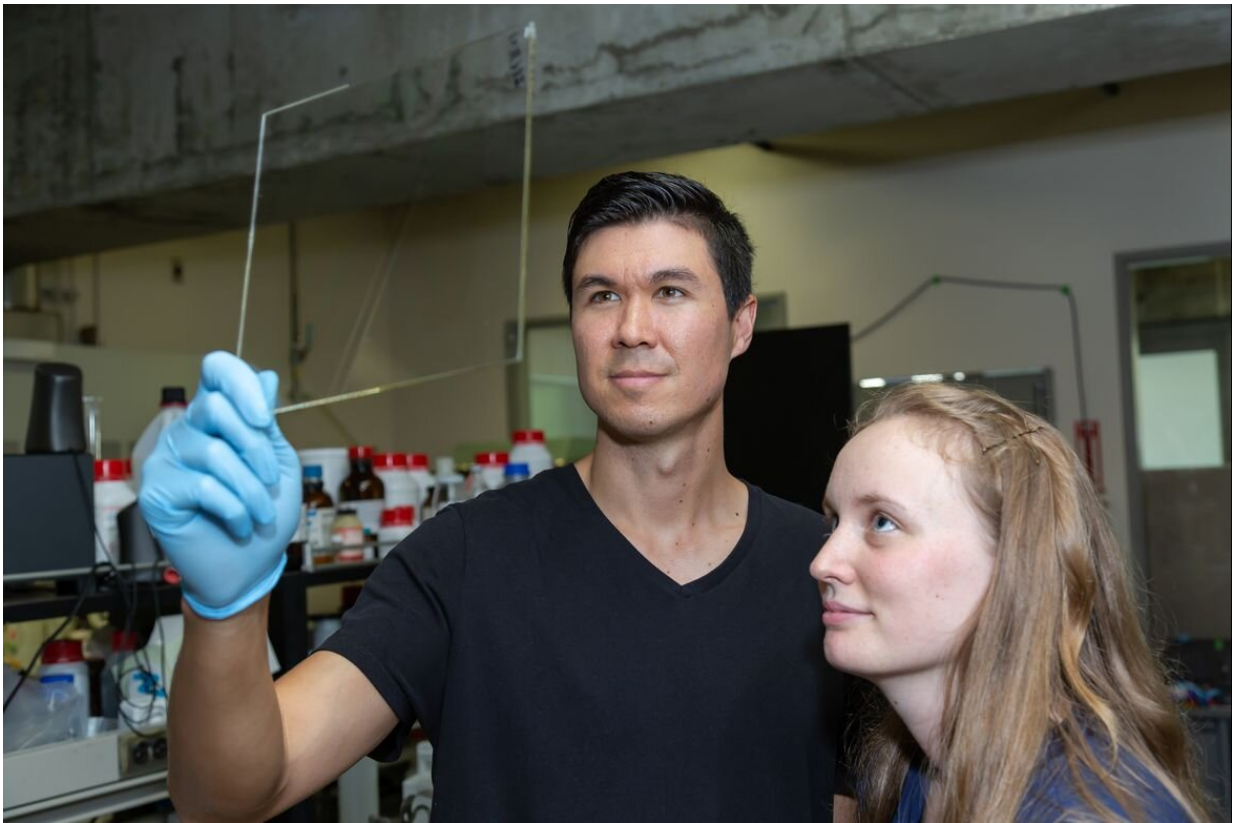


Technique could make better membranes for next-generation filtration and desalination

August 21 2019, by Wayne Lewis



UCLA postdoctoral scholar Brian McVerry and doctoral student Mackenzie Anderson examine an ultra-thin membrane film on a glass plate used in the T-FLO process. Credit: Marc Roseboro/UCLA

Deriving drinkable water from seawater, treating wastewater and conducting kidney dialysis are just a few important processes that use a

technology called membrane filtration.

The key to the process is the membrane filter—a thin, semi-porous film that allows certain substances such as water to pass through while separating out other, unwanted substances. But in the past 30 years, there have been no significant improvements in the materials that make up the key layers of commercially produced membrane filters.

Now, UCLA researchers have developed a new technique called thin-film liftoff, or T-FLO, for creating [membrane filters](#). The approach could offer a way for manufacturers to produce more effective and energy-efficient membranes using high-performance plastics, [metal-organic frameworks](#) and [carbon materials](#). To date, limitations in how filters are fabricated have prevented those materials from being viable in industrial production.

A study describing the work is published in the journal *Nano Letters*.

"There are a lot of materials out there that in the lab can do nice separations, but they're not scalable," said Richard Kaner, UCLA's Dr. Myung Ki Hong Professor of Materials Innovation and the study's senior author. "With this technique, we can take these materials, make thin films that are scalable, and make them useful."

In addition to their potential for improving types of filtration that are performed using current technology, membranes produced using T-FLO could make possible an array of new forms of filtration, said Kaner, who also is a distinguished professor of chemistry and biochemistry, and of materials science and engineering, and a member of the California NanoSystems Institute at UCLA. For example, the technique might one day make it feasible to pull carbon dioxide out of industrial emissions—which would enable the carbon to be converted to fuel or other applications while also reducing pollution.

Filters like the ones used for desalination are called asymmetric membranes because of their two layers: a thin but dense "active" [layer](#) that rejects particles larger than a specific size, and a porous "support" layer that gives the membrane structure and allows it to resist the high pressures used in reverse osmosis and other filtering processes. The first asymmetric membrane for desalination was devised by UCLA engineers in the 1960s.

Today's asymmetric membranes are made by casting the active layer onto the support layer, or casting both concurrently. But to manufacture an active layer using more advanced materials, engineers have to use solvents or high heat—both of which damage the support layer or prevent the active layer from adhering.

In the T-FLO technique, the active layer is cast as a liquid on a sheet of glass or metal and cured to make the active layer solid. Next, a support layer made of epoxy reinforced with fabric is added and the membrane is heated to solidify the epoxy.

The use of epoxy in the support layer is the innovation that distinguishes the T-FLO technique—it enables the active layer to be created first so that it can be treated with chemicals or high heat without damaging the support layer.

The membrane then is submerged in water to wash out the chemicals that induce pores in the epoxy and to loosen the membrane from the glass or metal sheet.

Finally, the membrane is peeled off of the plate with a blade—the "liftoff" that gives the method its name.

"Researchers around the world have demonstrated many new exciting materials that can separate salts, gases and organic materials more

effectively than is done industrially," said Brian McVerry, a UCLA postdoctoral scholar who invented the T-FLO process and is the study's co-first author. "However, these materials are often made in relatively thick films that perform the separations too slowly or in small samples that are difficult to scale industrially.

"We have demonstrated a platform that we believe will enable researchers to use their new materials in a large, thin, asymmetric membrane configuration, testable in real-world applications."

The researchers tested a membrane produced using T-FLO for removing salt from water, and it showed promise for solving one of the common problems in desalination, which is that microbes and other organic material can clog the membranes. Although adding chlorine to the water can kill the microbes, the chemical also causes most membranes to break down. In the study, the T-FLO membrane both rejected the salt and resisted the chlorine.

In other experiments, the new [membrane](#) was also able to remove organic materials from solvent waste and to separate greenhouse gases.

More information: Brian McVerry et al. Next-Generation Asymmetric Membranes Using Thin-Film Liftoff, *Nano Letters* (2019). [DOI: 10.1021/acs.nanolett.9b01289](https://doi.org/10.1021/acs.nanolett.9b01289)

Provided by University of California, Los Angeles

Citation: Technique could make better membranes for next-generation filtration and desalination (2019, August 21) retrieved 18 April 2024 from <https://phys.org/news/2019-08-technique-membranes-next-generation-filtration-desalination.html>

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