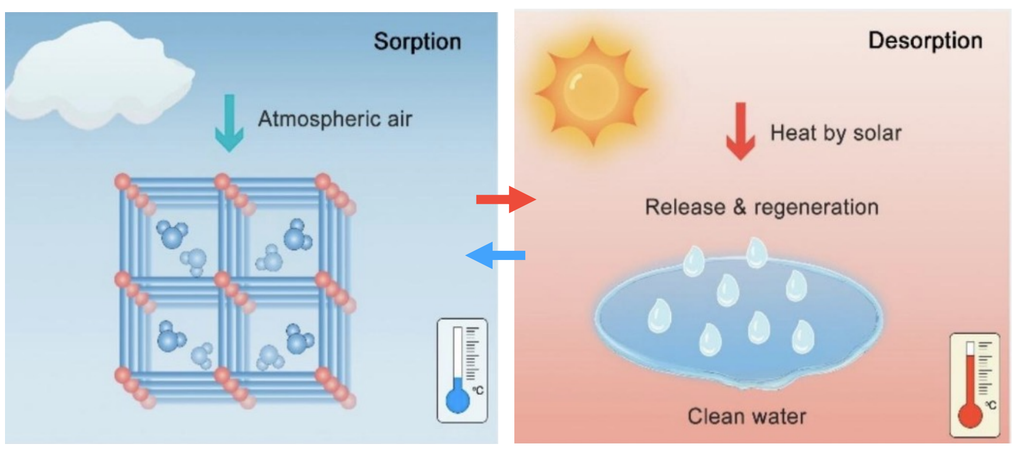
Could You Drink Air?

Bioinspired Thermoresponsive MOF-Based Hydrogels for Atmospheric Water Harvesting

Daniele Orlando Pentangelo, Ben Chu, Zhengmao Lu
Energy Transport Advances Laboratory, EPFL, daniele.pentangelo@epfl.ch

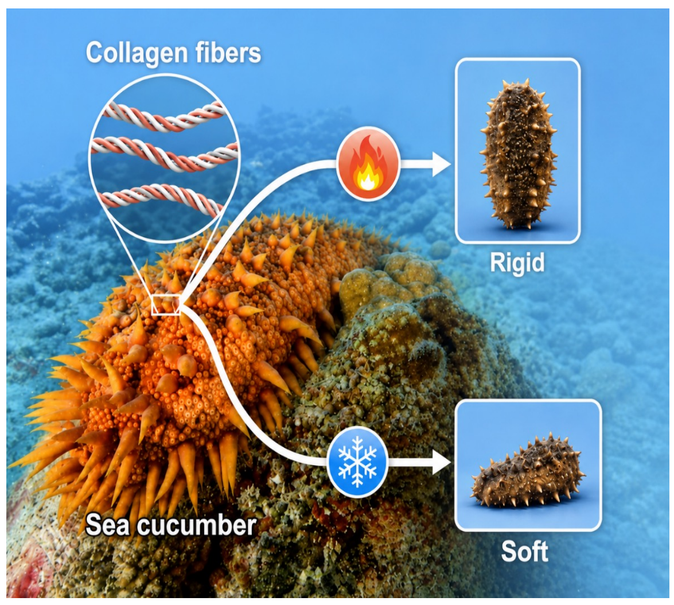
Introduction

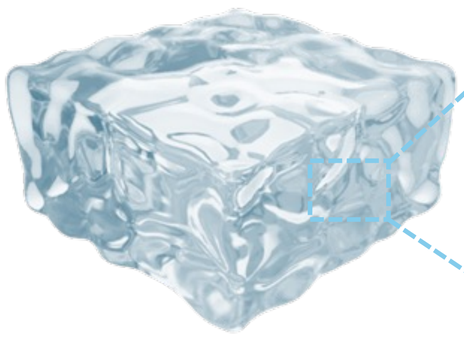


Water is scarce. Humid air is not.

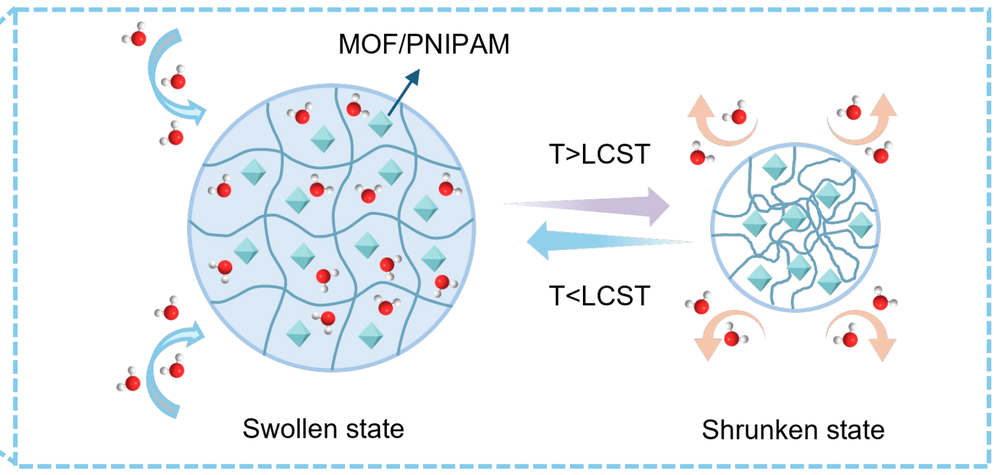
- ❑ Freshwater resources are under rising pressure from factors such as climate change and population growth.
- ❑ A metal-organic framework (MOF) with high porosity can harvest the moisture in the air, even in arid regions.
- ❑ The hygroscopic MOF has a strong affinity for water, and large amounts of energy are required for water desorption and regeneration.

Concept



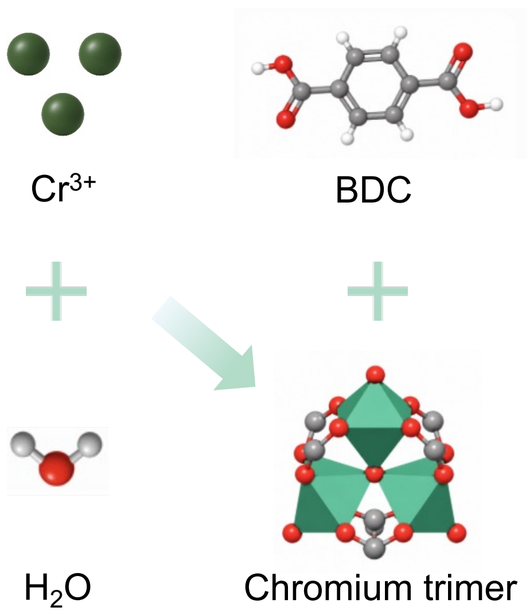


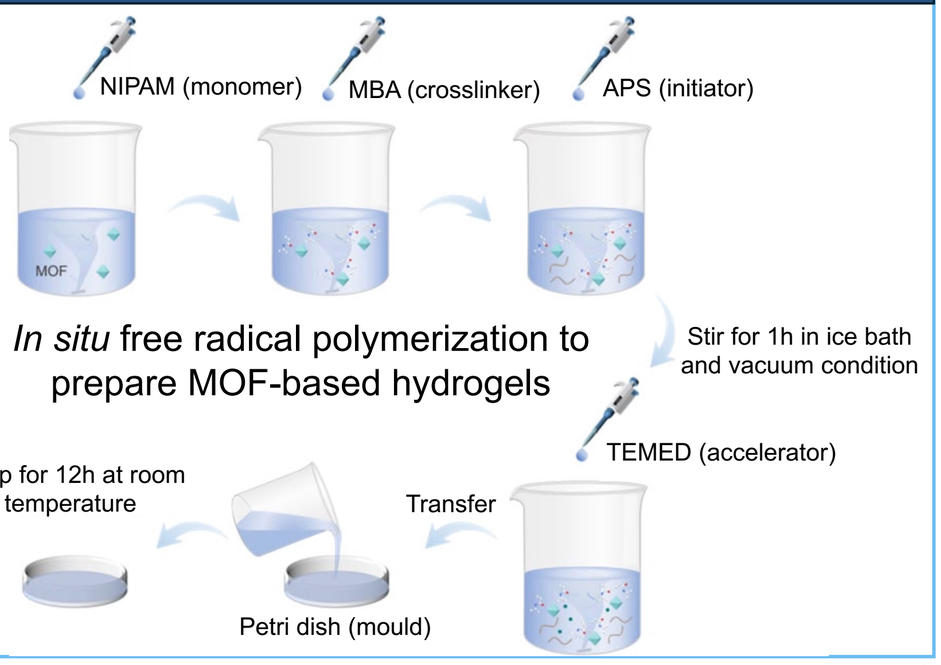
MOF-based hydrogel



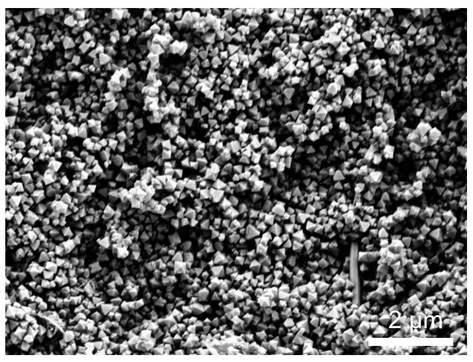
Inspired by the sea cucumber, we combine **thermoresponsive** PNIPAM, which shows **lower critical solution temperature** (LCST), with the MOF to promote captured water being released with mild temperature changes.

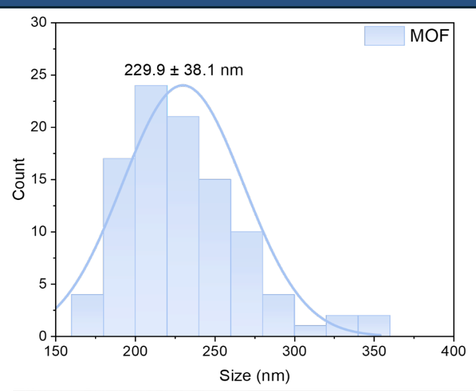
Material Synthesis

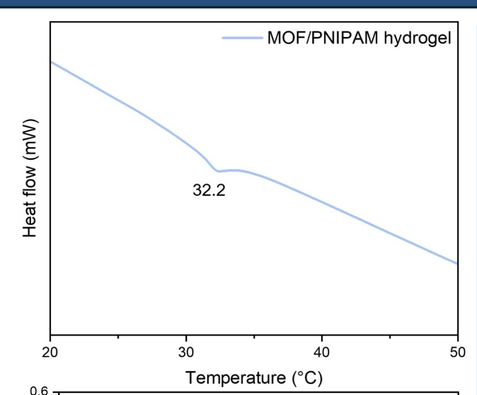


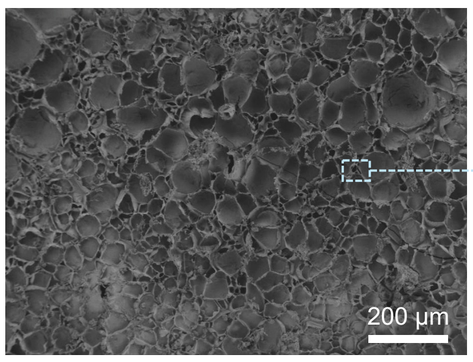


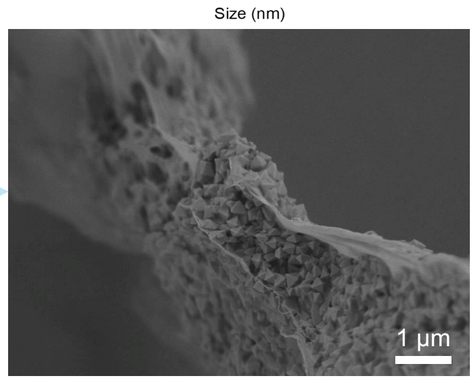
Results

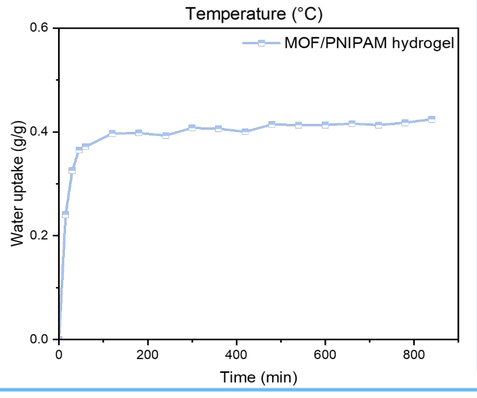












- ❑ The morphology of the MOF was an **octahedron crystal** with a smooth surface and a particle size of about 230 nm.
- ❑ The hydrogel shows a **porous, interconnected network**. MOF nanoparticles are evenly anchored on the framework of the polymer matrix.
- ❑ The LCST of the MOF/PNIPAM hydrogel is **32.2 ℃**, indicating that MOF incorporation doesn't change the LCST of the PNIPAM hydrogel.
- ❑ The MOF/PNIPAM hydrogel shows **high water uptake** and **rapid adsorption** at a relative humidity (RH) of 70%.

Conclusion and Outlook

- We developed a bio-inspired thermoresponsive MOF/PNIPAM hydrogel for atmospheric water harvesting. The hydrophilic-to-hydrophobic transition of the hydrogel above the LCST facilitates direct liquid water release with minimal energy input.
- Future work will focus on improving the performance of the MOF/PNIPAM hydrogel under realistic conditions and its integration into scalable water harvesting devices.

[1] Wee, M. G. V. et al. Advanced Materials Interfaces 2023, 10, 2300065. DOI: 10.1002/admi.202300065. CC BY 4.0. Adapted. https://creativecommons.org/licenses/by/4.0/