

TITLE: “Pre-industrialization study of heterogeneous polysaccharide-based organocatalysts for fine chemistry” (acronym: POLYCAT)

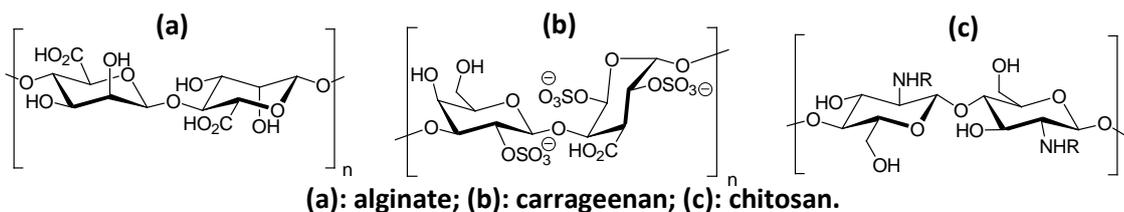
HOME INSTITUTION: Ecole Nationale Supérieure de Chimie de Montpellier, Institut Charles Gerhardt (ICG), Montpellier, France ; . Supervisors of the PhD student in Montpellier: Françoise QUIGNARD and Nathalie TANCHOUX (team “Advanced materials for catalysis and healthcare” (Matériaux avancés pour la catalyse et la santé, MACS), quignard@enscm.fr).

HOST INSTITUTION 1: Università di Bologna, Italy. Supervisor of the PhD student in Bologna: Luca BERNARDI (Dipartimento di Chimica Organica “A. Mangini”, luca.bernardi2@unibo.it).

HOST INSTITUTION 2: Politecnico di Torino. Supervisors of the PhD student in Torino: Barbara BONELLI and Edoardo GARRONE (Dipartimento di Scienza dei Materiali e Ingegneria Chimica, barbara.bonelli@polito.it).

PROJECT DETAILS

In the last years, new heterogeneous organocatalysts based on polysaccharides (chitosan, alginate or carrageenan) have been developed exploiting their self-assembly properties, their intrinsic chemical functions, the possibility to further functionalize them, their ability to complex ions and their easy shaping. The attractiveness of the applications of polysaccharides as catalysts stems both from their availability from renewable resources and their intrinsic properties. As far as the availability is concerned, most gelling polysaccharides are obtained from biomass wastes or from purposely-grown biomass not in competition with food resources. Algal polysaccharides, for the economics of their growth and their ease of extraction, are among the less-energy consuming alternatives to fossil fuels. Moreover, several gelling polysaccharides naturally bear functional groups that have to be inserted by energy-consuming operations in oil-derived polymers. For instance, chitosan brings basic functions, while alginate and carrageenan are acidic polymers. The variety of functional groups provides polysaccharides with a surface reactivity especially appealing for specific catalysis processes. The interaction between functional groups and their glucidic backbone confer them viscoelastic mechanical properties which, coupled to their easy formation in different shapes and sizes, contribute to an excellent accessibility of the active sites.



The PhD project represents a whole ecoconcept stemming from the raw material to the pre-industrial stage and will cover several aspects:

- The first aspect will consist in the preparation of polysaccharide-based materials. Organic reactions often require very high amounts of expendable additives and this drawback could be overcome by anchoring the additive on the polysaccharide. The preparation of these materials as well as their characterization will be done in Montpellier in the MACS team of ICGM.
- The materials prepared will be screened in several fine-chemistry reactions such as aldolisation, Huisgen cycloaddition or Mannich reaction (non exhaustive list). The first tests will be conducted and monitored in batch reactors, and these experiments will take place in Bologna in the Department of Organic Chemistry.
- Mechanistic studies based on the monitoring of the interactions of reaction media with intrinsic and grafted functions of the polysaccharides will be realized by in situ FTIR

measurements. These experiments will be carried out in Turin, in the Department of Materials Science and Chemical Engineering.

- Finally, the scale-up processes will be studied, by shaping the porous polymers to improve process efficiency and choosing the best reactor (continuous, with recirculation,...) for the end-properties needed (TON, selectivity, enantioselectivity,...). Shaping of the polysaccharides as well as continuous flow experiments will be carried out in Montpellier.

The project will give the PhD student the opportunity to apprehend very different areas of expertise, such as organic synthesis, catalysis, analytical chemistry and process engineering. The student is expected to spend two years of his/her thesis in Montpellier and six-month stages in each of the partner institutions.