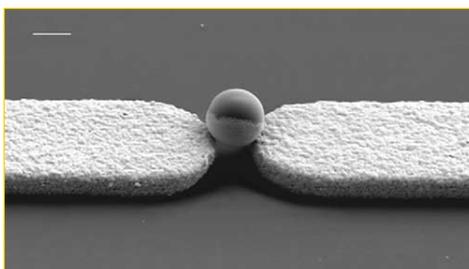


Magnetic assembly of molecular junctions

ELECTRONIC MATERIALS



Au/Ni-coated microsphere bridging molecular monolayer-coated electrodes. (© 2005 American Institute of Physics.)

Researchers at the US Naval Research Laboratory (NRL) and the University of California, Santa Barbara have formed molecular electronic junctions a few nanometers thick quickly, accurately, and in high yield through the simple, magnetically directed assembly of metallized silica microspheres [Long *et al.*, *Appl. Phys. Lett.* (2005) 86 (15), 153105].

A lithographically defined array of magnetic $\text{Ni}_{80}\text{Fe}_{20}$ electrodes is functionalized with self-assembled monolayers of molecular wire candidates: undecanethiol (C11), oligo(phenylene ethynylene) (OPE), or oligo(phenylene vinylene) (OPV). Magnetic microspheres are directed to

assemble from solution into the gaps between the electrodes, bridging the gap and forming two molecular junctions in series. The spheres are prepared via two-step evaporation of a 50 nm ferromagnetic Ni layer (for magnetically manipulating the spheres) then a 10 nm layer of conductive Au (oxide-free, for connecting organic molecules) onto a close-packed monolayer of 1.5 μm wide silica microspheres. The spheres are dispersed in ethanol before their directed assembly into the array.

Junctions incorporating OPV conduct about four times as much current as OPE. Both conduct nearly two orders of magnitude more than the insulating alkanethiol. "Magnetic entrapment can be considered a 'soft' self-assembly technique that will not chemically damage or alter the active molecules trapped in fabricated devices," says David P. Long (now at Geo-Centers). The ability to rapidly form thousands of junctions simultaneously should allow the screening of large libraries of candidate molecules, says NRL's James G. Kushmerick. The technique could also enable fabrication of hybrid molecular/CMOS electronic devices.

Mark Telford

A new spin on nanofibers

NANOTECHNOLOGY

The assembly of one-dimensional nanostructures into well-aligned and highly ordered arrays is a key step for practical applications. Electrospinning is a simple, generic method that uses a strong electric field to draw a solution into long, uniform fibers. But the conventional setup can only collect randomly oriented nanofibers as nonwoven mats.

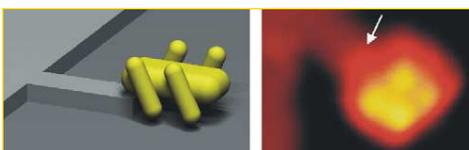
As-spun fibers are highly charged before they contact the collector. Their trajectory is determined by the electrostatic interactions between the fibers and the collector. Fibers tend to align so that the net torque of electrostatic forces is minimized. Work at the University of Washington has shown that electrospun poly(vinyl pyrrolidone) nanofibers can be aligned uniaxially into ordered arrays by tailoring the shape and feature size of the insulating region of a patterned conductive collector electrode. This manipulates electrostatic interactions with the as-spun fibers and controls the deposited fiber orientation [Li *et al.*, *Nano Lett.* (2005), doi: 10.1021/nl0504235].

Varying the design of the collector's electrode pattern can be a simple and convenient way to control the orientation of collected nanofibers, says principal investigator Younan Xia. This enables directed assembly of nanofibers into well-controlled architectures and makes it possible to produce nanofiber-based devices efficiently and economically. Recent advances in electrospinning have made this technique well-suited to producing nanofibers made of carbon, ceramics, conducting polymers, and composites with either solid or hollow (core/sheath) structures. The researchers believe that very complex nanoscale devices and systems could be produced.

Mark Telford

Controlling molecule-contact interactions

ELECTRONIC MATERIALS



(Left) A molecule's end group and nanopad make electronic contact, arrowed in an STM image (right). (© 2005 American Chemical Society.)

A group at Freie Universität Berlin, Germany and CEMES-CNRS in Toulouse, France has used low-temperature scanning tunneling microscopy (STM) to vary the vertical separation between a molecular wire and an atomic-scale metallic contacting electrode (nanopad) and quantitatively control their electronic interaction [Grill *et al.*, *Nano Lett.* (2005), doi: 10.1021/nl050197z].

The researchers used a reactive Lander (RL) molecule, which consists of a conductive board with four lateral spacer legs. These legs electronically decouple the wire from the metallic substrate and control the vertical spacing.

At monatomic step edges on Cu(110), the RL's particle adsorption behavior, aided by annealing at 370 K, forms a Cu nanopad, two atoms wide by seven atoms long, underneath the RL molecule and projecting from the step edge.

Lateral manipulation of the RL molecule with the STM tip yields several stable conformations with respect to the nanopad. In 'contact conformation', the molecule reaches the lower terrace of the step and its end group is in electronic contact with the end of the nanopad. Three further conformations differ not only in lateral position but also in vertical separation with respect to the nanopad. As height is increased, electronic contact decreases. The next stage is to quantify the current through the wire, from the nanopad electrode to the STM tip, as a function of vertical wire-electrode distance. Such characterization is of interest for molecular electronics, where the quality of a network of molecular devices is determined by the contacts.

Mark Telford