**Characterisation of Nanoporous Materials Using Adsorption at Cryogenic Conditions**

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Adsorption measurements at cryogenic conditions are used widely to characterize the textural properties of nanoporous materials. This is based on measuring adsorption equilibrium isotherms using probe molecules, such as argon or nitrogen and it is a general tool applicable to rigid and soft materials. Remarkably, even though such measurements are often routine (think of BET surface areas), very little is available in the literature on the kinetics of adsorption at these conditions. This project addresses this gap through volumetric and in-flow measurements, which provide both equilibrium and kinetic information, to be used to better understand the structure of nanoporous materials and provide the basis for the design of more efficient cryogenic separation processes.

In our laboratory we have access to state-of-the-art equipment for this project including: two Autosorb iQ systems; Cryo-cooler unit for Autosorb iQ2 that allows direct control of temperature without the use of liquid N2 or Ar; PoreMaster mercury intrusion porosimeter; in-house designed and built adsorption differential volumetric apparatuses (ADVAs for both low and high pressure); in-house designed and built zero length column (ZLC) chromatographic system modified for cryogenic measurements.

One of the systems to be investigated will be the metal-organic-framework MIL-53 (MOFs are coordination networks with organic ligands), which is a breathing MOF that at the nanoscale resembles a collapsible wine rack. This system is particularly interesting, because adsorption initially triggers a reduction in size of the system due to attractive interactions between the adsorbate molecules and the MOF, while at higher pressures the repulsive forces trigger the full opening of the structure. In our group we have recently developed a thermodynamic model for this system (J. Phys. Chem. C 2019, 123, 14517 – DOI 10.1021/acs.jpcc.9b02977) which will be the basis for the interpretation of the kinetic experiments.

Part of the project will be carried out in collaboration with Prof. Mathias Thommes at Friedrich-Alexander Universität in Erlangen, Germany, who is the lead author of the 2015 IUPAC recommendations on the characterization of nanoporous materials.