Researchers Invent Way to Mass Produce Microscopic Plastic Components

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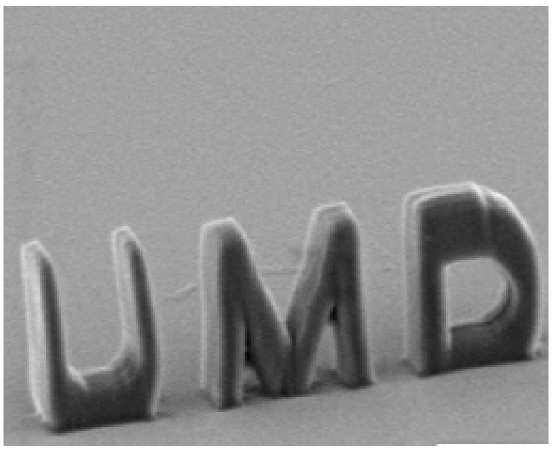
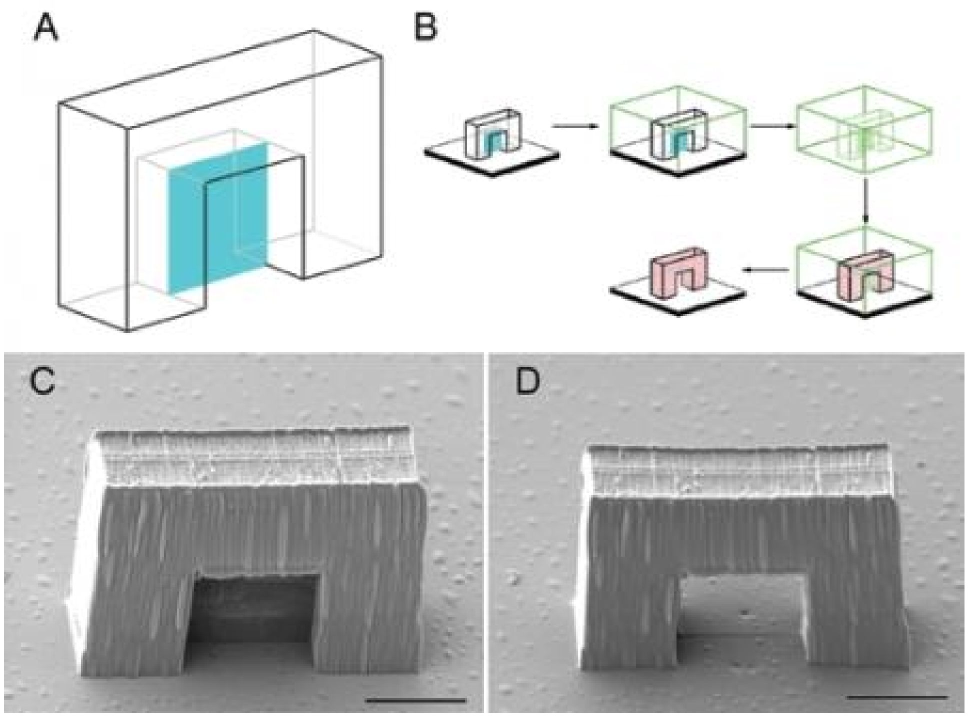


These microscopic University of Maryland letters were made with the PDMS wall method. The wall has been removed from the M and D. Credit: The Fourkas group.

Plastic parts in kitchenware, children's toys, and even automobiles are generally mass-produced with a molding process. But mass producing complicated plastic micro components, so small you can only see them with a microscope, has been difficult.

In the May 22 issue of the *Proceedings of the National Academy of Sciences*, University of Maryland chemistry professor John Fourkas and his group report the development of a new technique that promises to make the mass production of complex plastic microstructures a routine, one-step process.

“Molds for producing large objects are usually composed of two or more pieces that fit together,” says Fourkas, who has developed a number of groundbreaking techniques in micromachine technology. “That makes it possible to create components with extremely complicated shapes that include features such as holes -- the dust guard on a computer keyboard, for example. But when you try to use this same procedure to create microscopic objects, you encounter a number of problems, such as aligning the different parts of the molds.”



Replication of a master structure with a closed loop. The drawings above depict the master structure for the creation of an arch. The blue plane is the membrane. (C) is a master structure for the arch. (D) is the corresponding daughter structure. The Fourkas group.

To solve the problem of mass producing plastic parts that are smaller than the diameter of a human hair, Fourkas's team modified a technique known as microtransfer molding. In that process, a mold is made by curing an elastic substance called PDMS (a major component of bathtub caulk) over an original object, which is attached to a surface. The hardened mold is then removed and used to create copies.

"The problem with microtransfer molding comes when the original object contains closed loops," says Fourkas. "Imagine that you want to mass produce a microscopic version of the Golden Gate Bridge. The bridge is anchored to the surface at its towers, forming a closed loop. Once the PDMS has been cured, the original bridge model will therefore be stuck inside of it."

Up to now, the closed loop problem has been addressed by molding in layers. "This layer-by-layer technique can only be used to mold a limited range of structures, and it requires precise alignment of each mold," says Fourkas. "We realized that we could take advantage of a property of PDMS that is usually viewed as a problem, which is that it likes to stick to itself."

The Fourkas team created a thin wall of PDMS in the original structures, effectively removing any closed loops. "For instance, on the Golden Gate, we would create a thin wall underneath the entire length of the bridge model. That would make it possible to remove the mold from the original object," says Fourkas. Then, once the mold is free, the wall region in the mold can be closed off by gentle pressure, making it possible to create copies of the bridge that do not contain a wall.

"One of the exciting things about this technique," says Fourkas, "is that it vastly increases the range of microscopic structures that can be created in a single molding step. This represents an important step towards the mass production of micromachines made from plastic."

The Fourkas team also recently invented a successful method to incorporate a broad range of materials, including metal, into micro structures fabricated by multiphoton absorption polymerization (MAP).

Source: University of Maryland, College Park