3D-printed solar-powered ceramic device desalinates water

To address the global issue of fresh water, scientists from China and Singapore have developed three-dimensional (3D) printed devices capable of using solar energy to desalinate seawater. Although reverse osmosis, distillation, and ion exchange-based desalination devices are available and have been used commercially for many years, they require high-energy consumption and have high costs.

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doi.org/10.1021/acsami.1c04209), Hui He of Shanghai Jiaotong University, China, Jun Ding of the National University of Singapore, and their colleagues have developed a fully 3D printed ceramic device that minimizes heat loss and maximizes solar-to-vapor energy conversion. This device is more environmentally friendly, resulting in a more sustainable solution than other solar devices due to its durability and ability to prolong usage without deterioration.

This portable solar desalination device has a solar absorber, a thermal insulator layer, and a water transporter to enable the desalination of water without any additional setup. With a solar-to-vapor conversion efficiency of

98%, this device exhibits an excellent ion rejection ability (Na^+ , Mg^{2+} , K^+ , and B^{3+}) meeting the drinking water standards of the World Health Organization (WHO).

The top part of the device is made of MG@Silica (modified graphene using silica as the core structure), a hydrophilic solar absorber, and the bottom part is made of a porous silica mesh, a super hydrophilic thermal insulator (**Figure 1b**). This ceramic structure was fabricated with robocasting (a 3D printing technique), which can produce complex ceramic architectures.

The complex ceramic architecture was formed from silica powder, a plasticizer, and a binder. The printed ceramic was coated with graphene using an economical chemical vapor deposition process. The graphene coating made the silica hydrophilic and ensured that it served as an effective solar absorber. The solar absorber itself was fully enclosed by a ceramic floater. This silica floater acts as a buoyancy aid making it portable and capable of being placed on the water surface.

After creating the device, the researchers performed various tests. They optimized device performance by increasing the mesh spacing of the absorber to increase water transport speeds. Also, placing the desalinator's absorber on the top of the base avoids contact with the water reservoir, reducing the heat loss and maintaining a high vapor generation rate. In outdoor experiments, the device generated fresh water at a rate of 0.5 liters per hour, removing magnesium, sodium, and potassium, meeting WHO standards.

This 3D-printed ceramic solar desalination device is robust, durable, non-toxic, and antifungal, contributing to clean water production in a greener and sustainable form.

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Figure 1. (a) Collection of fresh water using the enhanced 3D design; and (b) 2D schematic diagram depicting how it works. Credit: © 2021 ACS Publications.

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