MEMORIES

Current performance

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The surface of a rewritable digital video disk is covered in a material that can reversibly switch between crystalline and amorphous phases when irradiated by a laser. An electronic memory based on such a phase-change material would have numerous advantages, including non-volatility. However, electronic phase-change memories have required high programming currents to generate the heat necessary for a phase transformation. Now, Eric Pop and colleagues at the University of Illinois at Urbana-Champaign have constructed an electronic phase-change memory that can be programmed with currents 100 times smaller than those required by state-of-the-art devices.

The key to the advance was reducing the volume of the active phase-change material. Gaps as small as 20 nm in width were created in carbon nanotubes with diameters of less than 6 nm, and then filled with a chalcogenide phase-change material. Voltages applied across the nanotubes resulted in large electric fields across these gaps, causing sufficient Joule heating to switch the chalcogenide from a resistive to a conducting state while drawing as little as 1 μA of current. Switching back to a resistive state took as little as 5 μA. This translated to a minimum energy per bit of 100 femtojoules, with the potential to scale to lower values for smaller gap sizes.

HYDROGEN STORAGE

Polymer protection

Nature Mater. doi:10.1038/nmat2978 (2011)

Hydrogen is a promising alternative energy carrier that can burn without producing carbon dioxide and when used in a fuel cell creates only water as a by-product. Materials are, however, required to store and then release the hydrogen (through a small increase in temperature) when needed. A variety of potential storage materials have been examined, including metal–organic frameworks and carbon-based nanostructures, but in general they are capable of physisorbing only a small quantity of hydrogen at room temperature. Metal hydrides have been of particular interest, but they typically require high temperatures to release the hydrogen. Jeffrey Urban and colleagues at the Lawrence Berkeley National Laboratory and the FEI Company have now shown that magnesium nanocomposites can store a high density of hydrogen with rapid storage kinetics.

The nanocomposites are synthesized using a one-pot, room-temperature reaction in which an organometallic Mg^{2+} precursor is reduced in the presence of a soluble organic polymer called PMMA. The reaction creates metallic magnesium nanocrystals encapsulated by the polymer. The polymer provides a gas-selective barrier to the magnesium nanocrystals that allows the nanocrystals to absorb and release hydrogen while protecting them from oxygen and water, which are detrimental to their hydrogen storage capabilities.

Urban and colleagues find that the nanocomposites exhibit rapid hydrogen uptake with a storage capacity of up to 6 wt% of magnesium and a volumetric capacity greater than that of compressed hydrogen gas.

WATER TREATMENT

Silver lining

Environ. Sci. Technol. doi:10.1021/es103302t (2011)

Clean water is taken for granted in many countries but more than one billion people worldwide do not have access to water that is safe to drink. The biggest threat is the presence of bacteria that cause diseases such as cholera and giardiasis, so there is a demand for portable systems that can purify water. Theresa Dankovich and Derek Gray of McGill University have now shown that paper impregnated with silver nanoparticles can kill bacteria in water that percolates through it.

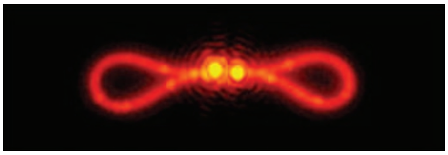
Dankovich and Gray immersed sheets of blotting paper in silver nitrate solution, and then placed them in aqueous sodium borohydride to form silver nanoparticles that had an average diameter of 7.1 nm. Model bacterial solutions were then passed through the paper and the effluent water was analysed for bacterial activity.

The McGill researchers found that the nanoparticles killed most of the *E. coli* and *E. faecalis* bacteria in the water. Moreover, the silver nanoparticles remained attached to fibres in the paper and did not contaminate the water. The large pores in the blotting paper also allow for the rapid flow of water though the system under the force of gravity without the use of pressure or suction.

NANOLASERS

In the loop

Nano Lett. doi:10.1021/nl1040308 (2011)



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Nanowire lasers are promising for many applications but they operate at a number of wavelengths, whereas single-mode output is preferable for some uses. Now Limin Tong and co-workers at Zhejiang and Peking universities have demonstrated single-mode lasing in a single cadmium selenide nanowire.

In general the cavity in a nanowire laser is equal to the length of the nanowire, with the endfaces of the nanowire acting as the mirrors that define the cavity. It is possible to select just one laser mode by shortening the cavity, but this increases the threshold for laser operation. However, if one end of the nanowire is folded or bent to form a loop, this acts as a mirror. Moreover, the threshold is reduced because the reflectivity of this loop mirror is higher than that of an endface.

Tong and co-workers bend both ends of the nanowire to form two loop mirrors (see image), which means that there are four coupled cavities defined by different combinations of the endfaces and the loop mirrors. The Zhejiang–Peking team then uses the Vernier effect to select the output from one of these cavities. The team also shows that the output wavelength can be tuned by changing the length of the cavity defined by the loop mirrors.