Gold, DNA Combination May Lead To Nano-Sensor

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The ability to use genetic material to assemble nanoscopic particles of gold could be an important step toward creating tiny “spies” that will be able to infiltrate individual cells and report back in real time on the cell’s inner workings.

A team of Duke University materials engineers and chemists has developed tiny gold nanostructures that can create signals from subtle changes in light reflecting off their nanoscale surfaces. The sub-cellular size of the nanostructures and their ability to absorb or scatter light as their structure changes makes them appealing as biological sensors, the researchers said.

By measuring color changes, researchers can tell what is happening at the molecular level, said lead researcher Anne Lazarides, assistant professor of mechanical engineering and materials science at Duke’s Pratt School of Engineering. But while these light-reporting particles are relatively easy to see, it is a challenge to get things that small organized.

“When dealing in such small realms, it is important that any nanostructure be able to assemble itself in a reliable and predictable fashion,” she said. “We engineered a structure whose organization and response to light are both reproducible and well-controlled.”

The results of Lazarides’ experiments were published online in *Nano Letters*, a journal published by the American Chemical Society. The research was supported by the National Science Foundation and the

Army Research Office.

The current line of research represents another step in plasmonics research, a field in which researchers use light to control the high frequency motions of electrons in materials. Because of the strength of interactions between light and electrons, the response of metallic particles or combinations of particles to light of particular colors is easy for the human eye to detect, researchers said.

Because they are just a few thousandths the size of a living cell, nanoparticles are small enough to pass through cell membranes, another reason they are an attractive potential biomedical sensor.

The Duke construct is known as a “core-satellite” structure, resembling a planet with numerous smaller moons tethered to it by tiny strands of DNA. Gold core particles and smaller satellite particles are mixed together in solution with strands of DNA and under controlled circumstances assemble themselves into the desired core-satellite structure.

Following assembly, the structures are ready to be used to detect new strands of DNA, Lazarides explained. If presented with the right DNA molecules, the DNA tethers between the planet and its moons contract or expand. As the satellites move in relation to the core, the optical properties of the structure change.

“In order for a nanostructure to work within a living system, it needs to include a biological component, like DNA, that recognizes other molecules,” Lazarides said. “DNA is both the glue that holds all the particles together and also the material to which specific target molecules bind.”

Theoretically, nanostructures that report on the presence of specific molecules could give scientists or medical researchers key information about processes within the cell, such as cell differentiation or the triggering of protein synthesis from RNA.

“We believe that our findings are important because they demonstrate that these nanoparticle-DNA structures can be engineered to assemble on their own in a controllable manner and that they can be used to measure biological processes in real time,” Lazarides said.

According to Lazarides, refinements of the methods will unfold rapidly because “within the team at Duke, we have the unique capability to both self-assemble many structures and monitor the behavior of individual ones.”

The researchers plan to continue testing different metals -- both in the pure form or in alloys -- to determine the composition of components that makes detection easiest to see.

Other members of the Duke research team were David Sebba, mechanical engineering and materials science; Jack Mock and David Smith, electrical and computer engineering; and Thomas LaBean, chemistry and computer science.

The journal article is available online at pubs.acs.org/cgi-bin/asap.cgi/ … /html/nl080029h.html

Source: Duke University