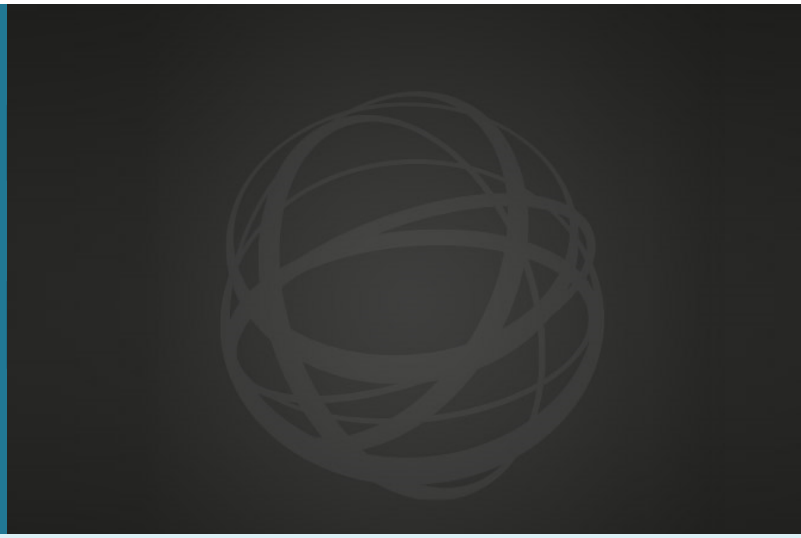
RESEARCH GROUP

www.list.lu/en/research-groups/group/green-polymers-group/

Green Polymers

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



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

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 & cellulosics, 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 (re-)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. 3DPRINTINN (ongoing)
   - Bio-derived materials for additive manufacturing
- CATBIOSE (ongoing)
   - Hemicellulose-derived polyesters
- Goodyear-LIST partnership (ongoing)
   - Bio-based process & performance additives
   - Novel traction resins
   - Additive compatibility, migration and performance
- LIGNORENZ (ongoing)
   - Lignin-based benzoxazine resins
- Other assets (academic & industrial)
   - Alternative thermoset, adhesive and coating formulations for industrial applications
   - Bio-based epoxies, vitrimers and fiber composites
   - Cardanol-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 LSCbasic freeze dryer
- LabThink VAC-VBS permeation analyser
- Masuko MKZA10-20J Supermasscolloider 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 conveyer
- 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.
- Dunkerley, E.; Schmidt, D. F. Understanding the Consequences of Intercalation Using Model Polymer Nanolaminates. *Macromolecules* 2015, *48* (20), 7620-7630.
- Puchot, L.; Verge, P.; Fouquet, T.; Vancaeyzeele, C.; Vidal, F.; Habibi, Y. Breaking the Symmetry of Dibenzoxazines: A Paradigm to Tailor the Design of Bio-Based Thermosets. *Green Chem.* 2016, *18* (11), 3346-3353.
- Buono, P.; Duval, A.; Averous, L.; Habibi, Y. Lignin-Based Materials Through Thiol-Maleimide "Click" Polymerization. *ChemSusChem* 2017, *10* (5), 984-992.
- Liu, W.; Reynaud, E.; Schmidt, D. F. Catalyst Selection, Creep, and Stress Relaxation in High-Performance Epoxy Vitrimers. *Ind. Eng. Chem. Res.* 2017, *56* (10), 2667-2672.
- Trejo-Machin, A.; Verge, P.; Puchot, L.; Quintana, R. Phloretic Acid as an Alternative to the Phenolation of Aliphatic Hydroxyls for the Elaboration of Polybenzoxazine. *Green Chem.* 2017, *19* (21), 5065-5073.
- Valdebenito, F.; García, R.; Cruces, K.; Ciudad, G.; Chinga-Carrasco, G.; Habibi, Y. CO_2 Adsorption of Surface-Modified Cellulose Nanofibril Films Derived from Agricultural Wastes. *ACS Sustainable Chem. Eng.* 2018, *6* (10), 12603-12612.
- Kuncho, C. N.; Liu, W.; Möller, J.; Kammleiter, J.; Stehle, J.; Kokil, A.; Reynaud, E.; Schmidt, D. F., In Enhancing the Sustainability of High-Performance Fiber Composites; *ACS Symposium Series*; Cheng, H. N., Gross, R. A., Smith, P. B., Eds.; American Chemical Society: Washington, DC, 2018; Vol. 1310, pp 281-295.
- Gesesse, G. D.; Li, C.; Paineau, E.; Habibi, Y.; Remita, H.; Colbeau-Justin, C.; Ghazzal, M. N. Enhanced Photogenerated Charge Carriers and Photocatalytic Activity of Biotemplated Mesoporous TiO_2 Films with a Chiral Nematic Structure. *Chem. Mater.* 2019, *31* (13), 4851-4863.
- Quienne, B.; Kasmi, N.; Dieden, R.; Caillol, S.; Habibi, Y. Isocyanate-Free Fully Biobased Star Polyester-Urethanes: Synthesis and Thermal Properties. *Biomacromolecules* 2020, *21* (5), 1943-1951.
- Trejo-Machin, A.; Adjaoud, A.; Puchot, L.; 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

Contact

5, avenue des Hauts-Fourneaux
L-4362 Esch-sur-Alzette
phone: +352 275 888 - 1 | LIST.lu

Daniel SCHMIDT (daniel.schmidt@list.lu)

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY | LIST