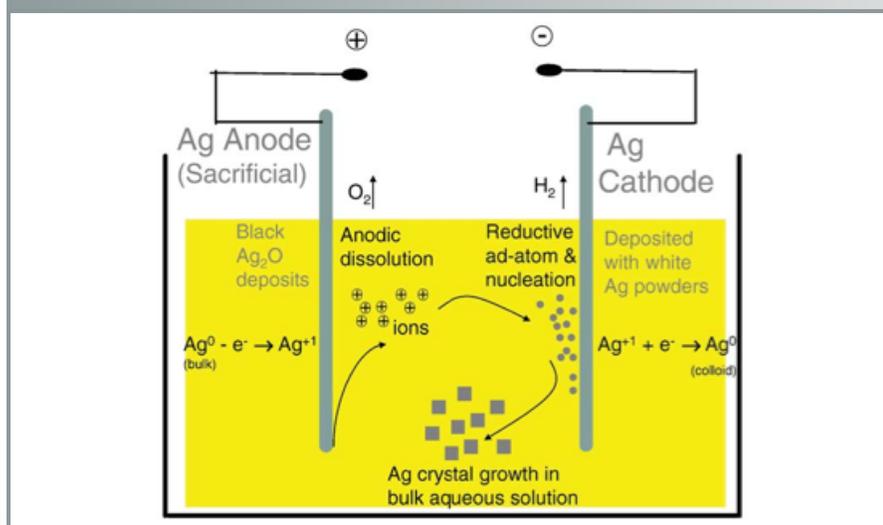


Synthesis Method for Stable Colloids of “Naked” Metal Nanocrystals

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Technology Summary

Researchers at ORNL have developed a unique membrane-assisted thermal electrochemical synthesis (TECS) process for making colloiddally stable aqueous solutions of small (<10 nm) metallic nanocrystals that are “clean,” stable, and uniform in size. The nanocrystals produced by the TECS process represent a unique class of colloids that could be used in a variety of applications, including coatings, catalysts, and sensor devices.

Metallic nanocrystals have generated considerable interest because of their unique optical and electrical properties, which differ considerably from those of bulk solids. Other methods for producing nanoparticle sols require organic stabilizers, surfactants, and/or dispersants, which can leave residues on/contaminate the nanoparticle surfaces rendering them useless for particular applications such as targeted therapies or sensors. Removal of these residues is difficult and typically causes flocculation.

The TECS process uses two silver electrodes in a solution of deionized water at moderate temperatures (10–100°C/50–212°F). Low voltage (1–50 V) electric current is applied for 20 minutes or longer, depending on the size of the reaction vessel and distance between the electrodes. The electrodes are surrounded by tubular dialysis membranes to enclose overgrown particles, allowing silver ions and small clusters to pass through, thus narrowing the size distribution of the resulting nanocrystals. (The size distribution can be further limited with a low power laser homogenization step, leading to a near-monodispersed system.) The silver nanoparticles can also be deposited on a substrate (e.g., a polymer, ceramic, or semiconductor) placed between the two electrodes.

ORNL research has concentrated on production of silver nanocrystals because of the exceptional medical applications of colloidal silver; however, the TECS process could be used to produce other metal nanocrystals such as copper, gold, and platinum.

Advantages

- Doesn't require surfactants or polymer dispersants
- Produces stable, pure, uniform size metal nanocrystals
- Doesn't require hazardous materials or generate hazardous wastes
- Simple reaction medium (water or aqueous solutions)
- Colloiddally stable in water solutions
- Enhanced optical and electronic properties

Potential Applications

- Coatings
- Electronic and sensor devices
- Tracers/labels
- Catalysis of industrial processes
- Structural materials
- Antibacterial/antifungal/anti-inflammatory products
- Targeted therapies and drug delivery
- Biological weapon antidotes
- Water treatment
- Optics (surface-enhanced Raman spectroscopy)
- Diagnostic biological probes
- Long-range ordered superlattices

Patents

Michael Z. Hu and Clay E. Easterly. *A Thermal Electrochemical Synthesis Method for Production of Stable Colloids of “Naked” Metal Nanocrystals*, U.S. Patent Application 11/154,973, filed June 16, 2005.

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