Developing methods for building precise nanostructures

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Researchers at Case Western Reserve University have received a $540,000 federal grant to devise methods for building minute structures tailored to precisely deliver medicines to tumors or carry dyes that help imaging technologies detect disease, create more efficient nanowires and nanoelectonics, and more.

Building precisely defined structures on the nanoscale has proven a challenge for chemists. To provide control and precision, the researchers propose to build complex polymer nanostructures on scaffolds made of plant viruses, tiny organisms that infect plant cells but are benign outside the plant.

Jon Pokorski, assistant professor of macromolecular science and engineering, and Nicole Steinmetz, assistant professor of biomedical engineering, will use the three-year grant from the National Science Foundation's Macromolecular, Supramolecular and Nanochemistry Program to test three methods of synthesizing rod-shaped nanostructures.

Typically, scientists build nanopolymers from small polymer chains that self-assemble and are used to make films, supercrystals and drug delivery devices. But there are always imperfections in the assembly.

"By using a template—the virus—we can produce an evenly dispersed polymer coating that yields more consistent and efficient properties," Pokorski said. "And this is very modular; it can be applied to lots of uses."

By controlling the size and surface features, they hope to reduce or eliminate the toxic side effects that can be caused by those two properties during drug delivery, he said.

Steinmetz, an appointee of the Case Western Reserve School of Medicine, will build the templates using tobacco mosaic virus. Instead of making spheres, the goal is to make materials that are considerably longer than they are wide, called "high-aspect" materials.

"The physical property makes them more useful for nanowires and electronics and applications in the body," she said.

The tobacco virus particles are about 300 nanometers by 18 nanometers, but Steinmetz will control sizes using genetic engineering, "which gives us more control than we could have using purely chemical production methods," she said.

Pokorski will add polymers. The rod shape allows a polymer with one function—such as carrying medicine—to be tied to one end, and another with a different function—such as carrying an imaging dye—to the other.

"Or," he explained, "we can grow one polymer on the exterior and a different polymer on the interior because the plant virus is a hollow tube."

In addition to using nanoparticles as vehicles to carry medicines to specific targets, they could be used as electrical connectors, replacing carbon nanotubes used to link nanoelectronics.

Provided by Case Western Reserve University