Researchers develop elastic material that is impervious to gases and liquids

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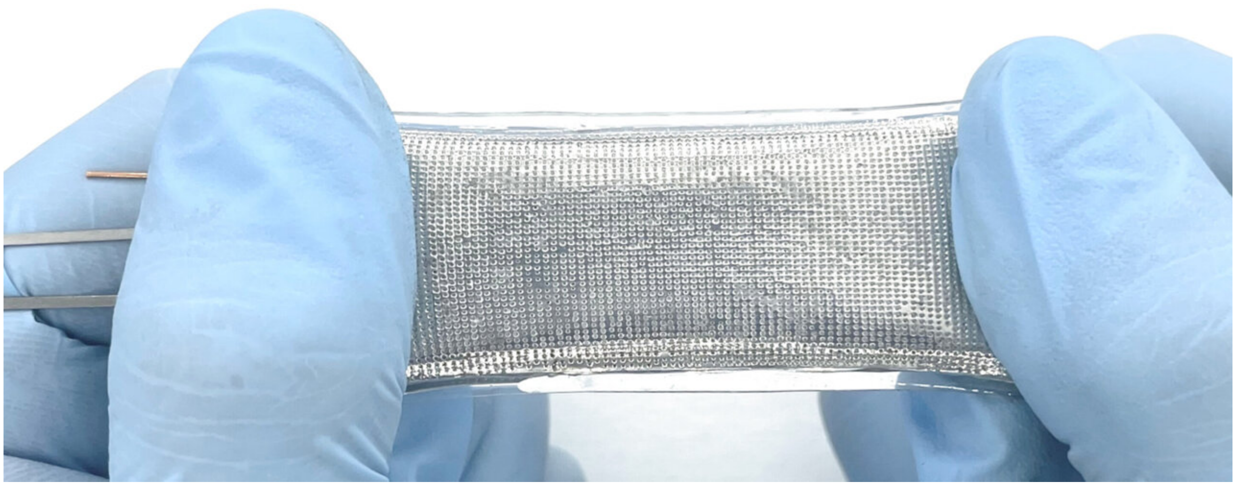

An international team of researchers has developed a technique that uses liquid metal to create an elastic material that is impervious to both gases and liquids. Applications for the material include use as packaging for high-value technologies that require protection from gases, such as flexible batteries. Credit: Michael Dickey, NC State University

An international team of researchers has developed a technique that uses liquid metal to create an elastic material that is impervious to both gases and liquids. Applications for the material include use as packaging for high-value technologies that require protection from gases, such as flexible batteries.

"This is an important step because there has long been a trade-off between elasticity and being impervious to gases," says Michael Dickey, co-corresponding author of a paper on the work and the Camille & Henry Dreyfus Professor of Chemical and Biomolecular Engineering at North Carolina State University.

"Basically, things that were good at keeping gases out tended to be hard and stiff. And things that offered elasticity allowed gases to seep through. We've come up with something that offers the desired elasticity while keeping gases out."

The new technique makes use of a eutectic alloy of gallium and indium (EGaIn). Eutectic means that the alloy has a melting point that is lower than its constituent parts. In this case, the EGaIn is liquid at room temperature. The researchers created a thin film of EGaIn, and encased it in an elastic polymer. The interior surface of the polymer was studded with microscale glass beads, which prevented the liquid film of EGaIn from pooling. The end result is essentially an elastic bag or sheath lined with liquid metal, which does not allow gases or liquids in or out.

The researchers tested the effectiveness of the new material by assessing the extent to which it allowed liquid contents to evaporate, as well as the extent to which it allowed oxygen to leak out of a sealed container made of the material.

"We found that there was no measurable loss of either liquid or oxygen for the new material," says Tao Deng, co-corresponding author and Zhi Yuan Chair Professor at Shanghai Jiao Tong University

The researchers are also conscious of costs associated with manufacturing the new material.

"The liquid metals themselves are fairly expensive," Deng says.

"However, we're optimistic that we can optimize the technique—for example, making the EGaIn film thinner—in order to reduce the cost. At the moment, a single package would cost a few dollars, but we did not attempt to optimize for cost so there is a path forward to drive cost down."

The researchers are currently exploring testing options to determine whether the material is actually an even more effective barrier than they've been able to show so far.

"Basically, we reached the limit of the testing equipment that we had available," Dickey says.

"We're also looking for industry partners to explore potential applications for this work. Flexible batteries for use with soft electronics is one obvious application, but other devices that either use liquids or are sensitive to oxygen will benefit from this technology."

The paper, "Liquid Metal-Based Soft and Hermetic Seals for Stretchable Systems," will be published this week in the journal *Science*.

More information: Qingchen Shen et al, Liquid metal-based soft, hermetic, and wireless-communicable seals for stretchable systems, *Science* (2023). DOI: 10.1126/science.ade7341. www.science.org/doi/10.1126/science.ade7341

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