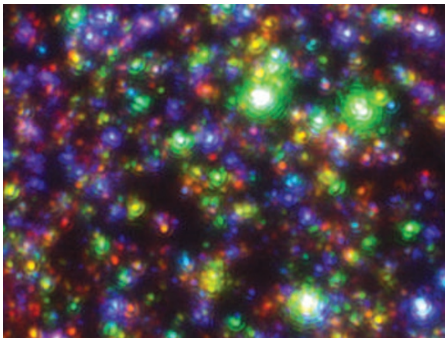
WHITE LIGHTING

LEDs learn to relax

Appl. Phys. Lett. **97,** 073101 (2010)



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White LEDs are a promising technology for next-generation lighting, but cannot emit efficiently over the whole visible spectrum. For example, indium gallium nitride, commonly used in LEDs because it emits efficiently in the blue, can be tuned towards the red by increasing indium content. However, this tuning also causes defects and strain owing to the large lattice mismatch between indium nitride and gallium nitride, and efficiency drops quickly. Now, Shangjr Gwo and colleagues at National Tsing-Hua University in Taiwan have demonstrated efficient indium gallium nitride electroluminescence across the entire visible spectrum.

The key to this accomplishment was relaxing the strain that usually accompanies high indium content. Gwo and colleagues began by self-assembling onto a silicon substrate vertical gallium nitride nanorods that contained a junction between hole- and electron-doped regions. They then grew disks of indium gallium nitride into these junction areas. The nanorod growth template allowed the disks to have relatively low strain, increasing their emissive efficiency. Although each disk emitted a slightly different colour (see image), the total emission summed to a white light. The technique is expected to allow a variety of new designs and to scale well to larger areas.

NANOPARTICLE UPTAKE

Charge matters in fish

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Several studies in cells and different organisms have shown that size, shape, surface chemistry and surface area of nanomaterials can affect the way they interact with biological and environmental systems. However, the results from these studies remain inconclusive and, in some cases, difficult to interpret because the toxic effects may not be related to the nanoparticles themselves. Using well-defined gold nanoparticles that do not aggregate or dissociate into ions, Vincent Rotello and co-workers at the University of Massachusetts now show that surface properties can affect the way fish take up and remove nanoparticles from their systems.

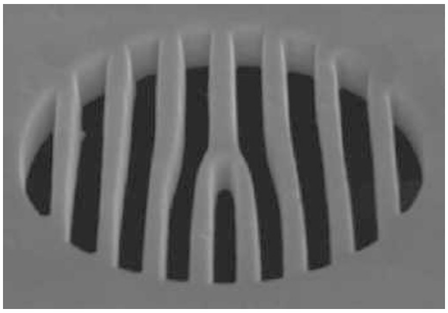
Rotello and colleagues synthesized positively charged, neutral, negatively charged and hydrophobic gold nanoparticles and exposed them to the freshwater Japanese medaka fish for 24, 72 and 120 hrs. Positively charged particles were taken up by the fish more readily than the neutral or negatively charged ones, and the three types of particle were found to accumulate mainly in the intestines. It is thought that the negatively charged mucus layer on the surfaces of the gills and intestines attracts the positively charged particles, whereas the accumulation of neutral and negatively charged particles may be mediated by positive ions such as calcium, magnesium and sodium. Hydrophobic particles killed the fish within 24 hrs and substantial amounts were found in the brain, gills, heart, liver and dorsal fin, suggesting entry into the circulatory system.

The study suggests that hydrophilic nanoparticle surfaces can prevent accumulation and facilitate their removal from the fish, whereas hydrophobic particles can distribute throughout the organs and cause mortality.

ELECTRON MICROSCOPY

With a twist

Nature **467,** 301–304 (2010)



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Twisted laser beams with wavefronts that spiral around their axis of travel are routinely used to trap and manipulate microscopic particles such as cells. Earlier this year, Masaya Uchida and Akira Tonomura of the RIKEN Institute in Japan showed that electron beams could also be made to twist by passing them through a spiral stack of graphite thin films. However, these vortex beams of electrons were difficult to reproduce reliably. Jo Verbeeck and colleagues at the University of Antwerp and Vienna University of Technology have now shown that such beams can be readily generated in conventional electron microscopes with the help of holograms.

In a similar approach to that previously applied in optics, the Belgian–Austrian team used computer-generated holograms to design a 'mask' that, when placed in the path of an electron beam, would convert a plane wave into vortex beams. The mask, which has a specific grid-like pattern with micrometre-sized gaps (see image), was then constructed from a 100-nm-thick sheet of platinum using a focused ion beam.

Verbeeck and colleagues illustrate the capabilities of their electron vortex beams by using them to probe the magnetic properties of a thin layer of iron. Moreover, they suggest that the beams could prove particularly useful in analysing and manipulating nanoscale materials.

MECHANICAL LOGIC

Coping with the heat

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Electronic devices made of conventional semiconductors such as silicon are unable to operate at high temperatures because they experience leakage currents — that flow in the off state — and other problems at the temperatures encountered in applications such as advanced propulsion systems and deep-well drilling. Silicon carbide (SiC) has much better thermal properties than silicon, but field-effect transistors made from this material tend to be slow and relatively bulky. Now Te-Hao Lee and co-workers at Case Western Reserve University in the USA have made an electromechanical switch from SiC that can operate at a frequency of 500 kHz at 500 °C.

The device made by Lee and co-workers contains two identical three-terminal switches in a simple circuit. The source in each switch is a cantilever that can be brought into contact with the drain by applying a voltage to the gate. The new switch is about three orders of magnitude smaller than a SiC field-effect transistor, and has a leakage current of less than ten femtoamps, which represents an improvement of four orders of magnitude.

The Case Western team was able to operate the SiC switches for more than 21 billion cycles at 25 °C and for more than 2 billions cycles at 500 °C, although the reasons for failure at the higher temperature are not yet understood.