PhD position - Chirality and supramolecular chemistry
Electro- and photo-active chiral derivatives and networks

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This PhD aims at developing electroactive materials based on coordination chemistry networks and discrete molecules. A huge deal of interest has stemmed around metal-organic frameworks (MOFs), that are self-assembled crystalline materials constructed from multi-dentate organic ligands and inorganic moieties having defined spatial configurations. Limitless variations in the porosity and functionalization of these materials led to applications in gas storage, drug delivery or heterogeneous catalysis. However, the vast majority of the networks are formed with organic ligands having a huge HOMO-LUMO gap and/or a poor overlap with the inorganic part orbitals, precluding the formation of long range electronic pathways. As a consequence, MOFs usually show very poor electrical conduction properties. On the other hand, several electroactive building blocks are well-known in the field of organic metals, such as tetrathiafulvalene (TTF) and other structurally related moieties (see figure). In particular, the synthesis of organic metals or organic superconductors sprung a tremendous interest since the 70s with the discovery of the first organic superconductors, commonly called Bechgaard’s salts. The crystals obtained are typically extremely stable and highly conducting but due to the tight packing often observed in organic crystals they do not display long-range porosity. Paradoxically, these two fields are late to converge. Hence, by combining appropriately functionalized conducting moieties with coordinating groups and networking them through coordination chemistry, crystalline materials displaying a combination in a single solid of the advantages associated with microporosity (high surface and volume accessibility, sorption selectivity, fast diffusion) and an easy electron transfer should arise.

Furthermore, our team has a long-lasting interest in chiral materials and the influence of chirality on conducting and luminescence properties. Helicenes form a class of chiral molecules renowned for their intriguing physical properties, particularly their typical helicoidal structure (see figure) and exceptional chiroptical properties (intense optical activity and circular dichroism). Association of these moieties with electroactive or photoactive parts will lead to synergistic effects such as Circularly Polarized Luminescence or Chirality Induced Spin Selectivity. We aim to continue our ongoing works on electroactive and luminescent helicene complexes for this purpose, and ultimately to include them in coordination networks.

The laboratory has a strong experience in the synthesis of electroactive (chiral) molecules and conducting functional materials, and possesses all the required equipment (synthetic laboratories, electrocrystallization apparatus, X-ray diffraction, CD, UV-vis., fluorimeter...). Furthermore, our collaboration network will take an essential part in the research projects (crystal conductivity at LPS Paris-Saclay and LNCMI Toulouse, CISS effect in Switzerland, porosity in Nantes...).

The candidate is expected to have knowledge in synthetic chemistry (organic/coordination chemistry, purification and characterization methods), comprehension and interest in the synthesis of crystalline materials, and to be skilled at English (oral and written) - a keen understanding of French being a plus. We are looking for a highly motivated student, eager to develop his/her skills in synthesis, supramolecular chemistry, X-ray crystallography, spectroscopic characterization and material chemistry.

Applications must include a résumé, the contact details of at least two people to reach out as references, the grades obtained during the two years of Master degree (or engineering school) and a cover letter.