Golden 'nanonets' conduct themselves in an orderly

THE rings left behind by spilled coffee have inspired a new way to make ultrathin coatings for LCD and plasma flat-screens.

In LCDs, transparent conductive coatings are used to form an electrode on the surface of the screen, while in plasma TVs they provide a shield that prevents electromagnetic fields from straying. The traditional techniques for making such coatings include sputtering a fine layer of indium tin oxide onto the surface. ITO is highly conductive and transparent to visible light, but the process is expensive, requiring clean rooms and vacuum chambers.

Ivan Vakarelski at the Institute of Chemical and Engineering Sciences in Singapore realised that coffee stains could point the way to a cheaper alternative. Spill coffee and the evaporating liquid drives coffee particles to the edges of the spill – which ultimately produces the circular stain. The coffee granules are being "assembled" by the varying evaporation and convection rates in the fluid. Vakarelski and his colleagues figured that if they could mimic the process in a controlled fashion, they could create a pattern of granules of other materials to form a nanoscale conductive coating.

Instead of coffee, they started with a suspension of gold particles, each about 20 nanometres across. The suspension was left to dry on a glass plate covered with closely packed latex microspheres, each about 50 to 100 micrometres in diameter.

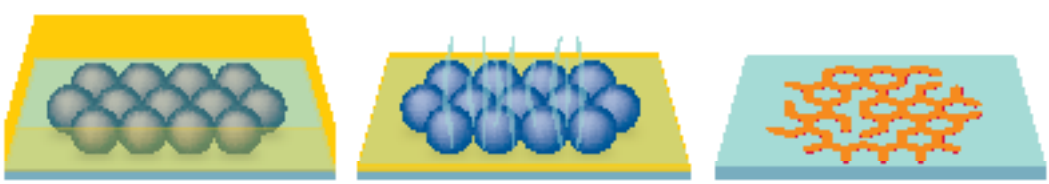
By adding suitable surfactants and lowering the temperature to 4 °C, the team was able to control the evaporation and convection rates, causing the gold particles to move to the base of the latex balls where they settled to form rings and bridges. Once the liquid had evaporated, they were left with a network of connected gold nanoparticles (*Physical Review Letters*, vol 102, p 058303).

"Our gold network is finer than spider's silk and is also conductive," says Vakarelski. He reckons that gold nanonets could make even better conductors than ITO coatings.

The team has made coatings a few square centimetres in size in the laboratory and aim to increase this tenfold. Unlike many new technologies, the nanonet process will be easy to scale up, says Vakarelski.

The work has "considerable merit", says Jennifer Lewis at the University of Illinois at Urbana-Champaign, an expert on the self-assembly of nanoparticles. "A key advantage of their approach is that the resulting networks are semi-transparent and their density can be tuned by varying the size of the [latex-microsphere] template." **Anil Ananthaswamy** ■

How to make a nanonet



...while gold nanoparticles linger in cells, blocking genes

GOLD nanoparticles could be an ideal way of delivering one of the hottest prospects in molecular medicine. The nanoparticles have successfully carried RNA molecules into human cells, where researchers hope they can be used to tackle everything from HIV to cancer.

Over the past few years, stretches of "short interfering" RNA, or siRNA, which are just over 20 bases long, have emerged as a powerful tool in biology because they are able to "turn off" target genes. They do this by selectively interfering with the messenger RNA that is the intermediate step between a gene and the protein it codes for.

This means that siRNAs could also act as exquisitely targeted drugs, shutting down key genes from HIV and other viruses, or disabling the human genes linked with conditions from age-related sight loss to cancer.

Getting large quantities of siRNA into human cells and protecting it from being broken down too quickly once inside is a tough challenge, however. Now a team led by Chad Mirkin of Northwestern University in Evanston, Illinois, has used gold nanoparticles to carry siRNA into cultures of human cells.

The team's delivery system consists of balls of gold just 13 nanometres across, each bearing about 30 short stretches of RNA bound to the gold by a connecting molecule. When these particles were added to human cell cultures, they entered 99 per cent of the cells within 6 hours. "These particles go in better than anything else," says Mirkin, although the mechanism of absorption is unclear.

The researchers then tested how well the gold-borne siRNAs did their job. They added siRNA-laden particles to cells carrying a loop of DNA bearing the gene for luciferase, the enzyme that gives fireflies their glow. A control group of cells was given the siRNA alone. Four days later, the reduction in the activity level of the gene in the gold-dosed cells was more than double the drop found in the control cells (*Journal of the American Chemical Society*, DOI: 10.1021/ja808719p).

"siRNAs could act as exquisitely targeted drugs, shutting down genes from HIV and other viruses"

"We can increase the lifetime of siRNA from minutes to hours – and sometimes even days," says Mirkin. He reckons that as RNA is a salt, its high density on the particles' surfaces creates an environment that inhibits the enzymes that break down RNA.

John Rossi, an siRNA specialist at the City of Hope hospital in Duarte, California, is impressed that Mirkin's team could deliver large amounts of siRNA to their cultured cells without obvious toxicity. Other delivery systems, such as lipids, tend to be toxic to cells at high doses, he notes.

The next test will be to find out whether the particles perform as well in a living body as in the culture dish. "It's early days, and there are a lot of delivery vehicles that work in cultured cells and haven't worked in animals," cautions Mark Kay, a gene therapist at Stanford University. Peter Aldhous ■