Ecole Doctorale des Sciences Fondamentales

Title of the thesis:

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Summary : Elaboration of Layered Double Hydroxides based composite materials with tunable hierarchical porosity by freeze-casting.

Hierarchical porous materials display interesting properties such as high porosity and high surface area of great interest for all chemical or physical processes taking place at the interfaces such as gaz and water depollution, molecular separation and even energy storage and conversion.

The main aim of this 3th year project is to design and develop tridimensional macroporous materials displaying high surface area and reactivity. These porous nanostructured materials involving layered double hydroxides (LDH) will be obtained by freeze-casting. This approach is based on the growth of ice crystal within a colloidal suspension inducing the nanoparticle concentration. Macroporous monolithes are finally obtained by lyophilization. A fine tuning of the soft chemistry synthetic process to prepare the LDH nanoparticles, the presence of additives in the medium and parameters used for the freeze-casting could provide the desired characteristics to the materials in terms of size, morphology and connectivity of pores. Materials with hierarchical porosity ranging from nano to macro-scale combining both a facile molecular transport through large « channels » provided by macropores and high internal reactive surface area provided by narrow nanopores could be obtained. To tune the material properties and reactivity, LDH nanoparticles will be associated with polymeric hydrosoluble matrices or cellulose nanofibers. In all cases, physico-chemical properties of all components in the medium will be a key point and will be investigated through the colloidal stability of the suspension and the surface properties. Elaborated materials will be deeply characterized by XRD, SAXS, spectroscopies (FTIR and Raman) and thermogravimetric analysis. To get better insight on the morphology modification scanning electron microscopy (SEM), transmission electron microscopy (TEM), SAXS and gas adsorption will be also carried out.

During this project, the pHD will develop knowledge and experience in different fields such as soft chemistry process, nanostructuration and characterization techniques in materials science. His/her competencies will also cover the area of adsorption and depollution.