Design of biodegradable and biobased tough hydrogels

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Résumé

Hydrogels materials have been increasingly studied and developed for food, cosmetic, electronic or biomedical applications as drug delivery or tissue engineering. With recent polymer engineering, the mechanical responses of synthetic networks have been considerably enhanced by using smart macromolecular architectures. Still, most of these hydrogels are petroleum based and not degradable. Indeed, biosourcing and biodegradation of gels are still little addressed in the community. One explanation lies in the fact that often biodegradable hydrogels are made from biobased high molecular weights polymers (as collagen, chitosan, alginate, starch, cellulose, etc.) that make difficult to control and to tune their architectures. The aim of our project is to develop fully biobased and biodegradable hydrogels based on an acrylate analog: itaconic acid (extracted from Aspergillus terreus fungi) as polymer network reinforced by stereocomplex (SC) crystallization between hydrophobic polymers which seems quite effective process to enhance the mechanical response of the network since stereocomplexation appears to be efficient in aqueous media. PLA-based stereocomplex can be used as they are biobased and biodegradable. Moreover, SC formation between PLLA and PDLA is reported to improved mechanical properties and provide resistance to thermal and hydrolytic degradation.
As a first result, we demonstrated the high potential of the itaconic acid to form hydrogel by developing an innovative synthesis path. Thus, under specific soft polymerization conditions, we successfully controlled the macromolecular architecture. We will work after at reinforcing the hydrogels by playing with the strength of polyester hydrophobic interaction in water to explore in a controlled way, the crystallization process and his effect on reinforcement mechanisms. Degradability (and its conditions) will also have to be properly quantified.

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