PhD Candidate position at IMAP

Design of new porous solids composites for CO_2 capture

Context. Power generation and carbon-intensive industries are responsible for a large share of the anthropogenic CO_2 emissions to our atmosphere. Shifting towards a low-carbon economy needs cost-effective novel carbon capture solution (CCS) to be conceived, tested and deployed afterwards. Current solutions either suffer from high energy penalties like in amines-based absorption or simply cannot offer sufficient performances. Adsorption process is widely considered as a promising alternative for capture and concentration of CO_2 arising from large sources such as power plants and other energy intensive industries. In this regard, capture of CO_2 from flue gas in post-combustion processes using Metal Organic Frameworks (MOFs) has been extensively studied. TSA cycles have also been tested with MOFs, showing that the energy required for regeneration is lower than for 13X zeolite for the same levels of purity and CO_2 recovery. For instance, CALF-20 (CALF stands for Calgary Frameworks), a microporous MOF (Shimizu *et al.*, Science 2021), is currently being deployed for the construction of a CO_2 capture unit at industrial level (ton scale).

The combination of MOFs as sorbent and the Microwave Swing Adsorption (MSA) as the regeneration process is a promising method to decrease further the energy penalty, by taking benefit of renewable electricity to regenerate the adsorbent. MOFs usually exhibit very low electrical conductivity, associated with low dielectric losses and slow microwave heating that would hamper their use for MSA processes. By combining them with carbonaceous nanomaterials, the electrical conductivity and the absorption of microwave can be significantly enhanced, which is of interest for a faster regeneration by MSA process.

Within the frame of a National strategic project PEPR SPLEEN (https://www.cnrs.fr/en/node/7517) gathering academic researchers (UPPA (Pau), IJL (Nancy), ICCF (Clermont-Ferrand) and EDYTEM (Savoie)) and IFPen, IMAP is seeking to hire a highly motivated PhD Candidate to work on the development of hybrid porous solids (i.e., MOFs) and related composites (e.g., carbon/MOFs) suitable for the CO_2 capture and related processes compatible with lower energy-cost separation processes (e.g., microwave-assisted temperature swing adsorption).

Work program, environment and PhD candidate profile.

The PhD candidate will be in charge of:

- selecting appropriate candidates (mainly MOFs) for the CO_2 capture;
- synthesizing the selected MOFs and their related composites (e.g., with activated carbon, graphene oxide, etc.);
- characterizing the obtained solids (i.e., X-ray diffraction, porosimetry, microscopy, CO_2 and H_2O sorption, electrical conductivity, etc.);
- analysing the different results obtained by the different partners in order to identify the most promising materials to be further produced at larger scale for the next steps.

The PhD candidate will be working at IMAP* and in collaboration with the different French partners as well as UMons (Mons, Belgium) for the microwave sorption tests. The candidate will also participate to the writing of reports, deliverables or publications and prepare regular presentations related to the project and the reporting duties. The participation to consortium meetings in France

will be mandatory. The PhD candidate fellow will be supervised by Dr Christian Serre, Dr Georges Mouchaham and Dr Farid Nouar.

The candidates should be highly motivated and willing to work in an international environment. An experience in the synthesis and characterization (X-Ray diffraction, TGA, FTIR, etc.) of crystalline solids is highly recommended. Knowledge on hybrid porous materials as well as their sorption properties would be a plus. A very good English level (oral, written) as well as strong communication skills are required.

*The **IMAP** (Institut des Matériaux Poreux de Paris) is a joint ENS, ESPCI and CNRS research unit within the PSL university in Paris (https://www.chimie.ens.fr/recherche/laboratoire-imap/imap/). It possesses a worldwide renown expertise in the synthesis and characterization of porous hybrid solids (MOFs) for applications in health, energy and environment. Lead by Christian Serre, the IMAP team is built up from 9 permanents staff (researchers, research engineers and assistant professors) and more than 30 post-doctoral fellows, PhD candidates and interns.

Starting date: 1st October 2023.

Application: email to G. Mouchaham (georges.mouchaham@ens.psl.eu) and F. Nouar (farid.nouar@espci.fr) including a cover letter and detailed CV.