

Elaboration and characterization of novel ultraporous materials for electrochemical systems

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Ultraporous Organic Frameworks based materials with hierarchical structures (COF/MOF) are being considered as highly promising materials towards electrochemical applications, including energy storage and electrocatalysis. However, low ionic and electrical conductivities limit their potentiality in such fields. Within this context, this PhD project aims to develop new families of materials basing on organic framework's structures, in particular those who possess intrinsic ionic/electrical conductivity thanks to their well-designed chemical structures. Accordingly, the PhD program will be organized in three mains work packages: (1) Synthesis and characterization of new organic ligands; (2) Synthesis and characterization of organic frameworks (COF/MOF) and (3) Investigation of electrochemical properties, understanding the interfacial processes between the material surface & solution and performances evaluation of final electrochemical devices.

Work package 1: New families of organic bridges (ligands) will be conceived and synthesized by introduction of task-specific functions towards targeted application. Indeed, a majority of commercially available ligands only possess single-tasked functionality which is the origin of their limitation for the final application. Under the roof of this PhD project, 3 main families of organic ligands will be developed, including π -conjugated molecules bearing high electrical/ionic conductivity, electroactive ligands and systems owing possibility for forming covalent organic structure followed by complexation with metal ions, e.g. Schiff bases.

Work package 2: Synthesis and characterization of organic frameworks (COF/MOF). The organic ligands synthesized in the WP1 will therefore be associated with tri- or tetra functionalized knots into 2D/3D porous framework structure by reticular chemistry. Our approach consists to systematically correlate the physical-chemical/morphological properties with the synthesis conditions (temperature, concentration, synthesis routes, etc.). A specific attention will be dedicated to the morphology and elementary composition by means of microscopic (SEM, AFM), spectroscopic (EDX, Raman) analysis as well as specific surface area (BET)

Work package 3: As-prepared materials will be therefore submitted to electrochemical evaluation, allowing to collect supplementary information about their behaviors as well as to understand the interfacial phenomenon between the material surfaces and electrolyte solution. Depending on the responses, the studied materials will be selected for specific applications, ranging from electrochemical storage devices (supercapacitors) to electrocatalysis (water splitting/ ammonia oxidation reaction)

Required qualifications: We are looking for highly motivated candidate who has solid background in organic chemistry with open mind in electrochemical applications. A good level in English will be appreciated.

If you are interested in applying for this position, please email to Dr. Thuan Pham (thuan-nguyen.pham-truong@cyu.fr)