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Mechanical self-assembly of highly-folded graphene oxides for ultralarge deforming actuators

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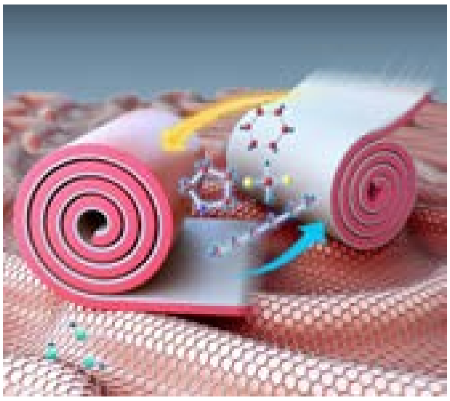
The fabrication of micro-/nano-patterns is of great significance to material science and technology, with numerous potential applications in microfluidics and microimprinting, wetting and adhesion, surface-enhanced Raman scattering (SERS), flexible electronics, mechanical property measurements, and cell culture biointerfaces. Gyrification in the human brain is driven by the compressive stress induced by the tangential expansion of the cortical layer, while similar topographies can also be induced by the tangential shrinkage of the spherical substrate. Herein we introduce a simple three-dimensional (3D) shrinking method to generate the cortex-like patterns using two-dimensional (2D) graphene oxide (GO) as the building blocks. By rotation-dip-coating a GO film on an air-charged latex balloon and then releasing the air slowly, a highly-folded hydrophobic GO surface can be induced. Wrinkling-to-folding transition was observed and the folding state can be easily regulated by varying the pre-strain of the substrate and the thickness of the GO film. Driven by the residue stresses stored in the system, sheet-to-tube actuating occurs rapidly once the bilayer system is cut into slices. In response to some organic solvents, however, the square bilayer actuator exhibits excellent reversible, bidirectional, large-deformational curling properties on wetting and drying. An ultralarge curvature of 2.75 mm^{-1} was observed within 18 s from the original negative bending to the final positive bending in response to tetrahydrofuran (THF). In addition to a mechanical hand, a swimming worm, a smart package, a bionic mimosa and two bionic flowers, a crude oil collector has been designed and demonstrated, aided by the superhydrophobic and superoleophilic modified GO surface and the solvent-responsive bilayer system. So the method demonstrated here is not only able to fabricate highly folded cortex-like patterns with superhydrophobic and superoleophilic properties, but also to fabricate interesting reversible bilayer actuators with ultralarge deformations for versatile applications.



Biography

Zengyong Chu has his expertise in Molecular Physics and Chemistry. He has completed his PhD from National University of Defense Technology. He is Full Professor and Director of a research team focusing on Molecular Physics and Chemistry at National University of Defense Technology.

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