Golden Nano-Dumbbells

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Nanotechnology appears to be an unstoppable trend and it requires defined nanoscale building blocks and patterns. “A typical difficulty with the synthesis of nanostructures is the modification of nanoscale objects at specific positions” says Alexander Bittner, whose work with a team from the Max Planck Institute for Solid-State Research in Stuttgart and Christina Wege's research team at the University of Stuttgart has led to an important breakthrough.

As reported in the journal *Angewandte Chemie*, the scientists were successful in selectively modifying the ends of nanoscale rods by selectively binding gold nanoparticles to the ends of tubular viruses. By using an electroless gold-plating technique, the gold ends can be enlarged to form dumbbell-shaped structures.

Their highly symmetrical structures and uniform size distribution make biological molecules like DNA and whole “almost organisms” like viruses ideal “molds” for the exact positioning of nano-objects and the synthesis of structured nanomaterials. In their experiments, the Stuttgart scientists chose to use the tobacco mosaic virus, a harmless plant virus shaped like a 300-nm long tube. The researchers mixed a suspension of these viruses with a liquid that contained very finely dispersed gold particles, called a gold sol. The gold particles in the sol carry citrate molecules on their surface.

Examination with an electron microscope revealed something interesting: Individual gold particles bind to the viruses, but only at the ends. The reason for this lies in the RNA, the genetic material of the

virus. Wege stated that “in the tobacco mosaic virus, the RNA is usually embedded deep in the protein shell, but not at the ends of the virus tubes”. In fact, it has been demonstrated that gold particles from the gold sol bind to free RNA in a similar way. Bittner and his colleagues postulate that the aromatic bases of the RNA are used to bind and displace citrate molecules from the gold surface.

The researchers then place the virus–gold structures on a support and dip them into a gold bath (an electroless gold-plating technique). Additional gold is thus deposited onto the gold nanoparticles that are already bound to the ends of the rods, resulting in dumbbell-shaped structures. Bittner and Wege envision a large number of different applications for these nanodumbbells; for instance, they could be used as junctions for nanoscale electrical wiring.

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