MATIÈRE et
SYSTÈMES COMPLEXES
UMR 7057

Internship subject : multi-scale study of nano-composites for the adsorption of heavy metals: application to water treatment

Contact alain.ponton@u-paris.fr

With technological advances and industrial activities, the demand for water for everyday use is increasing day by day. Water is easily polluted because it can dissolve more substances than any other solvent. The main contaminants come from various industries and contain heavy metals, dangerous dyes, radioactive pollutants, toxic chemicals, fluoride, etc. To address this problem, it has been shown that **hydrogels containing nanoparticles** can be used to treat this water. These three-dimensional networks of polymer chains cross-linked by covalent bonds, hydrogen bonds, van der Waals interactions or physical entanglements have low interfacial tension, good elasticity, high hydrophilic properties, selective permeability and very high adsorption capacities [1]. However, the mechanical properties of hydrogels are often poor, which limits their applications. Recently, a great deal of research has been devoted to improving the mechanical properties of hydrogels (resistance to deformation, cracking, compression, etc.) by loading them with silica or clay particles, or even carbon nanotubes [2, 3].

We therefore propose to **develop composite materials** based on **different types and designs of nanoparticles** (including **transition metal sulphides** [4], **graphene oxide** or **quantum dots**, used alone or as a mixture) and **different types of polymer matrix**, then to study and model their **thermomechanical and structural properties** using complementary experimental methods (structural and mechanical analyses). At the same time, their **capacity to adsorb heavy metals** alone and in mixtures (Pb, Cd, etc.) will be evaluated. The scientific approach will consist of linking the properties of use (adsorption) to the physico-chemical characteristics at different scales (structure, texture, surface properties, grafting, role of defects, etc.). For the best performing composites, **kinetic modelling of metal adsorption** will be carried out [5]. Finally, a **desorption study** will be carried out using standard acid treatments in order to assess their recyclability [6].

The internship will be mainly managed by MSC laboratory in strong collaboration with IFPEN (https://www.ifpenergiesnouvelles.com/). Some experiments will be also performed using platforms of Université Paris Cité.

The master's internship may be followed by a PhD.

References

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[4] Q. Wang, L. Yang, F. Jia, Y. Li and S. Song, Removal of Cd(II) from water by using nano-scale molybdenum disulphide sheets as adsorbents, Journal of Molecular Liquids 263, 526-533, 2018

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