Making conductors stretchable by using multiple layers arranged in a gradient

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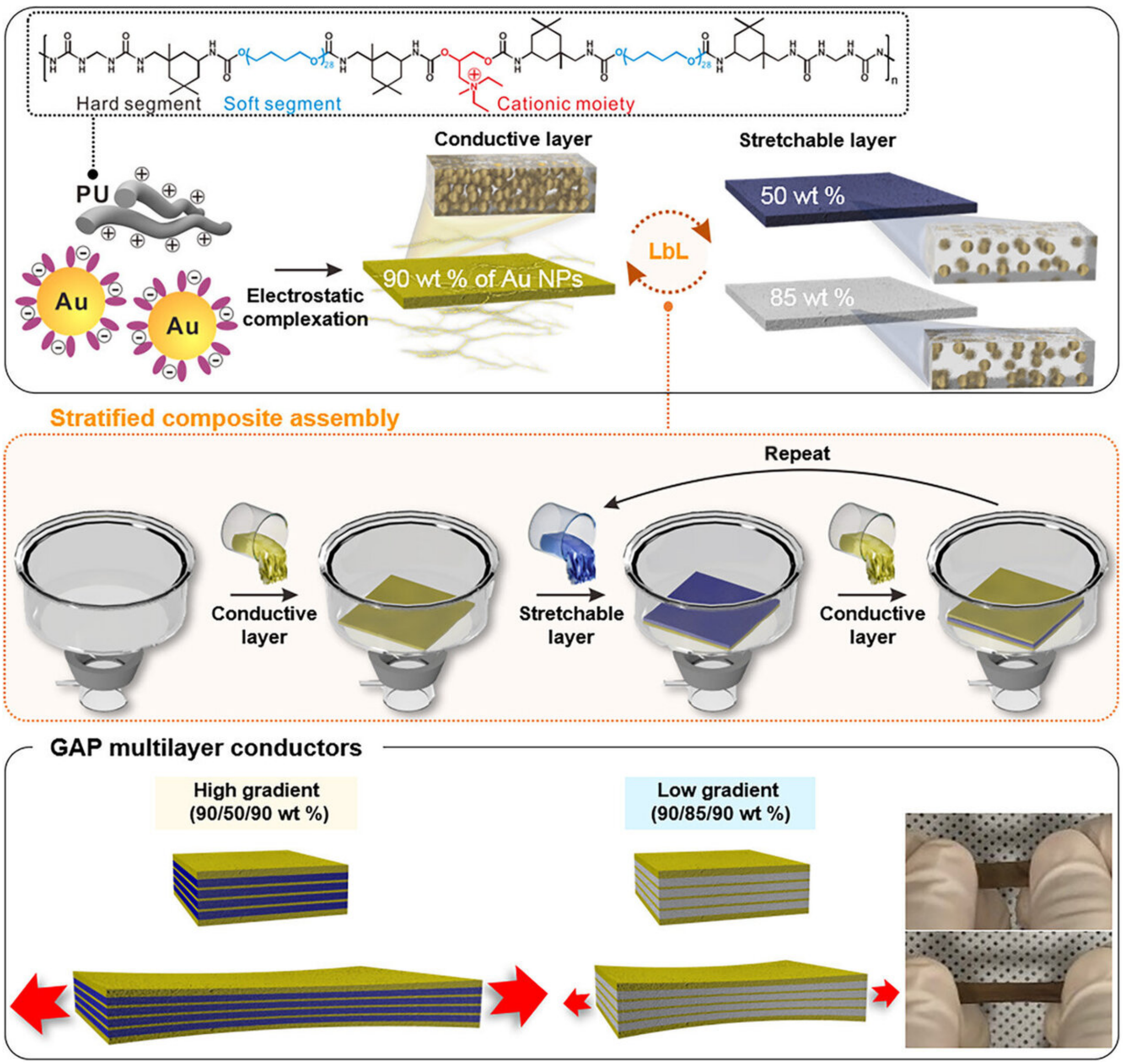

Stratified assembly of stretchable nanocomposites with different concentrations of Au NPs in the elastic layer. The interface boundary of the layered structure is stratified by the sequential filtration of each AuPU composite suspension with different concentration gradients. The photographs show a GAP multilayer conductor under relaxed and strained conditions. Credit: Woo-Jin Song, Pohang University of Science and Technology

A team of researchers affiliated with several institutions in the Republic of Korea and the U.S. has developed a means for creating a new kind of stretchable conductor. In their paper published in the journal *Science Advances*, the group describes their process and the conductors they made, and the results of testing with a battery.

Over the past several years, medical scientists have been looking into the possibility of using more types of wearable or even insertable devices to monitor or regulate bodily processes. While they have made progress, much more could be done if the electronics were stretchable and/or bendable. One of the roadblocks to the creation of such devices is the challenge engineers face as they balance electrical connectivity and stretchiness—typically, the more a conductor can be stretched, the less conductive it is. In this new effort, the researchers have found a way to circumvent this problem.

The researchers created a conductor with multiple layers of varying concentrations of nanoparticles. The layers consisted of films made of polyurethane with a positive charge and gold nanoparticles that were negatively charged—all arranged in a gradient. By using different ratios—90 weight percent at the bottom and top, weights of 50 or 85 percent in-between—the team was able to ensure conductivity as the material was stretched. A closer look showed the nanoparticles self-organized into aligned pathways as the material was stretched, which accounted for the continued conductivity.

Testing showed the material was able to maintain conductivity at strains up to 300 percent. But to see how it performed in a real live application, the researchers fashioned one of their conductors into an electrode and applied it to a lithium-ion battery. Measurements of its performance showed it to be in the range necessary for use in real world devices—and it proved able to continue working at 90 percent of original capacity after being run through 1000 cycles.

More testing will have to be done with the conductors, but the researchers are optimistic that their material will prove useful in developing medical devices and stretchable batteries—and perhaps devices that make use of both applications.

More information: Minsu Gu et al. Stretchable batteries with gradient multilayer conductors, *Science Advances* (2019). DOI: 10.1126/sciadv.aaw1879