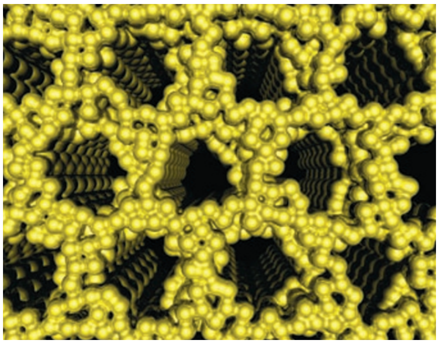
Purely platinum



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Science **320,** 1748–1752 (2008)

Making ordered mesoporous metal composites and mesoporous metals is a challenge because of the high surface energies of metals. As these materials have promise for use in catalysis, optical and electrical applications, their fabrication is sought after. Ulrich Wiesner and colleagues have successfully made such materials by the self-assembly of block copolymers and platinum nanoparticles. More specifically, ligand-stabilized platinum nanoparticles assemble with the polymers to make mesostructured nanoparticle–block copolymer hybrids that, on heating, form ordered platinum–carbon composites with pore sizes of ≥10 nanometres. The electrical conductivity of these composites is very high for a mesoporous structure made via this route. Using plasma treatment or acid-etch methods, the composites are converted to ordered mesoporous platinum (pictured). The key synthetic aspects are the preparation of hybrids with a large volume fraction of metal and, in particular, a high metal content in one copolymer domain. The interaction between the polymer and nanoparticles is thought to be largely governed by the nanoparticle ligands; as a result, it should be possible to extend the method to other metals.

Cancer marker

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Telomeres are sequences of DNA found at the ends of human chromosomes. The enzyme that catalyses the addition of telomeres to chromosomes is telomerase, which, having been found in over 85% of human tumours but not in neighbouring normal cells, is useful as a biomarker for cancer cells. The most sensitive telomerase detection procedures are based on the polymerase chain reaction (PCR), which has inherent problems, however PCR-free assays lack sensitivity. Using polyvalent oligonucleotide-functionalized gold nanoparticles (AuNPs) as a new means of signal amplification, Chad Mirkin and colleagues have designed a sensitive PCR-free assay. Excess functionalized AuNPs are mixed with telomerase extracted from cells, which binds to the oligonucleotides. Subsequent addition of DNA monomers to the mix enables the telomerase to elongate the oligonucleotides. By removing the telomerase, extracting any AuNPs that have elongated oligonucleotides then dissolving the AuNPs, the number of elongated and non-elongated oligonucleotides can be determined, giving an indication of telomerase activity. The authors have shown that the assay can also be used to measure telomerase inhibition.

Plasmonic horizons

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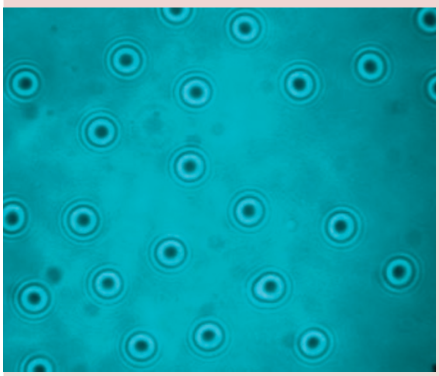
The plasmon coupling between two metallic nanoparticles is known to depend strongly on the distance between them. This behaviour can, for example, be used as a ‘molecular ruler’ to measure distances between biomolecules. An alternative sensor system for interacting nanoparticles may simply be single metal nanoparticles close to a metal film, where the surface plasmon polaritons on the film interact with the localized surface plasmons (LSPs) of the nanoparticles. The larger the distance between the film and the nanoparticles, the lesser this interaction. Jack Mock and colleagues have now realized such a model system, where a thin, charged polymer layer was used as a spacer to tune the distance between gold nanoparticles and a gold film. Variations in distance as small as a few nanometres cause the LSP resonance to shift significantly from green to red wavelengths. This colour change may be used as a very sensitive sensor to detect changes in environmental parameters such as temperature or pH.

A levitating array



KHALID SALAITA AND JAY GROVES

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Microarrays used for analysis of DNA are often reliant on fluorescence detection methods and require sophisticated instruments or image processing to read output signals. This complicates such diagnostics, limiting their widespread routine use, in particular in developing countries. Now, Jay Groves and colleagues have developed a label-free and sensitive way to read DNA and RNA hybridization on microarrays by monitoring the electrostatic response of negatively charged silica microspheres. Complementary binding of oligonucleotides changes the charge density of the microarrayed surface — areas of double-stranded DNA are more negatively charged than areas of single-stranded DNA. When the microspheres are randomly dispersed on the surface, they adhere to positively charged sections and levitate above negatively charged sections at an equilibrium height defined by the balance of gravitational and electrostatic forces. The microsphere–substrate interaction can be imaged by simple optical methods and can even be seen by the naked eye. Microarrays using this electrostatic-based detection could realise 50 pM sensitivity, single base-pair mismatch sensitivity and were used for gene expression profiling.

Tubular wells

Small doi:10.1002/smll.200701091 (2008)

Molecular beam epitaxy (MBE) has been used for decades to grow the best-quality semiconductor structures. By depositing very thin layers of materials on a substrate with very few imperfections — and consequently high carrier mobilities — scientists have been able to study a number of fundamental phenomena, such as the integer and fractional quantum Hall effects. Structures grown by MBE are usually planar, for example two-dimensional electron gases and quantum wells. The technique has now been extended with the growth of quantum wells wrapped around nanowires. The growth of GaAs nanowires by MBE is not new, but Anna Fontcuberta i Moorral and colleagues have now shown that by changing the growth parameters during nanowire growth they can deposit nanometre-thick shells of (AlGa)As and GaAs around a hexagonal base GaAs wire. Effectively, the wires act as the substrates for tubular GaAs/(AlGa)As quantum wells. The high crystal quality of the wells combined with their geometry could give rise to new phenomena otherwise inaccessible in standard structures.