



News and opinions

Nanostructured wood promises eco-friendly desalination

Cordelia Sealy

News and Opinions Editor, Nano Today, United Kingdom

ARTICLE INFO

Article history:

Received 19 August 2019

Accepted 20 August 2019

Available online 9 September 2019

A team of scientists has developed an efficient, nanostructured membrane derived solely from wood that is suitable for the distillation of water [Hou et al., *Sci. Adv.* **5** (2019) eaaw3203, <https://doi.org/10.1126/sciadv.aaw3203>].

Water scarcity currently affects nearly half of the world's population at some point during the year and could reach over five billion by 2050, exacerbated by climate change and urbanization. Using desalination technologies to extract fresh water from sources such as seawater, brackish ground water, or wastewater could help meet growing demand but current reverse osmosis processes are highly energy intensive.

Membrane distillation (MD) offers a potentially attractive alternative to harness solar, thermal, or other sustainable energy sources to power a thermally driven separation process. The technology works by evaporating water on the hot feed-in side of an MD cell, diffusing the vapor through a porous hydrophobic membrane, which removes ions and impurities, and then condensing clean, fresh water on the cold side. An ideal MD material needs to have large pores, high porosity, low thermal conductivity, and good mechanical strength, as well as being cost competitive and environmentally friendly.

Just such a membrane has now been reported by researchers at the University of Colorado Boulder, University of Maryland College Park, Princeton University, Norwegian University of Science and Technology, Research Center for Eco-Environmental Sciences in Beijing, and the University of California, Los Angeles. But unlike existing MD membranes, which are typically polymeric materials derived from petroleum, the new membrane is made from sustainable and recyclable wood.

"We were inspired by water and vapor transport in trees to develop a new nanowood membrane that can produce fresh water

efficiently from saline water using renewable energy sources," explains Zhiyong Jason Ren of Princeton University, who led the work with Liangbing Hu of the University of Maryland, College Park.

The membrane is fabricated by chemically removing lignin, the organic polymer in plant cell walls that confers rigidity and 'woodiness', and hemicellulose, the tangled crosslinking polymers found in cell walls, from a thin slice of natural American basswood. The remaining hierarchical cellulose structure is freeze-dried to preserve it and coated with silane to render it hydrophobic. The final structure is highly porous, with naturally aligned nanopores in the wood facilitating water vapor transport along the membrane, while simultaneously reducing conductive heat transfer in the perpendicular direction through the material (Fig. 1). Together with good mechanical strength, the nanowood membrane demonstrates vapor permeability and thermal efficiency on a par or better than with conventional membranes.

"This is the first membrane made entirely of wood material for thermal desalination," says Ren. "[We believe] the nanowood membrane could be scaled up with even better performance than commercial optimized polymer membranes."

While the nanowood membrane has great potential to harness low-grade heat from sustainable sources to drive water desalination, pore size and membrane thickness need to be improved and optimized by selecting different woods. The researchers are hoping to scale-up and optimize the manufacturing process, so that nanowood membranes can be tested in real desalination applications.

"This is an interesting paper with meaningful advances for materials science," says Yonggui Wang of the Key Laboratory of Bio-Based Material Science and Technology at Northeast Forestry University in Harbin, China. "The nanowood membrane derived from natural wood is certainly a promising candidate for MD. The most outstanding observation, in my view, is the imaginative

E-mail address: cordelia.sealy@googlemail.com

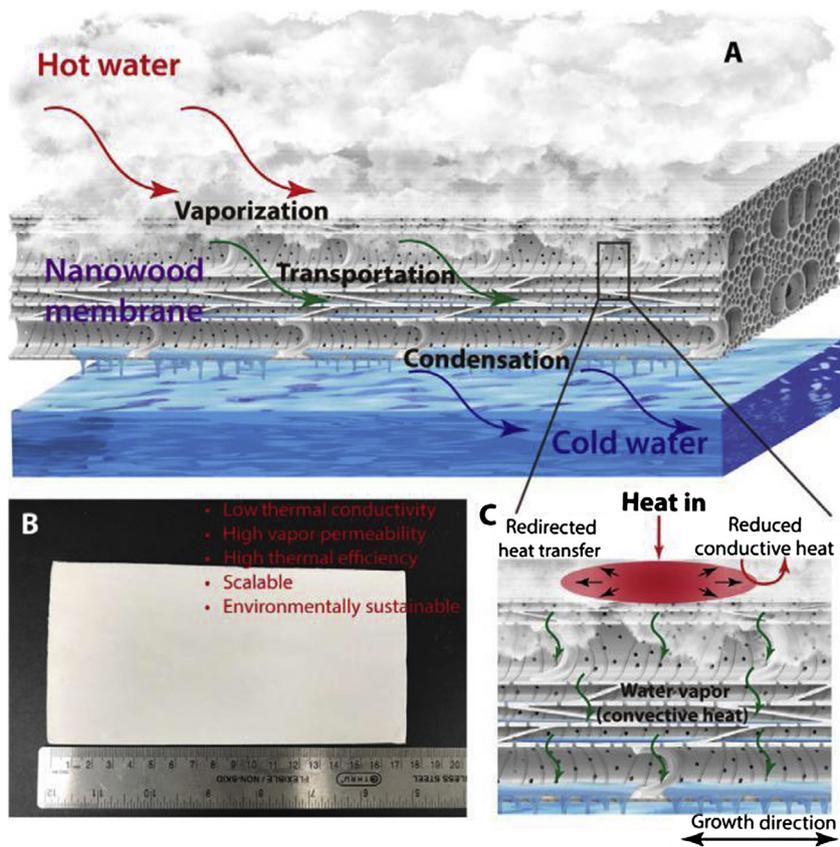


Fig. 1. Schematic of the process of using the new wood membrane to distill water. [Credit: Tian Li, University of Maryland.]

exploitation of the wood's features including its high porosity, anisotropic orientation of cellulose fibrous, and low thermal conductivity, which lead to membranes with good water vapor transportation and excellent thermal efficiency."

He cautions that there will be challenges to overcome in terms of the durability and large-scale fabrication of such nanowood membranes.