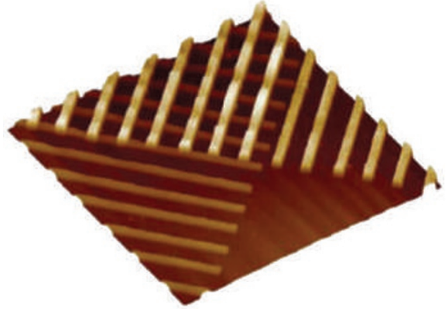
NANOELECTRONICS

Semiconductors join forces

Nature **468,** 286–289 (2010)



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Silicon dominates the electronics industry but III–V semiconductors such as indium arsenide offer faster switching speeds and better optical properties. It is possible to make devices that contain both silicon and a III–V semiconductor, but defects and leakage currents cause problems. Now researchers in the United States and Taiwan have made high-performance nanoscale transistors by transferring nanoribbons of indium arsenide onto a silicon substrate.

Ali Javey and co-workers used epitaxy and etching to produce the nanoribbons on a GaSb substrate. The nanoribbons were then removed with a flexible substrate and transferred to a Si/SiO_2 substrate using a stamping process. An insulating layer of ZrO_2 was then added, followed by nickel electrodes. The quality of the interfaces between the nanoribbon and the dielectric layers above and below, and hence device performance, was improved by thermally oxidizing the InAs to produce a 1-nm layer of $InAsO_x$.

The team made transistors in which the nanoribbons were as thin as 8 nm, and explored how the performance varied with the thickness. And by using a two-step process to transfer an array of 18-nm-thick nanoribbons, and then place an array of 48-nm-thick nanoribbons at right angles to the first array, Javey and co-workers demonstrated the potential of their approach to make a variety of semiconductor devices.

CONTROLLED RELEASE

Tuning up silver

ACS Nano doi:10.1021/nn102272n (2010)

Silver nanoparticles have antimicrobial properties and their biological activity has been attributed to the release of silver ions and/or oxidative reactions on the particle surface. There is, therefore, a significant interest in optimizing their formulation for performance and safety. Now, in a systematic study, Robert Hurt and colleagues at Brown University show that the biological activity of silver nanoparticles can be tuned by controlling the release of soluble silver ions from their surface using different chemical approaches.

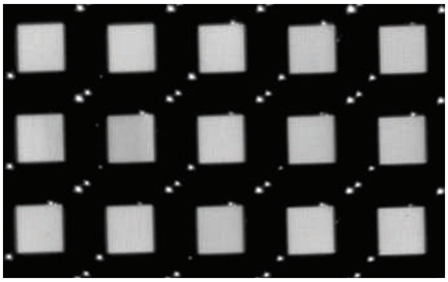
Hurt and colleagues examined whether ion release can be controlled by manipulating the particle size or surface, the availability of oxidants, and the composition of the surrounding media. It was found that release of ions can be slowed down by binding ligands (such as thiols and citrate) or creating a sulphidic coating on the surface to prevent the access of oxygen, or by scavenging reactive oxygen intermediates from the surrounding medium using enzymes. Preoxidizing the nanoparticles with dry ozone or reducing the size of the particles can enhance the release of ions. The different formulations tested on a bacterial inhibition assay confirmed that the biological activity of silver nanoparticles can be fine-tuned according to the desired application.

This controlled-release approach offers a way to manage the dose for optimum bactericidal effects or release profile in biomedical applications, to limit toxicity, and to control the lifetime of products containing silver nanoparticles.

NANOPARTICLES

Grown in position

Proc. Natl Acad. Sci. USA
doi:10.1073/pnas.1014892107 (2010)



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The properties of metal nanoparticles are often sensitive to minute changes in the size of the particles, and these effects can be exploited to create catalysts and nanoscale devices. However, synthesizing nanoparticles with precise dimensions is challenging and, furthermore, such applications often require the individual species to be carefully positioned on a substrate. Chad Mirkin and colleagues at Northwestern University have now reported an approach that can control both the growth and position of single metal nanoparticles.

The technique uses dip-pen nanolithography (DPN) or polymer pen lithography (PPL) — two scanning-probe-based methods previously developed by Mirkin and co-workers — to transfer small volumes of phase-separating block copolymer ink to a substrate. The block copolymer is mixed with metal ions and acts as a synthetic nanoreactor for the formation of the nanoparticles. Once the hybrid ink has been patterned on the substrate, plasma treatment is used to reduce the metal ions and to remove the polymer, leaving behind single-crystal nanoparticles at each ink feature. The size of the nanoparticles can be controlled by adjusting the dwell time of the scanning probes, which alters the amount of block copolymer deposited, and gold and platinum nanoparticles were synthesized with diameters as small as 5 nm.

The Northwestern team illustrate the capabilities of the technique by fabricating their university's wildcat logo out of sub-10-nm gold nanoparticles and by generating an array of approximately 25 million features in less than five minutes.

MOLECULAR DETECTION

Dark and hot

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Detecting single molecules is a critical tool for molecular biology and materials science. It is usually accomplished by coaxing the molecule to emit light. However, many important molecules (including DNA) are not efficient emitters. An alternative approach, called photothermal imaging, involves heating the molecule with a pump beam and observing the effects of this heat on a probe beam. Michel Orrit and colleagues at Leiden University have now shown that this technique can detect a single molecule at room temperature.

The researchers chose to image a molecule specifically designed to quench emission and this molecule was immersed in glycerol, a poor conductor of heat whose refractive index changes strongly as its temperature changes. A pump beam heated the molecule, causing a refractive index change in the surrounding glycerol, creating in turn an effective scatterer of an intense probe beam to which the molecules themselves were transparent. The technique's high signal-to-noise ratio and single-molecule discrimination was made possible by the use of glycerol, as well as by a synchronous detection scheme that modulated the pump beam at a high frequency to eliminate background noise.