Press release

Lyon (France), October 18, 2018

A critical step change has been accomplished pivotal to the industrialisation of nanoporous materials (MOFs)

In 2018, a group of EU project partners (ProDIA[1]) have successfully developed synthesis processes enabling the manufacture of metal organic framework (MOFs) materials at an industrial scale. These innovative methods have reduced production costs permitting MOFs to be priced competitively against many current market leading materials. Being able to offer MOFs at an economically viable cost and utilising their superior performance, these materials are perfectly suited to meet tomorrow's big challenges in energy, environmental and health related application areas.

What is a MOF?

Metal organic frameworks (MOFs) are some of the most exciting materials to have emerged in science in the last two decades. They are solids comprised of metals or metal clusters linked by organic ligands into extended networks, which often have very high porosity in the nanopore range (1 nanometre = 10^{-9} m). It is these small pores or cavities that make these MOF materials ideally suited for the storage of gases such as CH_4, H_2O, CO_2, NH_3 and NO to name but a few. Indeed, coupled with their chemical flexibility it has been shown that MOFs have great potential in a diverse range of sectors covering energy, environmental and biological application areas. To date, the number (several 1000's) and rate of scientific publications relating to the synthesis, characterisation and application of MOF materials has broken all previous records. The momentum gained in these academic studies however, has not yet been translated to industrial use until now!

MOFs and Axel'One

In the framework of the European collaborative research project ProDIA, the partners have developed two innovative processes for the synthesis and shaping of MOFs compatible with industrial manufacturing scale. These processes produce high purity MOF materials utilising aqueous media, a step change from the costly and environmentally unfriendly organic solvents typically used at laboratory scale. Thanks to its pre-industrial pilot lines, Axel'One validated the extrapolation of MOF materiak synthesis. Not only were the technological barriers linked to production removed, but the criteria pertaining to costs, availabilities of raw materials, production safety, and toxicity upon use were successfully met.

The first process was developed on a adsorbent of the UiO-66 family, a zirconium-based MOF, whose thermal stability equals that of activated carbons. A pilot batch of 150 kg was produced with a yield of more than 95%. The crystalline powder can be extruded with no loss of porous properties. The MOFapps start-up company will thus offer zirconium-based MOF pellets for air purification, notably for personal and collective

[1] The ProDIA project brings together Axel'One, CNRS, ENGIE, IFP Energies nouvelles (FR), Fraunhofer IKTS (DE), Institute of Nanoscience and Nanotechnology (ES), Johnson Matthey, MOF technologies, University of St Andrews (GB), MOFapps, SINTEF and University of Oslo (NO). European Union's Horizon 2020 research and innovation program, GA 685727. http://www.prodia-mof.eu/

ammonia protection cartridges. The lifetime of these cartridges is doubled compared to that of the cartridges currently on the market, which use active carbon based absorbents.

The second process deals with the synthesis of a MOF named HKUST-1, using a spraying process. Unique in Europe, a versatile spray dryer system capable of the continuous production of new materials has been designed, installed and commissioned at Axel'One. Production of the copper based MOF, named HKUST-1 has run successfully. The 10 metre high unit produced several 10's of kilos of high purity material in only a few hours. On spraying the aqueous reactant mixture, the droplets formed are simultaneously dried and shaped. This combined capability improves the efficiency of the manufacturing process as many applications require MOF bodies with specific shapes. Notably, if required, Axel'One spray drying system can even be carried out in a closed system under a nitrogen atmosphere (ATEX conditions) affording the ability to operate with organic compounds. This pre-pilot system success paves the way for larger industrial-scale spray drying capacity production (~300kg/day), thereby reducing production costs further and allowing these materials to be competitively priced in the marketplace.

Prof S. Kitagawa (Kyoto University), pioneer and most cited researcher on MOF, explains: "The ProDIA project is a real success in the innovation field. Axel'One and its scale-up results made a major contribution. Today, the availability of MOFs at the pilot scale makes it possible to foresee their future use in large-scale applications."

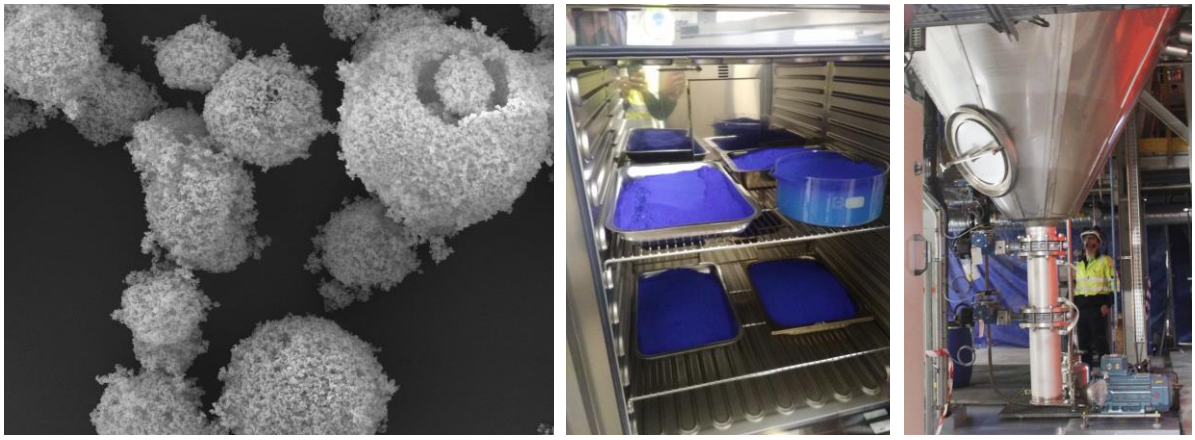

Figure 1: MOFs (HKUST-1) beads of 80 µm in diameter prepared by spray-drying process
Figure 2: Batches of spray dried HKUST-1
Figure 3: Picture of the 10-metre-high spray drying facility
Watch the spray-drying campaign video of HKUST-1

About Axel'One

Located in the Lyon area, the Axel'One collaborative innovation platform hosts and supports collaborative R&D projects as well as VSEs/SMEs, in the chemistry and environment sector. The Axel'One platform was created in June 2011 as an association under the law of 1901. It has 10 founding and Premium members: Adisseo, CNRS, CPE Lyon, Elkem Silicones, ENS de Lyon, IFP Energies nouvelles, INSA Lyon, Solvay, Suez Environnement, and Université Claude Bernard Lyon 1. Axel'One has three sites in the vicinity of Lyon: Axel'One PMI (Innovative Materials Platform) in Saint-Fons, Axel'One PPI (Innovative Processes Platform) in Solaize, and Axel'One Campus (Basic Research) at LyonTech-la-Doua, all of which provide services to the competitiveness clusters that are members of the association: Axelera (chemistry-environment in Lyon), Plastipolis (plastics processing in Oyonnax), and Techtera (textiles and flexible materials in Lyon). Axel'One currently hosts about 40 collaborative projects, 10 VSEs/SMEs, and technology platforms that provide tools and skills pooled around three strategic areas: industrial analysis and smart processes; catalysis; polymers and advanced materials (transformation, characterisation and simulation).

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