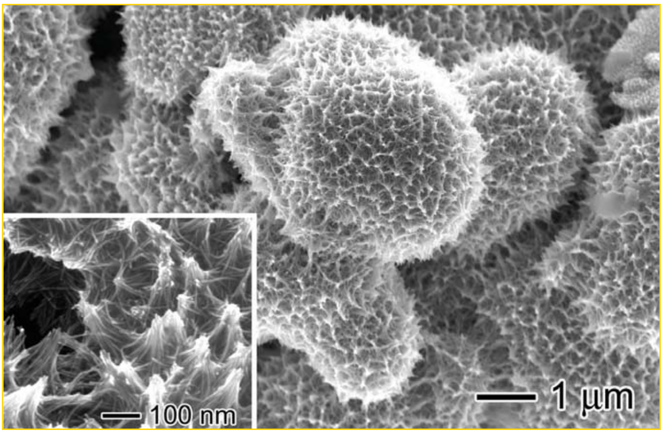
Reaction slowdown produces nanowires

NANOTECHNOLOGY



Scanning electron micrograph of Pt agglomerates showing nanowires on the surface. (Courtesy of Younan Xia, University of Washington.)

Researchers from the University of Washington have demonstrated a purely chemical route for the fabrication of Pt nanowires [Chen *et al.*, *J. Am. Chem. Soc.* (2004) 126, 10854].

Pt is widely used as a catalyst for the industrial synthesis of nitric acid, to reduce vehicle emissions, and in proton membrane exchange fuel cells. There are, therefore, many chemical routes for the synthesis of Pt nanoparticles. However, fabrication of Pt nanowires and rods requires the use of a template, such as a porous material or a surfactant. The resulting nanowires are also typically polycrystalline, i.e. aggregates of nanoparticles.

Younan Xia and coworkers, however, have successfully harnessed the polyol process to produce large quantities of Pt nanowires without the use of any kind of template. "To our knowledge, no template-free method has ever been reported for the synthesis of one-dimensional Pt nanostructures," says Xia. The process uses ethylene glycol (EG) as both a reducing agent and a solvent. First, Pt(II) is produced when H_2PtCl_6 or K_2PtCl_6 is reduced by EG at 110°C in the presence of poly(vinyl pyrrolidone) (PVP). Continuing the reaction in air produces Pt nanoparticles ~5 nm in diameter. "The key strategy is the introduction of a trace amount of Fe^{2+} (or Fe^{3+}) species to reduce the level of supersaturation kinetically and thus the growth rate by slowing down the reduction reaction," explains Xia. The Pt nanoparticles tend to agglomerate into spheres and larger structures. By the end of the reaction, the Pt(II) is reducing at such a slow rate that Pt atoms begin to nucleate and grow into nanowires rather than nanoparticles. The nanowires grow on the surface of the agglomerates of Pt nanoparticles, taking up a structure that resembles the spines of a sea urchin. The nanowires are only loosely attached to the surface of the agglomerates and can be easily removed by sonication. Subsequent centrifugation recovers the Pt nanowires, which can then be redispersed in water or ethanol.

The results could be important for the design and synthesis of other metal nanostructures. "This method is remarkable for its simplicity and for its superior control over the morphology of Pt nanostructures," says Xia. "By adjusting the experimental conditions and thus the reaction rates, we have recently found that other morphologies can also be generated," he told *Materials Today*. He also believes that scale up for mass manufacture should be easy as the process is conducted under ambient conditions and requires no templates.

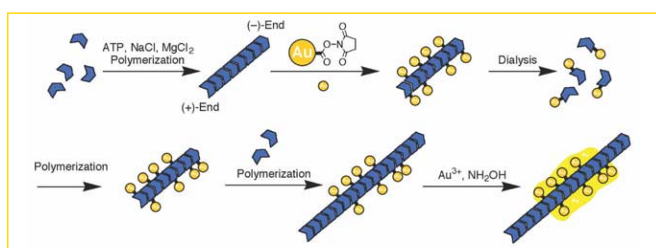
Cordelia Sealy

Nanowires act as biotransporters

NANOTECHNOLOGY

Researchers from the Hebrew University of Jerusalem have designed and fabricated patterned actin-based Au nanowires [Patolsky *et al.*, *Nat. Mater.* (2004) doi: 10.1038/nmat1205]. Not only are the nanowires highly conductive, they can also function as nanotransporters.

Actin is a protein monomer found in muscle that, together with myosin, is active in muscle contraction. Itamar Willner and his colleagues use G-actin labeled with 1.2 nm Au nanoparticles as building blocks to create nanowires 1-3 µm long, 80 nm wide, and 110 nm high. The process consists of two stages, polymerization of the Au-labeled G-actin units followed by chemical enlargement of the particles, which act as seeds for the nanowires. By varying the step sequence, nano-patterning of the wires can be tailored. For example, if the polymerization of the Au-nanoparticle-labeled G-actin units is followed by the attachment of free G-actin, patterned actin-Au wire-actin structures are produced. Alternatively, if the polymerization of nonlabeled G-actin is followed by the polymerization of Au-labeled G-actin at the ends of the actin filament, an Au wire-actin-Au wire structures are created.



Scheme for the synthesis of nanowires. (© 2004 Nature Publishing Group.)

Both types of nanowire show metallic-type conductivity, while the actin-Au wire-actin structure can also act as a nanotransporter. "Actin binds to the myosin to form a motor protein complex. The addition of ATP fuel results in the activation of the motor function," explains Willmar. The results demonstrate the possibility of self-assembling predesigned conductive circuits by patterning with myosin and powering the organization with ATP. "Another possible use of the nano-motor is the transport and delivery of chemical components," says Willmar.

Cordelia Sealy