PhD position

“Covalent Organic Frameworks-POlymers” COlloids: from macromolecular design to self-assemblies

« Covalent Organic Frameworks-POlymères » COlloïdaux : du design macromoléculaire aux auto-assemblages

36 months from September 2022, funding already secured

“Covalent organic frameworks” (COFs) are organic crystalline materials organized in 2D or in 3D made up of covalent bonds that give them a good mechanical and chemical stability. The geometry of the monomers and the orientation of their reactive groups determine the dimensions, the topology of the network, and define the pore size. No other multi-dimensional polymerization strategy allows for today to predict and adjust the structure of the network to such a level.

The intrinsic characteristics of COFs, their pore size and shape, their porosity, their high specific surface area, their lightness make them materials that first found applications related to gas storage and molecular separation. The incorporation of functional units in their structure has opened the way to new potential applications (catalysis, molecular recognition and detection, energy storage, optoelectronic devices, encapsulation and delivery of bioactive molecules). However, COFs suffer from significant limitations: they are by nature crosslinked materials, insoluble or even sparingly dispersible in solution and often produced as polycrystalline inert powders or films. Despite much effort having been devoted towards the design of the physical and/or chemical properties of these materials by selecting their initial building blocks, the importance of processability for their applications has only recently emerged.

In this context, the project proposes an original “win-win” combination of colloidal COFs and polymers. It aims at producing well-defined COF nanoparticles with macromolecular chains covalently attached on their surface. Well defined crystalline COF NPs offer a means of organizing the orientation of the polymer chains and will be used as building blocks to form nanostructured materials. Since self-assembling processes of colloidal particles are dependent upon particle size, dispersity, and shape, the organization of the resulting structures should positively correlate with COF NPs uniformity. Such an approach could pave new ways for designing macroscopic materials with oriented and tunable porosity over long distances showing sensing and capture properties.

The project will be conducted in the "Polymer Systems Engineering" team of the Unité Matériaux et Transformations (UMET CNRS UMR 8207) in Villeneuve d'Ascq (59).

Profile of the candidate: Priority will be given to candidates holding a master’s degree in polymer science. A strong interest in material science, material characterization, as well as organic and polymer synthesis skills is desired. Knowledges in scattering techniques is a plus.

Characterization techniques: NMR, FTIR, TGA, UV-Visible spectrometry, light scattering, X-ray scattering.

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