

Green Polymers

The Green Polymers group applies science and engineering principles to enable the more sustainable generation and use of polymeric materials.



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Main expertise fields

- Generation of monomers, pre-polymers and fillers from renewable resources
- Synthesis, formulation and structure-properties relations of bio-based / sustainable thermoplastics, thermosets and their composites
- Materials classes: aminoplasts, benzoxazines, cellulose & cellulose derivatives, elastomers & rubbers, epoxies, fiber composites, interpenetrating networks, lignin, nanoparticles & nanocomposites, plant oils & derivatives, phenolic resins, polyesters, polysaccharides & derivatives, polyurethanes (conventional & non-isocyanate, foams), silicones, vinyl ester resins, vitrimers
- Process approaches: additive manufacturing, chemical recycling, composite & nanocomposite processing, compression molding, extrusion, injection molding, mechanical recycling
- Characterization techniques: FTIR, NIR & NMR spectroscopy, fire testing, gas sorption & surface area analysis, GPC, mass spectrometry, permeability testing, porosimetry, rheology, thermal analysis, x-ray diffraction

Research challenge

- Design of monomers, (pre-)polymers and fillers with enhanced safety and sustainability in mind
- Extraction, isolation and chemical modification of monomers, (pre-)polymers and fillers from biomass
- Identifying of safer, more sustainable synthetic methods and (pre-)processing approaches
- Developing new approaches to manage the end-of-life of polymeric materials
- Ensuring that solutions deliver necessary performance levels, scalability, industrial relevance and socioeconomic impact

Application areas

- Additive manufacturing
- Adhesives and coatings
- Automotive and transportation
- Biomedical applications
- Electronics and electrical applications
- High performance polymeric materials
- Packaging
- Space & aerospace
- Structural materials
- New polymers and additives for tires

Main assets

1. **J2024BIBU** (ongoing)
 - Bio-derived materials for additive manufacturing
2. **CARBIOSE** (ongoing)
 - Hemicellulose-derived polyesters
3. **Goodyear-LIST** partnership (ongoing)
 - Bio-based process & performance additives
 - Novel traction resins
 - Additive compatibility, migration and performance
4. **LIGNOREX** (ongoing)
 - Lignin-based benzoxazine resins
5. **Other assets (academic & industrial)**
 - Alternative thermoset, adhesive and coating formulations for industrial applications
 - Bio-based epoxies, vitrimers and fiber composites
 - Carbanion based additives and polymeric materials
 - High performance foams and porous materials for industrial applications
 - Nanocomposites adapted to specific industrial needs

Equipment

- Anton Paar MCR 302 rheometer
- Christ Martin Alpha 3-4 LSC basic freeze dryer
- LabThink VAC-VBS permeation analyser
- Nussli MK24120 Supermassivolver ultra fine friction grinder
- Mbraun LABStar four-arm glove box
- Mbraun SPS 800 solvent purification systems
- Parr 4564 benchtop carbon dioxide reactor
- Schlenk lines
 - Synthesis reactors up to 5 L
 - Top Industrie custom-built polycondensation reactor
- UV conveyor
- Vacuum ovens

Selected publications

- Schmidt, D. F. Processing of polymer nanocomposites. In *Industry Guide to Polymer Nanocomposites*, 1. ed.; Beyer, G., Ed.; A PID technical book; Plastics Information Direct: Bristol, 2009.
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- Liu, W.; Reynaud, E.; Schmidt, D. F. [Catalytic Selection, Kinetic, and Stress Relaxation in High-Performance Epoxy Vitrimers](#). *Ind. Eng. Chem. Res.* 2017, 56 (10), 2667-2672.
- Trejo Machin, A.; Verge, P.; Puchot, A.; Quintana, R. [Dioxane Acid as an Alternative to the Detection of Diisocyanate Residues in the Synthesis of Polybenzoxazine](#). *Green Chem.* 2017, 19 (21), 5065-5073.
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- Quenne, B.; Kasmi, N.; Dieden, R.; Callot, S.; Habibi, Y. [Isocyanate-Free Fully Bio-Based Star Polyester-Urethanes: Synthesis and Thermal Properties](#). *Biomacromolecules* 2020, 21 (5), 1943-1951.
- Trejo Machin, A.; Ajjouf, A.; Puchot, A.; Dieden, R.; Verge, P. [Elucidating the Thermal and Polymerization Behaviours of Benzoxazines from Lignin Derivatives](#). *European Polymer Journal* 2020, 124, 109468.

Partners

University of Cergy-Pontoise, Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Goodyear Tire & Rubber Company, Roquette

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