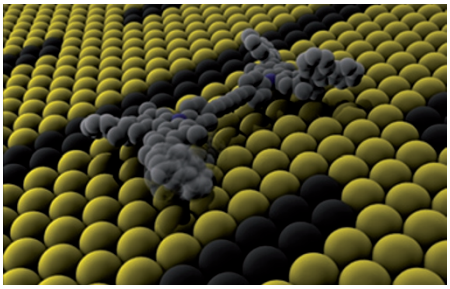
MOLECULAR MOTORS

Test driving the latest model

Nature **479,** 208–211 (2011)



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It is relatively easy to make a molecule rotate on a surface with the help of thermal energy. Controlling the direction of rotation is more difficult, but has been achieved with rotary motors powered by light, chemical and electrical energy. Similar challenges are encountered when trying to control the translational motion of a molecule over a surface, though previous systems have been limited to those that diffused along the surface or were dragged by the tip of a scanning tunnelling microscope (STM). Syuzanna Harutyunyan, Karl-Heinz Ernst, Ben Feringa and colleagues have now shown that a molecule containing four rotary motors can be driven over a metal surface using electrons.

The researchers — who are based at the University of Groningen, the Swiss Federal Laboratories for Materials Science and Technology, and the University of Zurich — built a car-like molecule by attaching four unidirectional rotary units to a central axis. The molecules were deposited on a copper surface at 7 K and electrons supplied from the tip of an STM. The electrons induce conformational changes in the rotors and a paddlewheel-like motion that pushes the molecule forward.

The four-wheeled molecule can move 6 nm across the surface with ten doses of electrons and, by altering the direction of the rotary motion of individual motor units, can be made to follow linear or random trajectories. *OV*

METAL NANOPARTICLES

Already in the background

ACS Nano http://dx.doi.org/10.1021/nn2031319 (2011)

Silver nanoparticles are used as an antimicrobial agent in various consumer goods but it is unclear whether these nanoparticles are released and if they cause hazards specific to their nanoscale form. This is partly because detecting nanomaterials in the environment and monitoring their transformations due to weathering is difficult. Researchers at the University of Oregon and Dune Sciences have now shown that under ambient conditions new metal nanoparticles can spontaneously form close to parent nanoparticles.

James Hutchison and colleagues immobilized silver nanoparticles with diameters of 75 nm on positively charged transmission electron microscopy (TEM) grids and exposed the samples to light and different levels of humidity. Samples that were exposed to relative humidities greater than 50% showed that new silver nanoparticles formed around the parent nanoparticles. More new nanoparticles were observed when samples were stored for longer times at 100% relative humidity, suggesting that humidity can influence their formation. Potential effects of the electron beam from the TEM and the effects of the charged surface were ruled out by control experiments. The researchers propose that the new nanoparticles are formed in three stages: oxidation of silver nanoparticles into silver ions, diffusion of ions in the absorbed water layer, and finally reduction of the ions into new silver nanoparticles.

Hutchison and colleagues also found that new nanoparticles could be formed from macroscopic objects including a sterling silver earring and a silver cutlery set, as well as from copper objects. The results suggest that metal nanoparticles may have been present in our environment for many years. *ALC*

SILICON NANOCRYSTALS

More is better

Nano Lett. http://dx.doi.org/10.1021/nl203275n (2011)

The poor optical properties of silicon have restricted its use in photonics applications. However, computer simulations by Holger Vach of the Ecole Polytechnique now suggest a surprising way to improve the optical properties of hydrogenated silicon nanocrystals — add more silicon!

Vach first computed the properties of nanocrystals that contain three parallel hexagons of silicon atoms, with hydrogen atoms bonded to the silicon atoms in the top and bottom hexagons. These $Si_{18}H_{12}$ nanocrystals absorb light in the ultraviolet region of the spectrum but not at any other wavelengths. Vach then computed what would happen if an extra silicon atom was inserted into the middle of these nanostructures. He found that the resulting $Si_{19}H_{12}$ nanocrystals also absorbed light at certain visible and infrared wavelengths. Furthermore, he found that the $Si_{19}H_{12}$ nanocrystals should be more stable than any other known silicon nanocrystals.

Vach attributes the increased stability and improved optical properties of the $Si_{19}H_{12}$ nanocrystals to the increased electron delocalization caused by the addition of the extra silicon atom. This delocalization means that the silicon hexagons resemble benzene rings in many ways. Moreover, the stability of the nanocrystals, together with their compatibility with the existing infrastructure for making silicon chips, could lead to a variety of applications. *PR*

PHOTOVOLTAICS

Performance on order

Appl. Phys. Lett. **99,** 163301 (2011)

An intimate and random mixture of two organic semiconductors is used in many of the best-performing organic solar cells. These bulk heterojunction devices benefit from a large active surface area and are easy to make. However, the disordered nature of the mixture makes it difficult to extract charges, which hinders power-conversion efficiencies. Now Charles Black and colleagues at Brookhaven National Laboratory and State University of New York, Stony Brook, have improved charge extraction from a bulk heterojunction device by reducing disorder.

The researchers mixed the hole-conducting polymer P3HT and the electron-conducting polymer PCBM into a templated array of vertically aligned cylindrical pores, each with a diameter of approximately 75 nm. Previous work had demonstrated that P3HT was a better hole-conductor when confined to nanoscale volumes because individual polymer chains were better aligned. Black and colleagues confirmed that their confined P3HT had improved alignment, and measured hole mobilities ~500 times larger than in unconfined blends. As a result, they found that, relative to an untemplated device of the same thickness, their device absorbed only 38% of the light, but produced 80% of the photocurrent. Normalized to volume, the photocurrent density was double that of the untemplated device.

Further performance improvements may result from increasing the electron mobility of PCBM, and increasing the areal fraction accounted for by the cylinders. *MS*

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