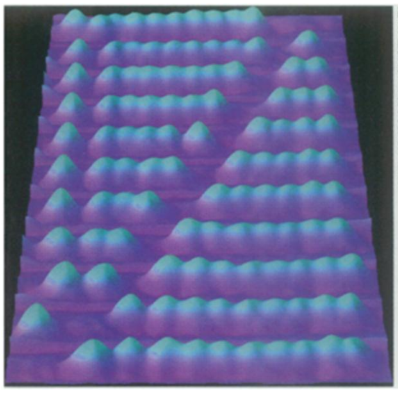
Molecular abacus counts on buckyballs

One of the world's oldest counting machines is now also one of the newest. Scientists at the IBM Zurich Research Laboratory have constructed a tiny abacus that substitutes carbon-60 buckyballs for the traditional beads. This nanoscale abacus is the first room-temperature device that can store and manipulate numbers at the molecular level.

The buckyballs rest in orderly rows along shallow steps cut into a piece of copper. The tip of a scanning tunneling microscope (STM) pushes the molecules along the steps, just as a person's finger would slide the beads of an abacus back and forth on a wire. Some of the underlying copper atoms move too, forming tiny "kinks" that fix the buckyballs in their new positions. The scientists report their achievement in the Nov. 11 APPLIED PHYSICS LETTERS.


IBM Zurich Research Lab.

Micrograph of a buckyball abacus.

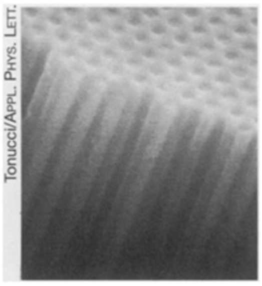
The inspiration to make a nanoscale abacus came not only from previous work that moved single atoms with an STM, but also from a trip to Japan, says project leader James K. Gimzewski. "I saw that in the Tokyo railway station, many of the ticket sellers actually use abacuses." From that observation, Gimzewski and his group decided to "start from the bottom up and make a working demo of an abacus, using single molecules."

Right now, only one buckyball can be moved at a time, a process Gimzewski describes as "moving grains of sand with Mount Fuji." Faster STM tips and designs with many probes working in parallel could improve the speed of the device.

Glass molds a forest of whiskery wires

Researchers have developed a quick way to make billions of wires only 50 nanometers in diameter. They fill the narrow capillaries of a porous glass with a semiconductor.

The most common way to make nanowires now, says Ronald J. Tonucci of the Naval Research Laboratory in Washington, D.C., is with molecular beam epitaxy, in which a very pure semiconductor is deposited in a slow, controlled fashion. The method that he and his colleagues report in the Nov. 4 APPLIED PHYSICS LETTERS makes use of glass that contains an array of thin, parallel pores arranged in a honeycomb pattern. This nanochannel glass system is "dirtier, but it's a cheap and inexpensive way to make a lot of parallel wires very fast."


Tonucci/APPL. PHYS. LETT.

Semiconductor wires with 50-nanometer diameters.

To make gallium arsenide semiconductor wires, the researchers fill the glass capillaries with a liquid gallium compound. They add an arsenide compound and heat the product to form the solid wires. A final heating step increases the size of crystal grains in the wires and reduces their number, thus optimizing the wires' properties. The glass can then be etched away to yield freestanding wires.