Nano Focus

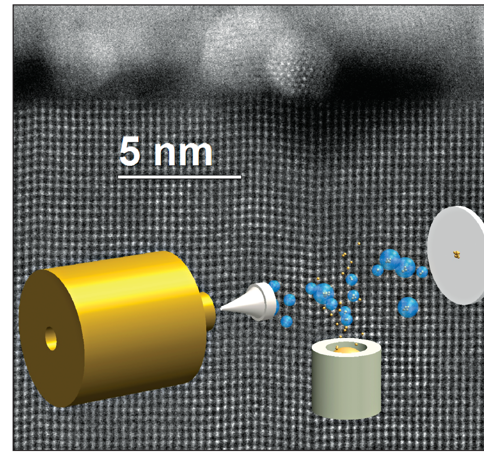
He droplet method produces narrow distributed nanoparticles as stable catalyst

Conventional synthesis methods for nanoparticles (NPs) suffer from low uniformity, surface contamination, and poor stability, limiting their practical use. A significant step toward overcoming these problems was recently developed by researchers at Stony Brook University, who devised a novel synthesis route based on helium nanodroplet isolation that produces a narrow distribution of clean and stable gold NPs.

"This is a very powerful method for producing active nanoparticles, which can be extended to other metals [beyond gold]. The helium droplet method produces very clean nanoparticles," says Alexander Orlov, the leader of the research team in the Department of Materials Science and Chemical Engineering at Stony Brook University, The State University of New York. "By depositing them on any substrates this approach can be applied to produce energy in a clean way, and address environmental issues by oxidizing various atmospheric pollutants," he adds.

As reported in the July issue of *The Journal of Physical Chemistry Letters* (doi:10.1021/acs.jpclett.6b01305), Qiyuan Wu and his colleagues created "nanoscale cryostats" using helium droplets. These droplets capture and condense the vaporized gold atoms, then carry them to the collector. The helium atoms evaporate immediately once they hit a collector, and simultaneously Au atoms form NPs with pristine surfaces.

By varying the nozzle temperature and deposition time, the researchers could tune the size of the resulting NPs, achieving diameters down to <0.75 nm. The method results in a remarkably narrow size distribution, with the variation of the diameter (ΔD) smaller than 0.3D. This method offers a significant improvement over previously reported synthetic methods for NPs. Exceptional thermal and chemical stability were achieved under CO oxidization reaction conditions, with temperatures up to 475 K.



Schematic of the growth of Au nanoparticles through the helium droplet method. High-resolution transmission electron microscope image of Au nanoparticles on a substrate. Credit: *The Journal of Physical Chemistry Letters*.

"This is a significant achievement in synthesizing uniform and clean metal nanoparticles. Without any assistance from organic surface ligands, gold nanoparticles can be produced that exhibit high monodispersity, which would be very useful for heterogeneous catalysis," says Bo Zhang, an expert in electrocatalysis for clean energy storage at the University of Toronto. To further benefit the catalysis field with the advantages of this synthetic method, Bo points out that comparing the CO to CO_2 conversion performance of the new gold nanoparticles with conventional ones at various temperatures would be of great interest.

"The next stage of our research is to fine-tune the shape of nanoparticles, to establish structure–reactivity relations and extend this methodology to other metals," Orlov says. "We also plan to demonstrate the advantage of this method for accelerating other chemical reactions than carbon monoxide oxidation."

Xiwen Gong

Nano Focus

Growth of low-temperature Si nanowires suitable for electronic memory devices

Digital information can be stored in magnetic, optical, or semiconductor devices. Although significant breakthroughs have occurred in the development of semiconductor-based memories in the last few decades, further increases in storage density and further miniaturization of memory cells are needed for improved performance. Silicon nanowires (Si NWs), due to their large surface-to-volume ratio and high crystallinity, are a promising candidate for miniaturized memory structures.

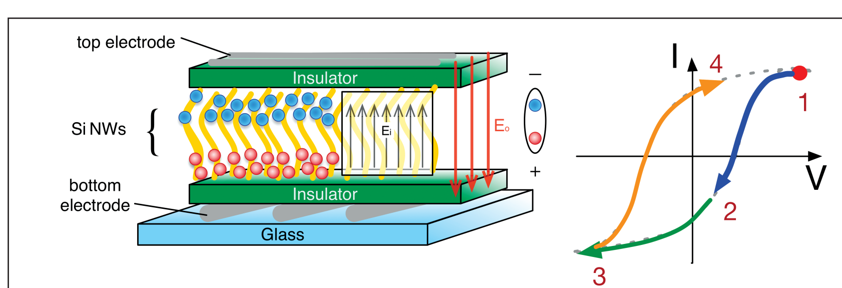


Illustration of schematic two-terminal nonvolatile device (2TNV) with Si nanowires (NWs) as a charge-storage medium in the READ process with applied electrical field E_o and internal electric field E_i in the opposite direction. The current–voltage hysteresis plot explains the working principle of the 2TNV memory. Credit: *Scientific Reports*.

However, the high growth temperatures and low trapped charge density limits the development of Si NWs-based electronic devices. A research group has now introduced a new approach to build a two-terminal nonvolatile (2TNV) memory, a device

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