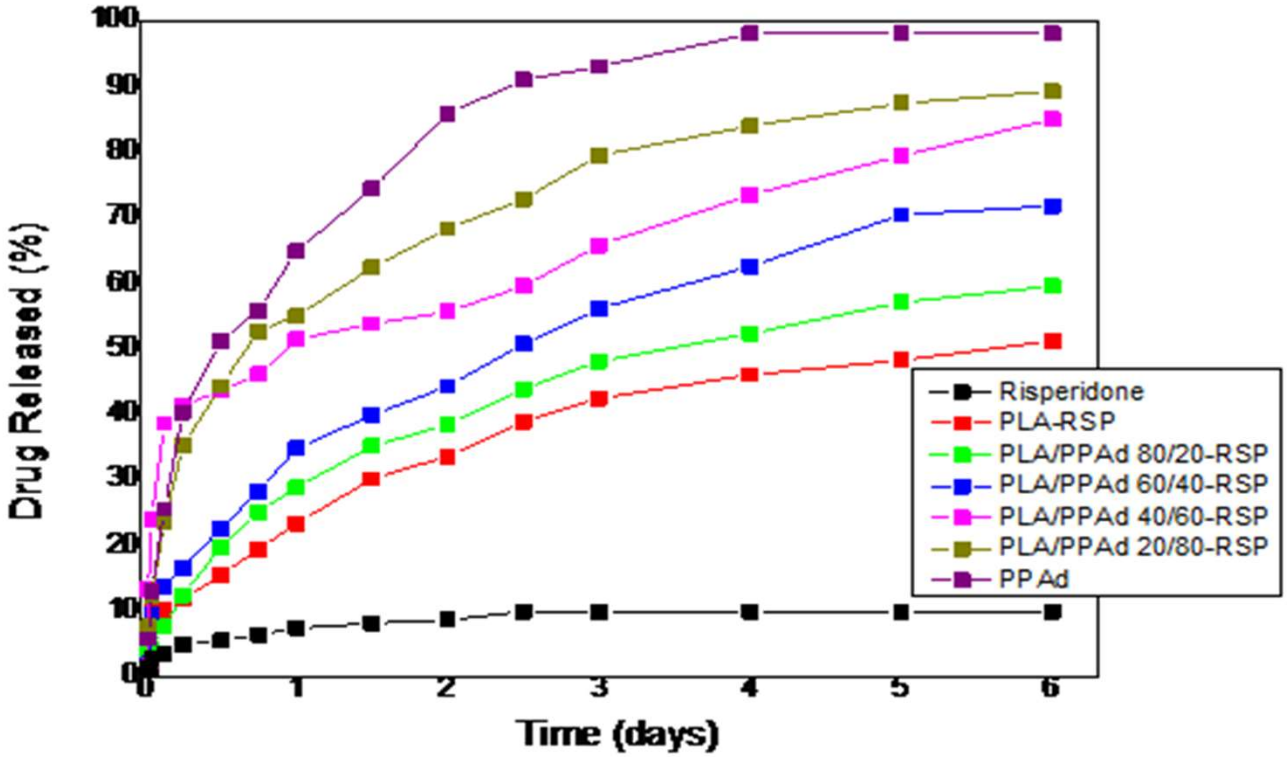
Drug Release from Polymer microparticles





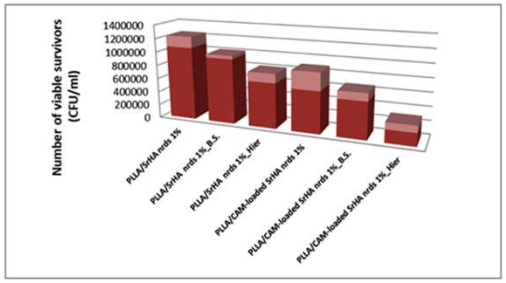


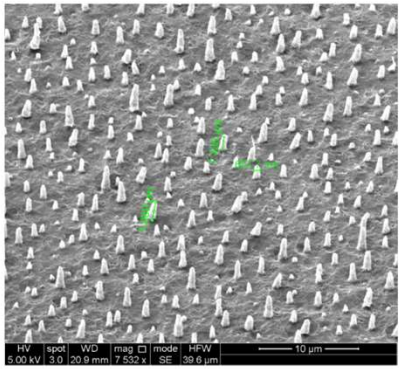
Matrix erosion

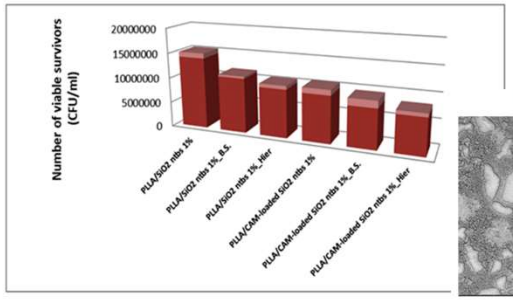


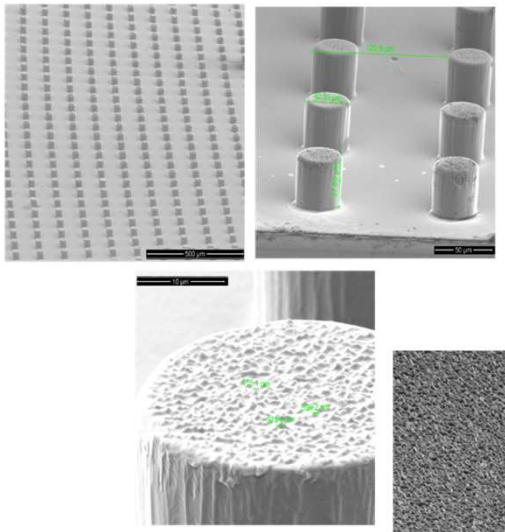
Design of Multifunctional Nano-engineered PLLA Surface by Maximising the Synergies Between Biochemical and Surface Design Bactericidal Effects

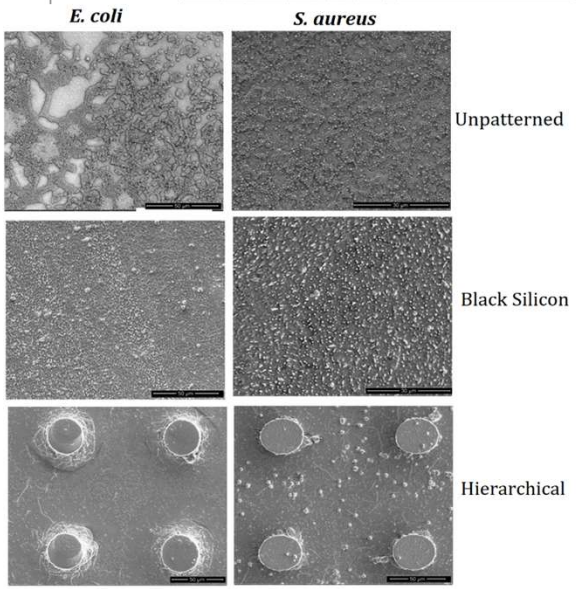
Catalan Institute of Nanoscience and Nanotechnology











SEM images of the Black Silicon nanostructured PLLA surface at different magnifications.

Nerantzaki et. al. ACS Omega 3; 1509: 2018.