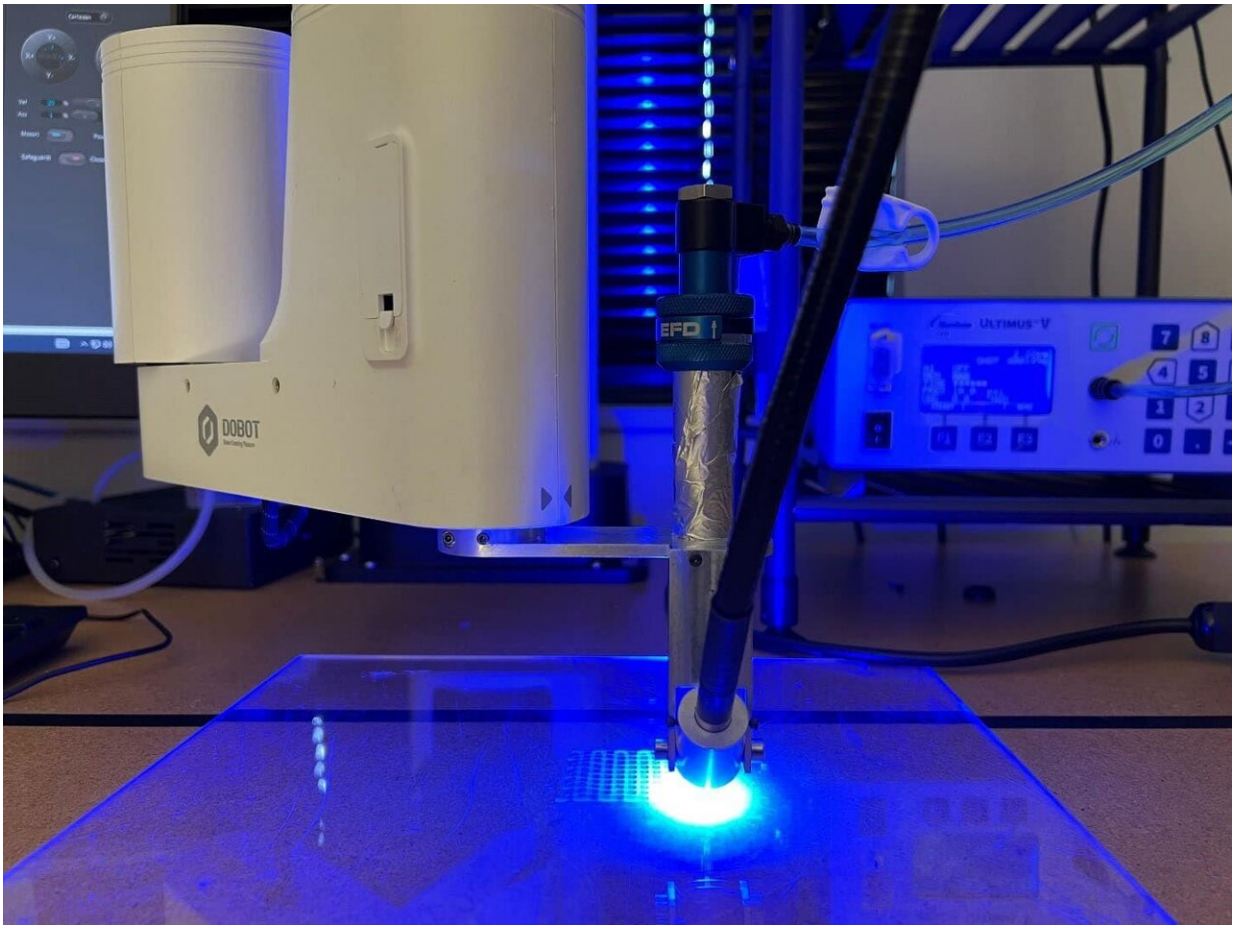
You can make carbon dioxide filters with a 3D printer

May 31 2023, by Laura Oleniacz



NC State researchers demonstrated that it's possible to make carbon dioxide capture filters using 3D printing. Credit: Sen Zhang and Jialong Shen, NC State.

In a new study, North Carolina State University researchers demonstrated that it's possible to make carbon dioxide capture filters using 3-D printing. Specifically, they printed a hydrogel material that can hold carbonic anhydrase, an enzyme that speeds a reaction that turns carbon dioxide and water into bicarbonate.

The findings, published in the journal *Gels*, suggest 3-D printing could be a faster, more versatile method of making filter designs.

"This manufacturing process, using 3-D printing, makes everything faster and more precise," said the study's lead author Jialong Shen, assistant research professor of textile engineering, chemistry and science at NC State. "If you have access to a printer, and the raw materials, you can make this functional material."

In the study, researchers in the NC State Wilson College of Textiles mixed a solution containing two different organic compounds—or the printing "ink"—and an enzyme called carbonic anhydrase. The researchers then printed thread-like filaments of the hydrogel into a two-dimensional grid while solidifying the solution with UV light as it was printed.

"We formulated the hydrogel in a way that would be mechanically strong enough to be 3-D printed, and also extruded into a continuous filament," Shen said. "The inspiration behind our design was our own cells, which have enzymes packed into compartmentalized spaces, filled with a fluid. That kind of environment is good for helping enzymes do their job."

The researchers tested the properties of the material to understand how well it would bend and twist, and investigated the filter's carbon capture performance. In a small-scale experiment, they found the filter captured 24% of the carbon dioxide in a gas mixture. While the capture rate is lower than what they've achieved in previous designs, the filter was less

than an inch (2 centimeters) in diameter, and it could be made larger and in different modular shapes in order to stack them in a tall column. That could increase the capture efficiency, researchers said.

"In order to get a higher capture rate, we would need to make the filter larger in diameter, or stack more filters on top of each other," Shen said. "We don't think that's an issue; this was an initial test at a small scale for ease of testing."

The researchers also tested the filtration durability of the material, and found it retained 52% of its initial carbon capture performance after more than 1,000 hours.

"This work is still early stage, but our findings suggest there are new ways to make materials for carbon capture devices," said the study's co-corresponding author Sonja Salmon, associate professor of textile engineering, chemistry and science at NC State. "We're offering hope for carbon capture."

The study, "Carbonic Anhydrase Enhanced UV-Crosslinked PEG-DA/PEO Extruded Hydrogel Flexible Filaments and Durable Grids for CO_2 Capture," was published online in *Gels*. Co-authors included Sen Zhang and Xiaomeng Fang.

More information: Carbonic Anhydrase Enhanced UV-Crosslinked PEG-DA/PEO Extruded Hydrogel Flexible Filaments and Durable Grids for CO_2 Capture, *Gels* (2023). DOI: 10.3390/gels9040341

Provided by North Carolina State University