Cereals for the environment

Hexavalent chrom-ium, Cr(VI), is a hazardous waste produced in many industrial processes. Chrome-plated vehicles and colour paints are just a few of the commodities that eventually lead to the discharge of Cr(VI) in wastewaters. Subsequent contamination of groundwaters is a critical environmental issue, given the dreadful effects of Cr(VI) on human health. And the conventional approach for decontamination, involving chemical reduction and precipitation or ion exchange, has high operational costs.

Now researchers in France have taken the environmentally friendly approach by using a waste material of the wheat industry. They found that the lignocellulosic by-product of the wheat-bran extraction process quickly absorbs Cr(VI) from acid water solutions (*Environmental Science and Technology* **37**, 4235–4241; 2003).

The lignin, cellulose and fatty acids that make up this material have chemical groups that allow for the reduction of Cr(VI) and the formation of additional sites to immobilize the reduced Cr(III).

Environmentalists on the lookout for alternative water decontamination systems may consider this by-product as a viable option that combines low costs with the opportunity to recover waste materials.

Decoupling the coupling group

The field of molecular electronics has taken off in recent years, with measurements of charge transport in single molecules becoming almost routine. These electrical measurements are performed by fabricating metal–molecule–metal junctions, in which the molecule of interest is connected to a metal contact (most commonly gold) by a coupling group such as thiol (S) or selenol (Se). Using a combined experimental and theoretical approach, L. Patrone and colleagues (*Physical Review Letters* 91, 096802; 2003) have studied the transport properties of two oligothiophene derivatives differing only in the coupling group (S or Se). By theoretically simulating the ultraviolet photoemission spectra of the two monolayers, the researchers conclude that Se is a better electronic coupling group than S, and that this is due to the difference in the adsorption behaviour of the two groups on the gold surface. The researchers expect that their combined experimental and theoretical procedure will provide a general method of predicting the transport differences in families of related molecules.

RECTIFYING BEHAVIOR AT THE LIQUID–SOLID INTERFACE

Scanning tunnelling microscopy (STM) investigations of individual molecules allows researchers to get a better understanding of their fascinating properties. Single molecules adsorbed on surfaces can present a rectifying effect — whereby they allow conduction in one direction but not another — raising hopes that they can be used in nanoscale electronic devices. In *Nano Letters* (http://dx.doi.org/10.1021/nl034515a), Steven De Freyter and colleagues report STM observations of the ordering of organic molecules at a liquid–solid interface under ambient conditions and show that the self-assembled redox-active components of the molecules are essentially isolated on the surface. They investigate the electronic properties of these components and observe a sharp rise in tunnelling current that is strongly correlated with the oxidation potential of the molecule, but independent of its molecular ordering. The authors believe that the structural reorganization generating this pronounced rectifying effect could be caused by some a local and reversible rearrangement of the molecule at the surface.

Monodisperse quantum dots

The usual batch-preparation methods for semiconductor nanocrystals (quantum dots) require organometallic precursors, and produce poor quality crystals with a wide size distribution. Now Bawendi and co-workers (*Advanced Materials* http://dx.doi.org/10.1002/adma.200305162) have developed a new chemistry for a continuous-flow method. They produce highly crystalline CdSe nanocrystals in a narrow size distribution with high photoluminescence quantum yields corresponding to a wide spectral range — essential for their application in lasers, electroluminescent devices and so on. Cadmium oleate and tri-*n*-octylphosphine selenide, chosen as the Cd and Se sources, respectively, were dissolved in appropriate solvents and injected separately into a 250-mm-diameter channel, which was then heated. The size and distribution of the crystals could be controlled by varying the Se:Cd ratio. Increasing Se produced more nucleation sites and hence a higher yield of monodisperse smaller particles, and vice versa. The crystal size could be further fine-tuned by varying the temperature and flow rate.

The authors suggest that their method could be adapted for other nanoparticle systems.

Magnetic superatoms

Nanoscale clusters are of great interest for the preparation of nanostructured surfaces, with lateral feature sizes in the range 1–10 nm. The size and properties of these clusters can be manipulated by doping them with metal atoms that enhance the stability of the cages, while changing the electronic properties. Vijay Kumar and Yoshiyuki Kawazoe have now made theoretical calculations to investigate the stability of icosahedral Si, Ge and Sn clusters doped with divalent metals (*Applied Physics Letters* **83**, 2677–2679; 2003).

The researchers find that metal-doped ten-atom clusters are particularly stable, forming new ‘magic’ clusters. In addition, non-magic clusters composed of 9, 12 and 14 atoms become ‘magic’ with large HOMO–LUMO gaps. Most importantly, Kumar and Kawazoe predict the existence of magnetic ‘superatoms’ – magnetic clusters of Ge and Sn formed by Mn doping. The large magnetic moment and large (1.6 eV) HOMO–LUMO gap of these magnetic clusters may make them suitable for assembly into novel magnetic surfaces.