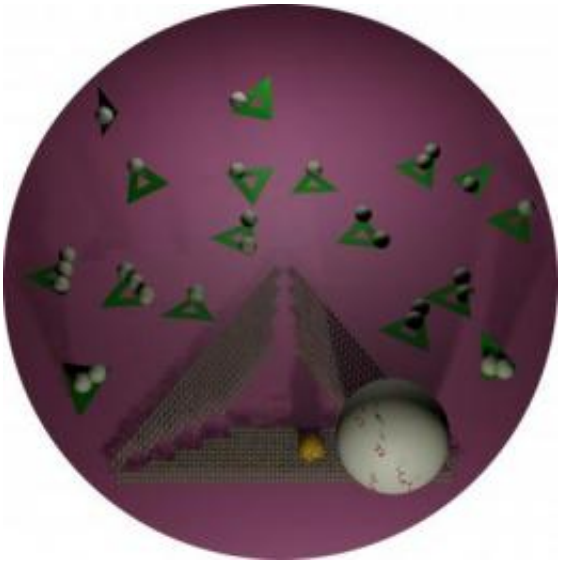
Silver proves its mettle for nanotech applications

March 19 2010, by Richard Harth



A long single-strand of DNA has been folded into a triangular building platform through a process known as DNA origami. This architectural foundation was then "decorated" with one, two or three silver nanoparticles, which self-assembled at pre-determined locations on the DNA nanostructure. Credit: Hao Yan, Yan Liu, Biodesign Institute at Arizona State University

The self-assembling properties of the DNA molecule have allowed for the construction of an intriguing range of nanoscale forms. Such nanoarchitectures may eventually find their way into a new generation of microelectronics, semiconductors, biological and chemical sensing devices and a host of biomedical applications. Now Hao Yan and Yan Liu, professors at the Biodesign Institute's Center for Single Molecule

Biophysics and their collaborators have introduced a new method to deterministically and precisely position silver nanoparticles onto self-assembling DNA scaffolds.

In their latest research, the group used a long single-strand of DNA, which had been folded into a triangular building platform through a process known as DNA origami. This architectural foundation was then 'decorated' with one, two or three silver nanoparticles, which self-assembled at pre-determined locations on the DNA nanostructure. The group's experimental results, which appear in the advanced online edition of the journal *Angewandte Chemie*, demonstrate for the first time the viability of using silver, rather than the gold nanoparticles traditionally applied to DNA-tile or origami based architectures. The study was co-authored by Suchetan Pal, Zhengtao Deng, Baoquan Ding.

One of many applications for DNA scaffolds studded with nanoparticles is to perform precise sensing operations at the molecular scale. Sensitive detection of single molecules with high specificity is of great scientific interest for chemists, biologists, pharmacologists, medical researchers and those involved in environmental areas where trace analysis is required. The detailed study of human genes is but one area where improved single-molecule detection could be of enormous benefit.

In their current effort, the group sought to exploit the properties of the silver nanoparticles to increase the surface plasmon resonance—a vibration of electrons that can give researchers clues regarding the molecular nature of the sample they are studying. "Theoretically, people predicted that a local surface plasmon resonance can be much stronger if you use silver particles compared to gold," said Yan. These locally enhanced areas between nanoparticles are referred to as electrical hot spots.

The group however, had to overcome significant obstacles to the use of

silver nanoparticles. Silver tends to be much less stable than gold and can easily oxidize in its normal state. To counter this tendency, Yan and Liu's team attached multiple sulfur atoms to the backbone of the DNA strand used to make the platform for the nanoparticles. Each silver nanoparticle is then firmly held in place by nine sulfur atoms, once it is mounted on the DNA origami shape.

The new study paves the way for creating a more functional DNA architecture. "I believe this work will open doors to implement and study distance-dependent plasmonic interaction between noble nanoparticles at the single particle level," Yan said, adding that the first critical steps to creating hierarchically organized silver nanoparticle structures have now been taken.

Provided by Arizona State University

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