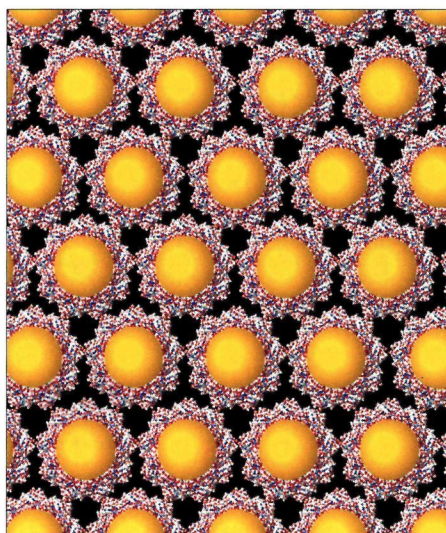


Bioengineered nanomachines

Nano-circuit fabrication using a living bacterium? Science fiction seems to have met with reality with the news that researchers at the NASA Ames Research Center, the SETI Institute and the Argonne National Laboratory have demonstrated the assembly of a new generation of tiny machines for electronic and photonic devices built on biological systems.

Bioengineered nanoscale arrays are stacked using genetically engineered proteins as templates to create honeycomb-like patterns of gold and a semiconducting material. First, a protein is isolated from *Sulfolobus shibatae*, a robust bacterium that lives in geothermal hot-springs and can tolerate near-boiling temperatures and high acidities. It is then genetically modified to create a chemically active site on its edge, and cloned into a routinely used form of *Escherichia coli* bacteria. Heating the resulting mix destroys the *E. Coli* proteins, permitting the isolation of large amounts of the heat-tolerant *Sulfolobus* protein.



Genetically engineered proteins form a template that creates an array of gold or semiconductor which is one-fifth the size of those produced by lithographic techniques. (NASA/ANL.)

The protein forms chaperonins or natural ring structures only 10–20 nm across. These are then applied to substrates such as silicon wafers, where they self-assemble into large, hexagonal, periodic patterns. When nanoparticles of gold or cadmium selenide-zinc sulphide, a semiconducting material, are added they adhere only to active sites around the hole in each protein ring.

The regular arrays of nanoparticles that result are very similar to the patterns used in the microelectronics industry, with the added advantage that they are much smaller. Arrays of nanoparticles like these could be used to make more compact computer memories, sensors or logic devices.

Further reading

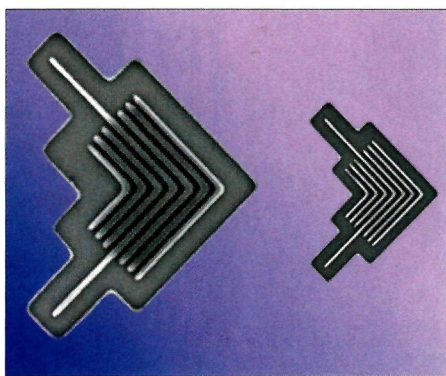
http://amesnews.arc.nasa.gov/releases/2002/02_122AR.html.

<http://www.anl.gov/OPA/news03/news030214.htm>.

Extreme ultraviolet lithography paves the way for crowded circuits

A couple of decades ago, the electronic equivalent of today's handheld computers was a room full of hardware and a truck-load of cables and cards. Since then computers and electronics have become much more compact, due mainly to advances in lithography. Creating circuits of smaller and smaller features uses shorter and shorter wavelengths of light. Limits imposed by current refractive optical systems use light in the deep ultraviolet range, and can print features with a resolution of around 100 nm at wavelengths of about 248 nm. Creating smaller features requires the extreme ultraviolet range, and this implies working with shorter wavelengths to create the templates used to engrave fine features on silicon or metal surfaces.

In moving from sub-micron to nanotechnologies, extreme ultraviolet projection lithography is now the leading contender. Researchers at the Advanced Light Source synchrotron radiation facility at the Lawrence Berkeley National Laboratory are testing this



Extreme ultraviolet lithography can easily create 70 nm features (left) but can also allow printing of 39 nm features (right). (LBNL.)

lithography and have produced 50 nm lines with 50 nm spacing, and isolated lines that are only 39 nm wide.

Further reading

Naulleau et al. 2002 *Journal of Vacuum Science Technology B* 20(6) 2829.

Superconductivity found in plutonium

Researchers from the Los Alamos National Laboratory and the University of Florida, US, and the Institute for Transuranium Elements, Germany, have observed superconductivity in a plutonium-based material for the first time. They discovered that an alloy of plutonium, cobalt and gallium exhibits superconductivity at temperatures below 18.5 K. Although well below the temperatures at which the high-T_c copper oxide-based materials become superconducting, 18.5 K is nonetheless an unusually high transition temperature. This has led the researchers to suggest that the plutonium compound is a new kind of superconductor, and could provide a bridge between high-T_c materials and the known heavy fermion superconductors based on uranium and cerium, which have transition temperatures of around 1 K.

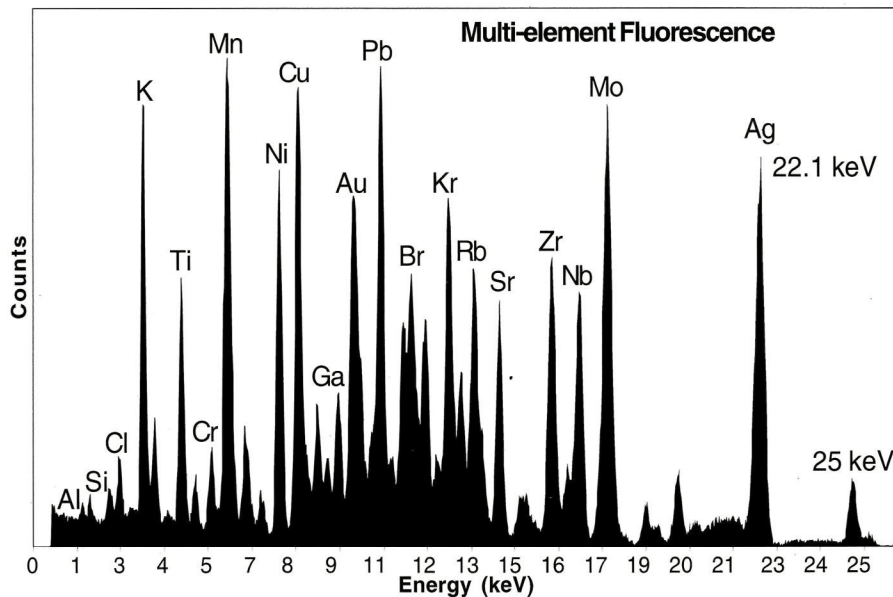
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Further reading

J L Sarrao et al. 2002 *Nature* 420 297.

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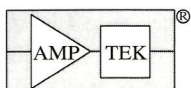
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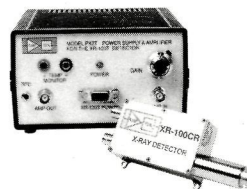
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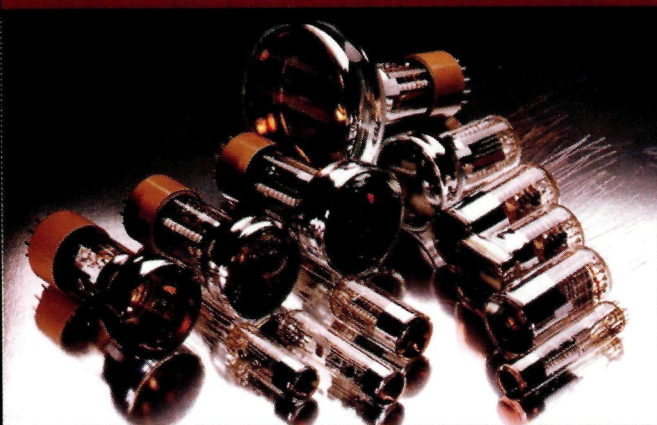


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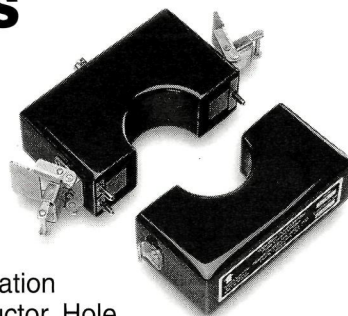
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