

AT THE FOREFRONT OF NANOTECHNOLOGY RESEARCH

Nanotechnology deals with materials that are the size of individual molecules and atoms, and its applications in electronics, medicine, and a range of other fields are considered highly promising. Japanese researchers have made a number of key breakthroughs, and two recent achievements are summarized below.

World's Smallest Letters

A research team led by Yoshiaki Sugimoto of Osaka University has developed an atom-embedding technology that enabled them to write the world's smallest letters. This work is promising for the possibilities it holds in new semiconductor development.

Semiconductors are made by adding minute amounts of a dopant, such as antimony, to highly pure crystals of silicon or germanium. In this experiment, the mixing of minute amounts of an element into a different material was done at the level of individual atoms.

The probe of an atomic force microscope was brought near the tin surface, and tin atoms were replaced one at a time with silicon atoms on the probe tip. In this way the group "wrote" the letters "Si" with 12 silicon atoms on the surface. The size of the letters together was about 4 nanometers in height and width, making them the smallest letters in the world.

Earlier attempts at making letters by aligning electrons were made under extremely low temperatures. The present study was the first time this had been achieved at room temperature.

In addition to the development of semiconductors, this atom substitution technology may also contribute to the development of quantum computers.

Carbon Nanotube Paper

One focus of nanotechnology research is the use of carbon atoms in the form of either hollow spheres (fullerenes) or cylindrical tubes (nanotubes). The latter was discovered in 1991 by Sumio Iijima, who is now director of the Nanotube Research Center, National Institute of Advanced Industrial Science and Technology. Japan has thus been at the forefront of research in this field.

Both fullerenes and nanotubes are already being applied in a number of products. In March 2009, Tokushu Paper Manufacturing, a maker and seller of specialized paper, succeeded in developing the world's first paper made using carbon nanotubes. Commercialization is scheduled for 2010.

Carbon nanotubes have a number of properties that make them promising as a material for the future, such as strength several hundred times higher than that of iron

and high electrical conductivity. By themselves, carbon nanotubes have a cotton-like shape, so that they must be added to a base material for practical use. Paper is one such candidate material, but when CNTs are immersed in water it forms clumps. Since water is used to make paper, embedding CNTs has been quite difficult.

The major feature of the newly developed CNT paper is its high electrical conductivity. Special paper with CNT content of 3% by weight exhibits conductivity 10 trillion times greater than that of paper without CNTs.

Substances with high conductivity have the feature of absorbing electromagnetic waves, and Tokushu Paper is looking to take advantage of this property by using CNT special paper as an electromagnetic shielding material.



A frog-shaped lamp lights up when placed on electricity-conducting CNT paper.

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