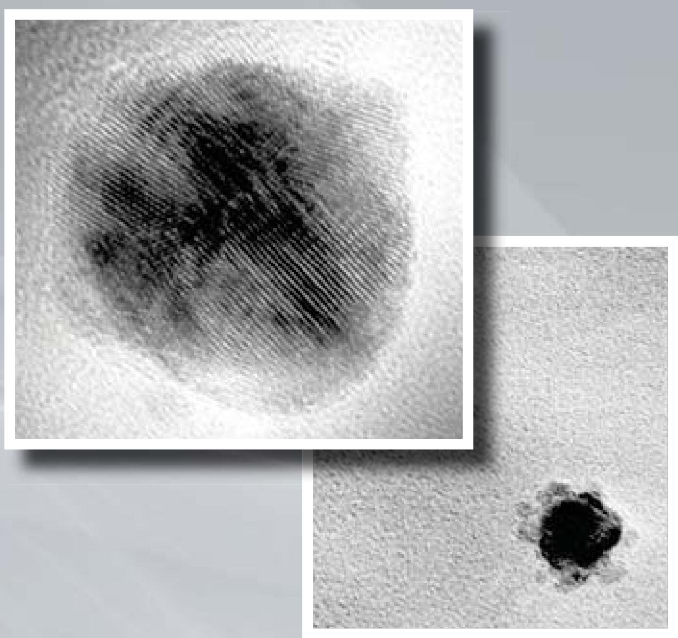
Nanoparticle Lubricant Produced by Biosynthesis

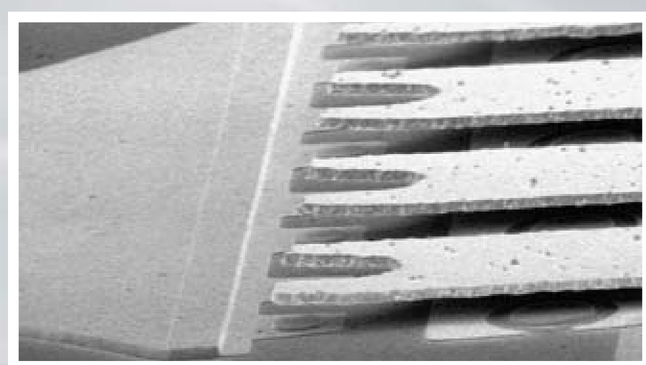
Accomplishment: Biological templates were successfully used to direct the synthesis and assembly of bimetallic nanoparticles. The performance of these nanoparticles was demonstrated as a conductive lubricant in micro-electro-mechanical systems (MEMS) electrical switches at high current with no failure through one million hot-switching cycles.



Impact: The present accomplishment demonstrates a simple, flexible real-time manufacturing capability that can produce a wide array of engineered nanoparticles in the field in response to locally identified specific threats. Potential applications include dechlorination of drinking water, decontamination of nerve agents and electrically conductive lubricants for micro-electro-mechanical systems (MEMS).

Motivation and Approach: Nanoparticle catalysts are currently used against a wide range of chemical agents, including dechlorination of drinking water, decontamination of nerve agents and environmental cleanup. However, these nano-particles must be tailored for a specific agent, and must currently be produced in a controlled manufacturing environment remote from the battlespace, dramatically increasing the response time and logistic requirements. The size, shape and composition of engineered nanoparticles must be carefully controlled during manufacture to give the needed optical, electronic, catalytic and mechanical properties. It has recently been shown that biological molecules, such as peptide chains containing up to 20 selected amino acid molecules, can be used to synthesize engineered nanoparticles. This approach uses simple and flexible chemistry techniques that can be easily applied in the field.

In the present accomplishment, two separate peptide chains were connected, forming a new biological template to synthesize hybrid nanoparticle structures. The first peptide chain directs the nucleation and growth of a metal nanoparticle from a liquid solution. When the nanoparticle grows to a specified size between 8 nm and 25 nm, the peptide chain coats the nanoparticle surface. A second type of metal ion was then dissolved in the solution, and the second peptide chain directs the growth of smaller nanoparticles (1-2 nm) that are attached to the larger nanoparticle through the peptide chain. These hybrid bimetallic nanoparticles have new or enhanced properties relative to single nanoparticles, and are highly desired for a number of applications. They were shown to be twice as efficient as traditional nanoparticle catalysts and use as a conductive lubricant for MEMS electrical switching devices was demonstrated in this work. Many other uses are envisioned, such as an enabling fuel cell technology.



Team: Dr. Rajesh Naik, Dr. Andrey Voevodin, Dr. Steve Patton and Dr. Joseph Slocik of the Materials and Manufacturing Directorate were responsible for the technical innovation leading to this accomplishment.