New technique to create super-sponges is a game changer

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Scientists have devised new methods for the post-synthetic modification of Metal-Organic Frameworks to produce properties in the material ideal for gas manipulation. Credit: DGIST

Metal-organic frameworks (MOFs) are unique micromaterial compounds consisting of a sponge-like network of metal ions or clusters linked together by organic linkers, and are able to store specific gas molecules in their pores. MOFs have such a high surface area due to their porosity that a single gram of the material has enough surface area to cover the size of a football field!

These super-sponges are used in research and industry to separate and store gasses within tailor-made pockets, enabling their use in gas storage, separations, and sensing. Unlike traditional porous materials, MOFs can be modified as per need; in theory, their structure can be controlled through careful selection of the components of the synthesis process. But in practice, this process is challenged by the restricted synthetic conditions and high thermal and chemical sensitivity of MOFs. An attractive alternative is the post-synthetic modification (PSM) of MOFs.

Leading a team of scientists from Daegu Gyeongbuk Institute of Science and Technology (DGIST), Korea, Professor Jinhee Park approached this issue with the dual goals of giving desired functional groups to MOFs and introducing "mesoscopic" (bigger than microscopic) holes, which improve adsorption kinetics. Professor Park says, "We believe that this kind of study can facilitate the use of MOFs as a key material in environmental and energy related areas."

PSM through carbon-carbon bond formation has historically been difficult due to the lack of suitable reaction conditions that maintain the MOF structures. The scientists introduced stable carbon-carbon bonds by converting existing carbon-hydrogen bonds using elevated temperatures and adding "electrophilic organic halides or carbonyl compounds," allowing simultaneous introduction of the required functional groups as well as the mesoscopic holes.

Professor Park says, "These results confirm the ability of the dual-PSM protocol to introduce desired alterations in MOFs while generating highly porous mesostructures." This technique could potentially improve the safety of workers in enclosed, gas-filled environments such as in the nuclear industry, and provide a more economically viable method of gas storage and purification.

More information: Microscopic and Mesoscopic Dual-Post-Synthetic Modifications of Metal-Organic Frameworks. *Angewandte Chemie International Edition*. DOI: 10.1002/anie.202000278

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