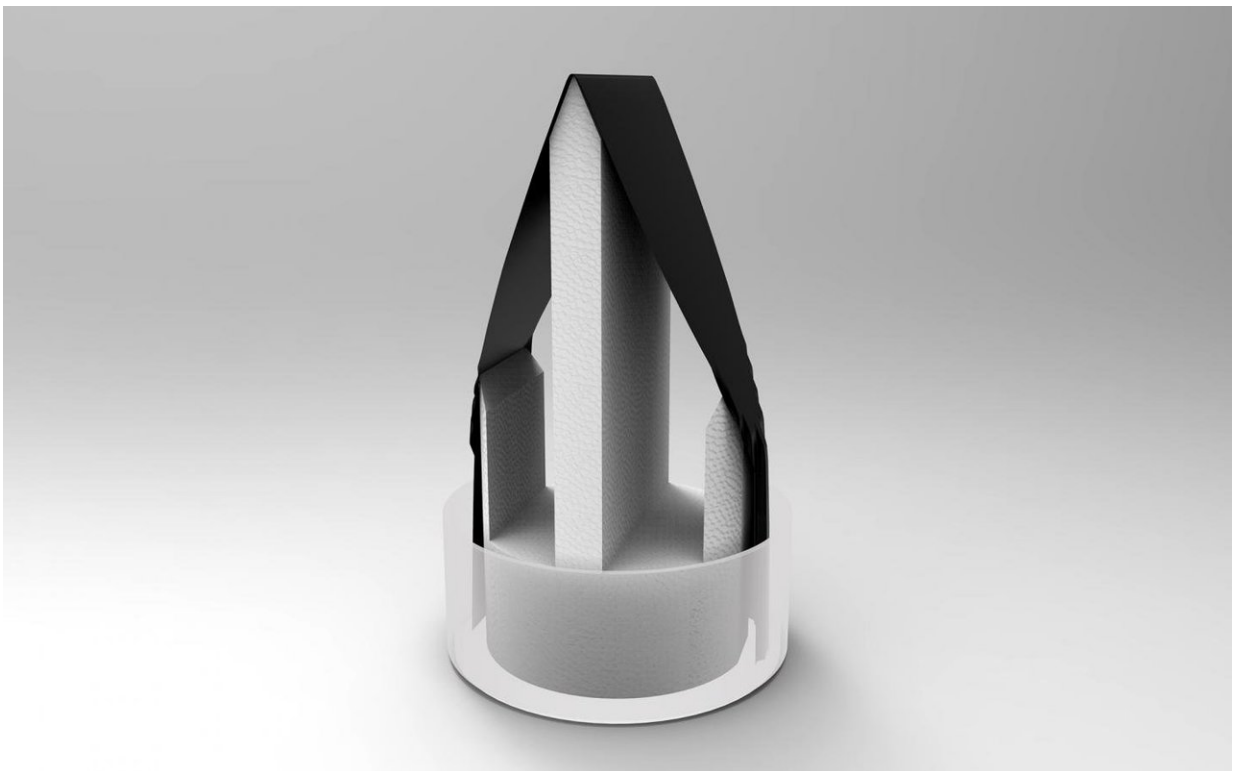


Engineers upgrade ancient, sun-powered tech to purify water with near-perfect efficiency

May 3 2018, by Charlotte Hsu



The new water purification technique involves draping a sheet of carbon-dipped paper in an upside-down "V." The paper's bottom edges soak up water, while the carbon coating absorbs solar energy and transforms it into heat for evaporation. Credit: Huaxiu Chen

The idea of using energy from the sun to evaporate and purify water is ancient. The Greek philosopher Aristotle reportedly described such a

process more than 2,000 years ago.

Now, researchers are bringing this technology into the modern age, using it to sanitize water at what they report to be record-breaking rates.

By draping black, carbon-dipped paper in a triangular shape and using it to both absorb and vaporize water, they have developed a method for using sunlight to generate [clean water](#) with near-perfect efficiency.

"Our technique is able to produce [drinking water](#) at a faster pace than is theoretically calculated under natural sunlight," says lead researcher Qiaoqiang Gan, PhD, associate professor of electrical engineering in the University at Buffalo School of Engineering and Applied Sciences.

As Gan explains, "Usually, when solar energy is used to evaporate water, some of the energy is wasted as heat is lost to the surrounding environment. This makes the process less than 100 percent efficient. Our system has a way of drawing heat in from the surrounding environment, allowing us to achieve near-perfect efficiency."

The low-cost technology could provide drinking water in regions where resources are scarce, or where natural disasters have struck. The advancements are described in a study published on May 3 in the journal *Advanced Science*.



A central component of the new technology is a sheet of carbon-dipped paper folded into an upside-down "V." The paper's sloped geometry keeps it cool by weakening the intensity of light illuminating it. (A flat surface would be hit directly by the sun.) This novel, slanted architecture helped to speed vapor and water generation in experiments. Credit: Youhai Liu

The project, funded by the National Science Foundation (NSF), was a collaboration between UB, Fudan University in China and the University of Wisconsin-Madison. UB [electrical engineering](#) PhD graduate Haomin Song and PhD candidate Youhai Liu were the study's first authors.

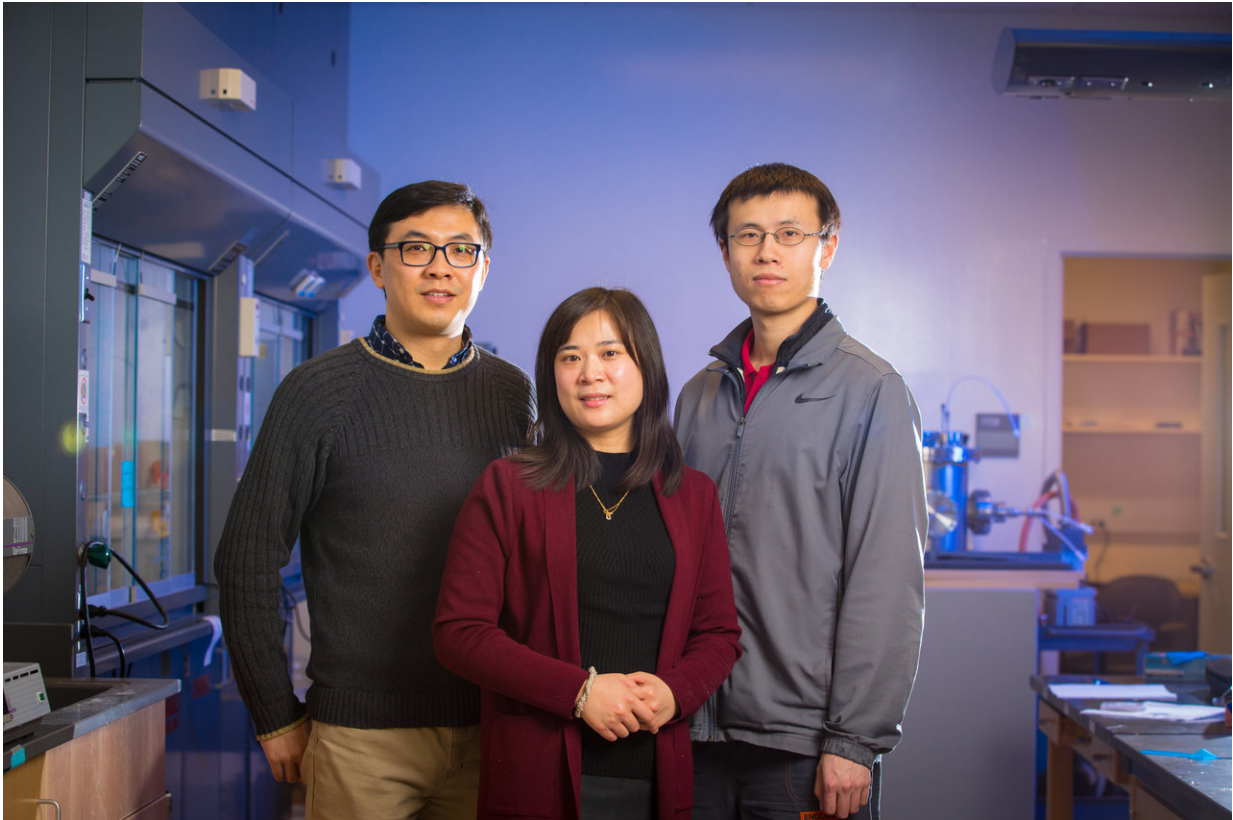
Gan, Song and other colleagues have launched a startup, Sunny Clean Water, to bring the invention to people who need it. With support from the NSF Small Business Innovation Research program, the company is integrating the new evaporation system into a prototype of a solar still, a sun-powered water purifier.

"When you talk to government officials or nonprofits working in disaster zones, they want to know: 'How much water can you generate every day?' We have a strategy to boost daily performance," Song says. "With a solar still the size of a mini fridge, we estimate that we can generate 10 to 20 liters of clean water every single day."

Modernizing an age-old technology

Solar stills have been around for a long time. These devices use the sun's heat to evaporate water, leaving salt, bacteria and dirt behind. Then, the water vapor cools and returns to a liquid state, at which point it's collected in a clean container.

The technique has many advantages. It's simple, and the power source—the sun—is available just about everywhere. But unfortunately, even the latest solar still models are somewhat inefficient at vaporizing water.



Left to right: Researchers Qiaoqiang Gan, Zongmin Bei and Haomin Song were among the authors of the new study in *Advanced Science*. The three engineers and their colleagues are working to bring the solar still to people who need it through their startup company, Sunny Clean Water. Credit: Douglas Levere/University at Buffalo

Gan's team addressed this challenge through a neat, counterintuitive trick: They increased the efficiency of their evaporation system by

cooling it down.

A central component of their technology is a sheet of carbon-dipped paper that is folded into an upside-down "V" shape, like the roof of a birdhouse. The bottom edges of the paper hang in a pool of water, soaking up the fluid like a napkin. At the same time, the carbon coating absorbs solar energy and transforms it into heat for evaporation.

As Gan explains, the paper's sloped geometry keeps it cool by weakening the intensity of the sunlight illuminating it. (A flat surface would be hit directly by the sun's rays.) Because most of the carbon-coated paper stays under room temperature, it can draw in heat from the surrounding area, compensating for the regular loss of solar energy that occurs during the vaporization process.

Using this set-up, researchers evaporated the equivalent of 2.2 liters of [water](#) per hour for every square meter of area illuminated by the regular sun, higher than the theoretical upper limit of 1.68 liters, according to the new study. The team conducted its tests in the lab, using a solar simulator to generate light at the intensity of one regular sun.

"Most groups working on solar evaporation technologies are trying to develop advanced materials, such as metallic plasmonic and carbon-based nanomaterials," Gan says. "We focused on using extremely low-cost materials and were still able to realize record-breaking performance.

"Importantly, this is the only example I know of where the thermal efficiency of the solar evaporation process is 100 percent when you consider [solar energy](#) input. By developing a technique where the vapor is below ambient temperature, we create new research possibilities for exploring alternatives to high-temperature steam generation."

More information: Cold Vapor Generation beyond the Input Solar

Energy Limit, *Advanced Science*, [DOI: 10.1002/adv.201800222](https://doi.org/10.1002/adv.201800222)

Provided by University at Buffalo

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