Easy nanoparticles

GETTY

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To increase the potential of the use of nanoparticles in applications, optimised properties are of utmost importance. Unfortunately, improving properties such as emission wavelength can involve tedious repetition of chemical syntheses in pursuit of the ideal reaction conditions and reactant concentrations. De Mello and colleagues eliminate the tedium by using an automated approach and shrinking the reaction vessel to fit a microfluidic device. The reactants are injected into a Y-shaped reactor, and an in-line spectrometer monitors the emission spectra of the resulting emergent particles. This data is reduced to a 'dissatisfaction coefficient' by a control algorithm, and the system then updates the reaction conditions in an effort to minimise this coefficient. Using repeated experiments, the system seeks out the globally optimum conditions. Without human intervention, the system adjusted injection rates of reactants and temperature to optimise the emission intensity at a chosen wavelength for cadmium selenide nanoparticles. The authors expect the route to be generally applicable, with other methods of monitoring, such as dynamic light scattering, for non-emissive particles.

Magnets for energy

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The conversion of heat into electricity could be used to partially recycle wasted energy. The Seebeck effect — the appearance of a voltage across a thermoelectric material in response to a thermal gradient — is traditionally used for this purpose. Motoki Ujihara and colleagues have now demonstrated an alternative strategy, based on the phase transition of a soft ferromagnet. In their device, the soft ferromagnetic component, initially in contact with a cold source, is attracted towards a hot source by a hard ferromagnet, and once heated up becomes paramagnetic. The attraction reduces dramatically and the soft ferromagnet is brought back to the original position by a spring, where the process restarts. In every cycle, the mechanical energy is converted into electricity by a piezoelectric component. The present structure produces 60% more power than equivalent thermoelectric devices, but the use of different magnetic materials could improve performances substantially.

Enzyme trilogy

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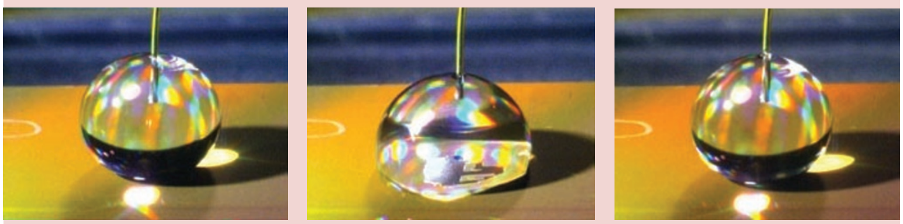
Within a cell, many enzymatic reactions run in close proximity. To enable this, enzymes are spatially separated and in the optimum position. Now, a synthetic mimic, in the form of a polymeric nanoreactor that performs a cascade of reactions, each catalysed by a different enzyme in its own microenvironment, has been made by Dennis Vriezema *et al.* The nanoreactors, or polymersomes, are composed of block-copolymer amphiphiles that allow small molecules to diffuse across their membrane whereas larger molecules, like enzymes, remain encapsulated in the centre. Three different enzymes are placed at various locations: in the polymersomes' central chambers, the surrounding solution and, for the first time, within their membranes. Once in place, the enzymes retain their activity. The first reaction is catalysed by the enzyme in the external solution and the second by the enzyme in the central chamber. A product of this reaction, hydrogen peroxide, passes through the membrane, where it meets the third enzyme and initiates the final reaction. The encapsulated system has a longer lifetime and a much higher conversion than the same enzymes in bulk solution.

The wetting planner



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The two extremes of liquid on a surface are the superhydrophobic and superhydrophilic states. Essentially, the energetics of the liquid–surface interface determines whether a droplet wets a surface or not. Tom Krupenkin and his co-workers have previously demonstrated that an electric potential applied to a surface of 'nanonails' can induce a transition from a superhydrophobic to superhydrophilic state. Alas, this transition was not reversible — once the liquid wets the surface, the droplet contact line becomes pinned and the system has insufficient energy to revert to the dewetted state. In their latest work, Krupenkin and colleagues now achieve complete reversibility between wetting and dewetting. The authors use short electrical pulses through the conductive top layer of their structures. The electrical current locally raises the temperature and therefore increases the volume occupied by the air between the nanonails. This slightly lifts the liquid above and 'pushes' it across the energy barrier, achieving complete dewetting. Such surfaces might find their application in microfluidics or in chemical microreactors.

Local temperature

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Measuring the temperature of nanoscale structures can prove problematic owing to the limited spatial resolution available. Shan Li *et al.* may have found a solution. They make use of wavelength shifts of CdSe quantum dots (QDs) for non-contact local temperature measurements. The QDs in solution were excited by a laser through a microscope. The peak emission of a single QD was found to red-shift to longer wavelengths with increasing temperature. The measurements were found to have a sensitivity of ~0.1 nm per °C, consistent with values of bulk CdSe. However, the peak wavelength varied from QD to QD, probably due to variations in size and shape of the dots. Nevertheless, measurements on a group of 1,200 dots gave a reliable reading with 1 °C precision. When tested on a MEMS microheater, the results were in line with numerical calculations, proving the potential for future applications. If QDs can be prepared with homogeneous size, the future could be bright for this technique.

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