Thermosets and ‘‘clic’’ reaction

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Issues of resource management, energy and environmental preservation have recently come to the fore. According to Statista, the global waste and recycling services market was worth a total of $55 billion in 2020, rising to $60 billion in 2022 and expected to reach $88 billion by 2030. Against this backdrop, and at the initiative of Nicolas Hulot and Brune Poirson, in 2018 the French government issued a circular economy roadmap (FREC) outlining the fifty measures to be put in place for a circular economy.[1] In this FREC, "managing resources more sustainably", "encouraging products to move upmarket and differentiate themselves through better environmental performance" and "recycling better" are among the key objectives.

In this context, the recovery and recyclability of plastics have become major issues for our society. Among all polymers, the thermosets (TS) are the most affected by these issues. Indeed, their three-dimensional macromolecular architecture, giving them specific macroscopic properties (temperature resistance, dimensional stability and resistance to friction), significantly limits their recyclability by standard methods. Currently, some strategies have been implemented for synthesizing recyclable TS using dynamic covalent networks (functional groups able to react by transesterification, Diels-Alder chemistry, disulfide metathesis and dynamic B-O bonds were added as co-monomers) but the type of TS are limited (mainly polyurethane) and the reversibility/recycling mechanisms are not yet fully understood.[2]

This PhD thesis will thus aim to make it possible to recycle various TS by integrating functional groups with the ability to form covalent bonds and then to break them easily (reversible reaction) under stimulation.[3,4] The main steps will consist in (i) investigating the various functional groups able to react by “click” reactions, (ii) synthesizing (non-)responsive TS, (iii) deeply investigating the ‘‘click” reactivity and (iv) optimizing the “click” conditions for various applications. We propose to start with acrylate derivatives before extending these steps to other TS.

References:

[1] *Ministères Écologie Énergie Territoires*. La feuille de route économie circulaire (FREC). https://www.ecologie.gouv.fr/feuille-route-economie-circulaire-frec
[2] Y. Zhang *et al. J. Mat. Sci. Tech.* **2021**, 92, 75.
[3] C. Alarcón *et al. Chem. Soc. Rev*. **2005**, 34 (3), 276
[4] M. Vauthier, C. .A. Serra. *Coll. Surf. A: Phys. Eng. Aspects* **2022**, *648*, 129321.

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