

A journey around circularity in polymers, from renewable resources to recycling

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Recent years have witnessed an increasing demand for environmentally friendly materials, particularly for polyurethanes (PU)s, which correspond to 6th polymer in the world with an annual production close to 20Mt. We have synthesized biobased polymers from renewable resources, particularly natural phenols, following a platform approach and convergent functionalization routes. Furthermore, in order to reduce the environmental impact, we have also proposed to replace some harmful substances and additives by less harmful monomers. Hence, we have proposed substitution of BPA in epoxy networks, and regarding PUs, we have developed a platform approach for the synthesis of non-isocyanates PUs. We have thoroughly investigated the reactivity, the interest and limits of this reaction leading to polyhydroxyurethanes (PHU)s, and particularly to hybrid PHUs. We have also designed self-healing polymers and coatings to improve the lifespan of polymers. In order to consider the full life cycle of materials, we also studied the recycling of thermosetting polymers by depolymerization and especially by the synthesis of vitrimers.

Fluorine-activated vitrimers

Vincent Ladmiral

Vitrimers are polymer networks possessing dynamic crosslinks via exchange reactions. These materials thus combine properties of thermoplastics and of thermosets: resistance to solvent, good mechanical properties, reprocessability, self-healing and improved recyclability. This talk will show how the strong electron-withdrawing effects of fluorinated groups can be harnessed to activate exchange reactions to produce vitrimer materials. Indeed, fluorine atoms located close to the exchangeable bond are shown to significantly accelerate exchanges on molecular model reactions and by DFT calculations. This acceleration is even more pronounced in crosslinked materials. These materials featured typical vitrimer behaviours with complete stress-relaxation and topological reorganisation via fluorine-activated exchange reactions, in the absence of any catalysts.