Researchers create a three-nanometer single-layer UiO-66 MOF nanosheet

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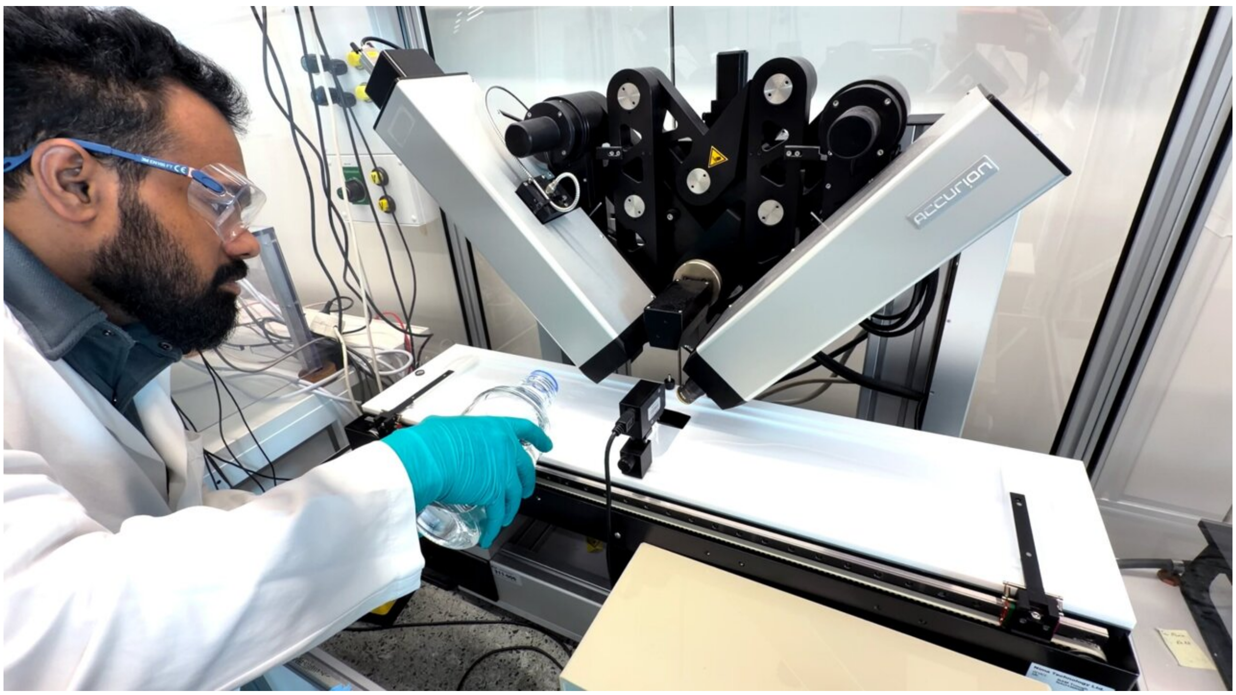

To synthesize two-dimensional metal-organic frameworks, zirconium oxo-clusters are dissolved in water. Amphiphilic linkers are then applied to the surface of this aqueous solution. Through self-assembly, two-dimensional monolayers of the metal-organic frameworks are formed. Credit: University of Basel

Metal-organic frameworks (MOFs) are porous structures composed of metal ions (or clusters) and organic linker molecules—much like a molecular scaffold. Thanks to their high porosity and large surface area, MOFs can store large amounts of gases, accelerate chemical reactions, or even transport drugs in a targeted manner. Until now, research has primarily focused on the use of rigid 3D crystals, which, however, have limitations in terms of flexibility and scalability.

Researchers led by Professors Patrick Shahgaldian (FHNW School of Life Sciences) and Jonathan De Roo (Department of Chemistry, University of Basel) have now, for the first time, produced a stable, single-layer-thick nanosheet of the well-known MOF UiO-66. The work is published in the journal *Small Structures*.

To do this, they use prefabricated metal-oxygen building blocks (zirconium and hafnium oxo-clusters) and organic molecules with water-repellent chains, applying them to the interface between air and a liquid (water or DMF). The clusters are dissolved in the liquid, while the organic molecules spread across the surface and float. "Through chemical bonds, the building blocks then self-assemble into an ordered layer just 3 nanometers thick at the interface," explains Dr. Ajmal Roshan Unniram Parambil, first author of the study, who conducted the work as part of his doctoral thesis at the Ph.D. School of the Swiss Nanoscience Institute at the University of Basel.

These ultrathin layers are particularly interesting for applications such as sensors, catalysts, or membranes, as they offer better access to the active catalytic centers and can be easily integrated into existing technologies. "Furthermore, we do not need toxic solvents or high temperatures during production—a decisive advantage for sustainable manufacturing processes," notes Patrick Shahgaldian.

"This work shows that we can assemble complex nanostructures like MOFs like a Lego system—and no longer just as rigid crystals, but as flexible, functional layers. This opens up entirely new possibilities for materials science and its applications," summarizes De Roo.

More information: Ajmal Roshan Unniram Parambil et al, Two-Dimensional Frameworks From Metal Oxo Clusters at Liquid Interfaces, *Small Structures* (2026). DOI: 10.1002/sstr.202600005

Provided by University of Basel

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