Amphibian batteries

GETTY

Chem. Mater. **19,** 2473–2482 (2007)

Lithium-ion batteries are a great success of modern materials chemistry. They are rechargeable, light and compact and their electrochemistry is well studied. But a substance as innocuous as water hinders extension of this technology to applications in humid or marine environments. Harry R. Allcock and colleagues have synthesized and studied alternative polymer electrolytes with the aim of making a material that will conduct well and at the same time prevent water from seeping in and ruining the battery. They explored different ways of conferring hydrophobic properties to a good lithium-ion conductor, phosphazene functionalized with polyether chains on the side. The authors indeed found a promising candidate: a macromolecule made of a hydrophobic polynorbornene backbone with pendent phosphazene rings bearing both hydrophilic and hydrophobic side chains. Ion conductivity can be improved by increasing the relative amount of hydrophilic side chains on which the lithium ions can hop. Moreover, the presence of hydrophobic groups provides a surface that is semi-hydrophobic rather than hydrophilic. Further engineering steps on the whole device might make this technology watertight.

MEMS in cross-talk

Appl. Phys. Lett. **90,** 173118 (2007)

MEMS cantilevers have established themselves as a common and convenient method to detect tiny changes in their resonating behaviour, for example on adsorption of a single molecule. However, the sensitivity of such a cantilever to changes in mass relies entirely on the precision with which its resonance frequency can be determined. A. Quazi and colleagues now report on an improved design that relies on a more dynamic method — cross-talk between adjacent cantilevers. This cross-talk occurs if the tiny gap between the driver cantilever and a follower cantilever is bridged by a molecule. In that case, the driver excites oscillations in the follower — in particular if the two are oscillating in resonance. Importantly, if the follower is flanked by an additional cantilever at each side, the system is more stable, energy dissipation is reduced and frequency sensitivity increased. The sensitivity of the structure reported is already comparable to the best single-cantilever arrays.

Smaller and smaller

Nano Lett. **7,** 1329–1337 (2007)

The realization of structures of only a few nanometres in size is in high demand for studying physical properties that occur at the nanometre scale. Although features of a few tens of nanometres can be achieved almost routinely, shrinking the sizes to less than 10 nm remains a problem. Michael Fischbein and Marija Drndić propose a solution based on a transmission electron microscope (TEM), using the interaction of transmitted high-energy electrons with metal surfaces that can give rise to spurious effects, including sputtering. After coarsely pre-patterning a metal surface using electron-beam lithography, they used TEM-sputtering to ablate the structures into much smaller features. With this method, not only have they realized several structures, including nanorings, serpentines and dots, with dimensions lower than 10 nm, but they have also obtained a very low surface roughness (<5 Å). The precision and reliability of the method makes it very promising for several applications and for fundamental studies at the nanoscale.

Rewriteable relief

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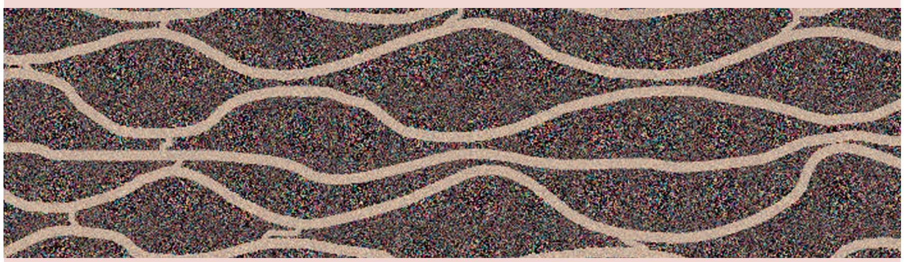
Photoresponsive gels and polymers are technologically interesting for a wide range of applications such as microactuators, permeable membranes and drug-delivery systems. These functional materials are particularly attractive because light irradiation can be immediately applied at high resolution without physical contact. Kimio Sumaru and colleagues now report on the response of thin hydrogel layers composed of a commonly used thermoresponsive polymer with an acrylated spirobenzopyran chromophore included in the backbone. Irradiation with blue light results in drastic volume change and immediate formation of structures forming microscale relief with a high aspect ratio. The photoinduced shrinking and swelling process was found to be reversible over a period of hours, suggesting that the behaviour of these materials could prove applicable for controlling integrated microsystems such as microfluidic chips.

Anisotropy explained



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PEDOT:PSS (poly(3,4-ethylenedioxythiophene):poly(styrenesulphonate)) is a highly conducting and transparent blend that is commonly used as a spin-coated layer in organic electronic devices to improve their charge-transport characteristics. For such a widely used material, however, little is known about the charge transport and morphology of the blend itself, other than that conductivity is much higher in the plane of the film than perpendicular to it. The widely accepted view is that PEDOT:PSS grains, which are highly conducting, are surrounded by weakly conducting PSS shells. Nardes *et al.* looked in more detail and discovered that the observed anisotropy in both the magnitude of conductivity and the conduction mechanism within spin-coated PEDOT:PSS films arises from pancake-shaped PEDOT-rich regions separated by lamellae of PSS (pictured). This understanding is vital for applications such as pixelated displays — where in-plane conductivity causes crosstalk between neighbouring pixels but out-of-plane conductivity affects the contact resistance — and raises the hope that the conductivity characteristics could be tuned by controlling the morphology.