WEARABLE LIGHT-EMITTING DIODES

Red–green–blue is in fashion

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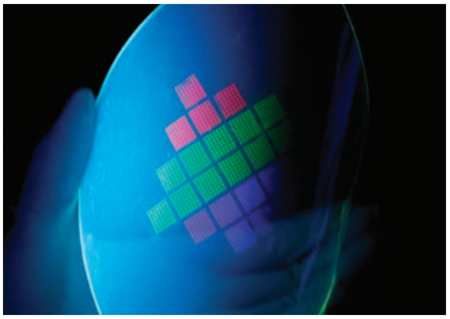

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The development of full-colour, high-resolution wearable displays is hindered by technical challenges in producing efficient, polychromatic, deformable light-emitting diodes (LEDs) as pixels. Conventional printing techniques for LEDs based on colloidal quantum dots do not achieve the required precision for full-colour displays in the alignment of red–green–blue (RGB) subpixels, and lack fidelity in pixel shapes to enable high resolution. Now, Taeghwan Hyeon, Dae-Hyeong Kim and colleagues have used an intaglio transfer printing method for quantum dots in order to fabricate arrays of wearable RGB pixels with a resolution of up to 2,460 pixels per inch.

Using intaglio transfer printing ultrathin layers of colloidal quantum dots can be deposited on various substrates to form pixels of different shapes and sizes. The researchers — who are at the Institute for Basic Science in Seoul, Seoul National University, Samsung Advanced Institute of Technology and Pusan National University — demonstrate that pixels as small as 6 μm can be printed, in various shapes, with a 100% transfer yield and a pattern matching the original design. In comparison, conventional stamping can only transfer pixels that are 35 μm or larger, and with a yield below 30%. The intaglio printing method can be used to transfer layers of quantum dots with different sizes, enabling the realization of RGB subpixels on flexible substrates. The subpixels are used in wearable white LEDs exhibiting stable electrical characteristics when bent. These quantum dot LEDs are also employed in wearable electronic tattoos with a record brightness of 14,000 cd m^{-2} at 7 V that is stable after 1,000 cycles of stretching under 20% strain. *ED*

NANOSWIMMERS

Designed for speed

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Most artificial micro- and nanoswimmers are designed to mimic natural flagella and are composed of a spherical head attached to a chiral helix, which through an actuation mechanism can rotate in one direction and propel the system in solution. Peer Fischer, Alexander Leshansky and colleagues have now worked out the optimal geometry for a nanoswimmer to achieve the highest velocity.

Contrary to common intuition, a long chiral tail is not necessary to swim fast. In fact, there are two opposing forces to be considered. On the one hand, a long tail increases the viscous drag, that is, the resistance the system encounters by the surrounding water as it moves along. On the other, a short helical tail has little torque to generate much linear motion. The optimal geometry therefore lies somewhere in between. In particular, the researchers calculate, and experimentally verify, that, when actuated by an external stimulus such as a rotating magnetic field, the fastest nanoswimmers have a tail that is only around one full helical turn long and a length-to-head-radius ratio of about 5.

Leshansky and colleagues — who are based at the Israel institute of Technology, the University of Stuttgart and the Max Planck Institute in Stuttgart — explain that this is a different regime than that found in bacterial flagella, which are usually much longer. This is because the bacterial flagella are actuated by an internal mechanism of chemical energy transduction and optimized to maximize power rather than speed. *AM*

SERS SUBSTRATES

A rose for Raman

Anal. Chem. **87,** 6017–6024 (2015)

There are a variety of substrates for surface-enhanced Raman scattering (SERS), which are typically in the form of plasmonic nanostructures made using either lithographic processes or biotemplates. However, these are often expensive to make and suffer from a low density of hot spots. Hsuen-Li Chen and colleagues at the National Taiwan University now show that fresh rose petals can act as an eco-friendly and inexpensive alternative substrate for SERS.

The researchers deposited a suspension of silver nanoparticles with diameters of 100 nm on either the upper or lower epidermis of a fresh rose petal and allowed it to dry before depositing a drop of the analyte, rhodamine 6G, on the nanoparticle-decorated petal. Because rose petals are hydrophobic, the large contact angle between the water droplets and the petal surface allowed the nanoparticles to form aggregates, and the analyte to be concentrated into a small spot on the surface upon evaporation. This concentrating effect increased the intensities of the SERS signals, and the method achieved a detection limit of 10^{-15} M. Further experiments showed that the lower epidermis of white petals gave the best SERS enhancement. Other colour petals gave rise to background signals, and simulation studies showed that nanoparticles distributed more efficiently on the planar nanofolds of the lower epidermis than the micropapillae structures on the upper epidermis. *ALC*

NANOPARTICLE CATALYSTS

Protected with graphene

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Proton exchange membrane fuel cells could potentially be used as portable power sources with high energy densities. However, the cells typically rely on catalysts made of expensive noble metals such as platinum, which limits their widespread commercialization. This has led to an extensive search for cheaper materials, but an alternative approach is to try to improve the long-term efficiency of platinum-based catalysts. Heeyeon Kim, Alex Robertson and colleagues have now shown that the lifetime of platinum nanoparticle catalysts can be increased by coating them with a porous layer of graphene.

The researchers — who are based at the Korean Institute of Energy Research, the University of Oxford and KAIST in South Korea — synthesized graphene-encapsulated nanoparticles in a one-step procedure in which carbon and platinum precursors were simultaneously vapourized at temperatures ranging from 400 °C to 1,100 °C; the resulting structures were then characterized using aberration-corrected transmission electron microscopy. At such temperatures, catalytic growth of graphene occurs on platinum surfaces and by limiting the temperature to around 400 °C, nanoparticles with graphene shells that were only 1–2 layers thick could be formed.

The shells were found to protect the nanoparticles from the operating conditions of the fuel cell, but at the same time degrade the catalytic performance. However, the growth of complete graphene shells could be inhibited by adding nitrogen precursors during synthesis and the resulting platinum nanoparticles, which had porous graphene shells, were found to offer both high performance and increased resilience. *OV*

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