Habilitation à Diriger des Recherches
Avis de présentation des travaux

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Présentera ses travaux en vue de l'Habilitation à Diriger des Recherches
Le vendredi 16 juillet 2021 à 15h15 à Le Mans Université

Le jury sera composé de :

Omar K. Farha, Professeur des universités – Northwestern University
François Goutenoire, Professeur des universités – Le Mans Université
Jianwen Jiang, Professeur des universités – National University of Singapore
Abdessadek Lachgar, Professeur des universités – Wake Forest University
Trikalitis Pantelis , Professeur des universités – University of Crete

Résumé des travaux :

Greenhouse gases is one of the most challenging issues that our modern economy is facing and originates from our consumption of fossil-fuel based energy. The well-known solution to overcome this situation is the use of renewable energy which unfortunately represents only 15% of our global consumption. Accordingly, while waiting for the full development of these alternative sources of energy, it seems of vital importance to find solution to decrease the amount of greenhouse gases such as CO_2 and also to provide alternative solution for the separation of high demanded industrial commodities associated with important energy consumption.

The history of chemistry shows different materials that were considered to overcome these associated issues related to gas separation, capture or storage. Currently, the most industrially deployed porous materials are zeolites that are commonly used for a wide range of applications including gas separation or dehydration. However, the limitations in precisely controlling their pore aperture size and/or shape prohibited their exploration in various key separations. Another class of adsorbents, namely polymers and carbons, were explored as separating agents especially in gas separation due to their facile fabrication and relatively high stability. Nevertheless, their separation scope is restricted due to their associated wide pore size distribution, limiting their effective use for the separation of molecules with very similar physical/chemical properties.

In this talk, we will introduce a relatively new class of porous materials, namely metal–organic framework (MOF), that has emerged in the last two decades and offers the prospects for addressing the challenges associated with gas separations or storage. Through various examples, we will show how the adequate use of topology tools and Reticular Chemistry allowed us to apply bottom-up approach to design MOF materials with perfect structural features (pore size/shape) for targeting key gas related applications.

The application of this strategy will be exemplified for gas (CH_4, CO_2, O_2) storage applications using soc-MOF platform. Particularly, Al-soc-MOF-1 fulfils the DOE target with the highest working volumetric capacity at 258 K and 80 bar. It is to highlight that this is the first time that a porous material has fulfilled both the challenging gravimetric and volumetric targets for the CH_4 working.

The design of MOF was also successfully applied for separating linear paraffin from branched paraffin which are of prime importance in the production of high efficacy fuels. The use of **fcu**-MOF platform with fumaric acid as linker was evaluated as adsorbent and shows remarkable performance to selectively separate butane from iso-butane. It is to note that this example represents the first example of MOF adsorbent that play the role of molecular sieve.

Finally, the design and structural control of a series of fluorinated MOF materials allowed the development of a new generation of adsorbent with remarkable properties for gas dehydration or capture (CO_2/N_2, $CO_2/SO_2/N_2$, $CO_2/H_2O/N_2$, propane/propene).