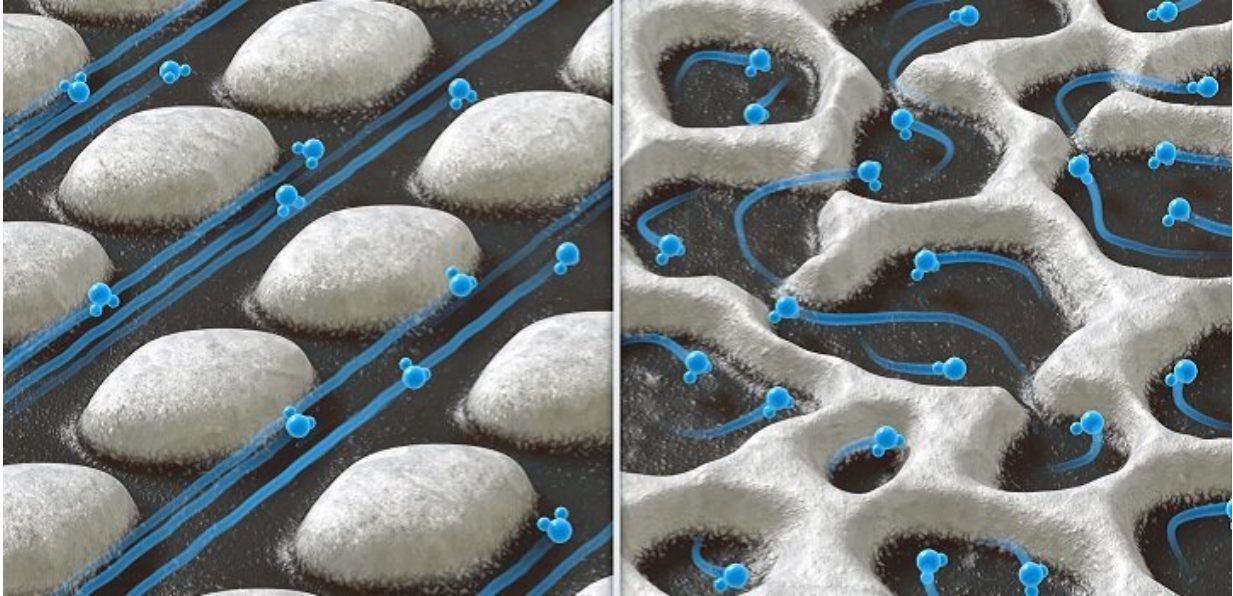


Driving water down nanohighways

March 11 2019



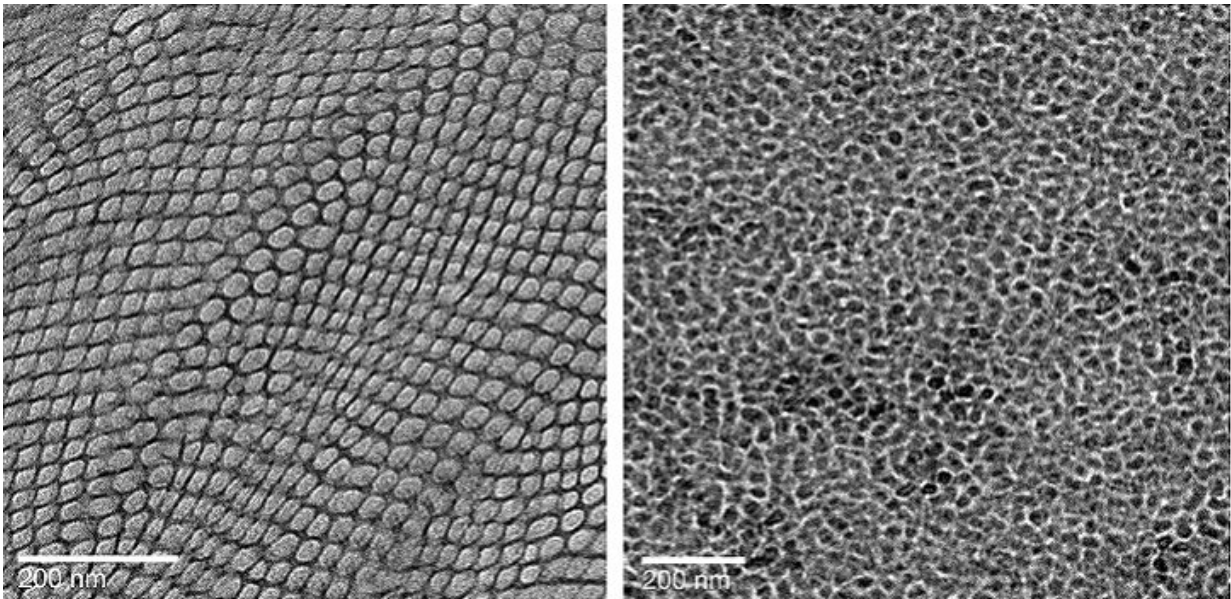
Schematic depictions of membranes with ordered (left) and disordered (right) channel structures. Credit: Xavier Pita

Removing water vapor from air and other gas mixtures, which is crucial for many industrial processes and air conditioning, could become cheaper and more effective through polymer membrane technology now developed at KAUST.

"We have made a [polymer film](#) with extremely high permeability for water vapor while presenting an effective barrier for other gases," explains Faheem Akhtar, a KAUST Ph.D. student.

The researchers found a way to create tiny nanochannels in the [membrane structure](#) that they describe as highways for water molecules. The channels attract water and divert it away for extraction, leaving dry gases behind. "The water transport is extremely fast," Akhtar adds. The membranes are composed of a commercial polymer called Nexar™. This is a [block copolymer](#) that assembles when short blocks of one repeating molecular unit become sequentially linked with short blocks of another type of unit. The chemical structure of the blocks controls the interaction with [water vapor](#) and other gases.

The key innovation, however, was the discovery that the fine structure of bumps and ridges in the membranes can be controlled by varying the conditions in which the polymer self-assembles. Changing the solvents used during the polymer formation generates membranes with a variety of ordered or disordered channels (see images).



Electron micrograph images of membranes with ordered (left) and disordered (right) channel structures. Credit: Elsevier

"Getting the right polymer morphology was very challenging and interesting," says team leader Klaus-Viktor Peinemann. He explains that the polymer contains water-friendly and water-repellent sections. When prepared using appropriate solvents, the water-friendly sections orient themselves like pearls on a string, forming the highways for [water transport](#).

"It took us a long time to find the right conditions," Akhtar points out. To succeed, theoretical understanding of the chemical interaction between the chosen solvents and the polymer was combined with a fair bit of trial and error. Through science and perseverance, the researchers eventually identified a procedure to make ordered structures that yield a six-fold increase in water permeability compared to disordered membranes.

Having demonstrated the basic potential of the membrane technology, the team now plan to scale-up the [manufacturing process](#) and to test it in realistic industrial applications. The commercial opportunities are considerable. More effective dehumidification methods could drastically reduce the energy consumption of an energy-intensive procedure.

More information: Faheem Hassan Akhtar et al. Highways for water molecules: Interplay between nanostructure and water vapor transport in block copolymer membranes, *Journal of Membrane Science* (2018). [DOI: 10.1016/j.memsci.2018.11.050](https://doi.org/10.1016/j.memsci.2018.11.050)

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