Nanostructures with Controlled Shapes, Properties, and Applications

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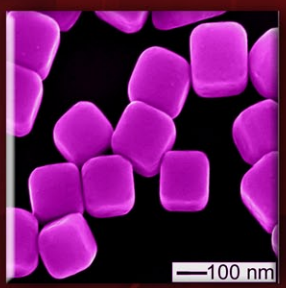
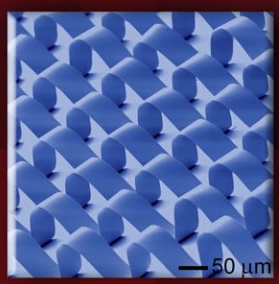


Silver Nanocubes

Synthesis of Shaped Metal Nanostructures

Approaches have been developed for the synthesis of shaped nanostructures made of varying metallic components. For instance, this scanning electron microscopy image shows cubic silver nanoparticles synthesized by the reduction of silver ions in liquid polyol (e.g., ethylene glycol). The silver nanoparticles and their derivatives exhibit strong optical absorptions in a wide spectral range. These unique properties offer promise for use in the efficient harvesting and conversion of solar energy, as well as for non-invasive medical therapy that would convert infrared light to heat.



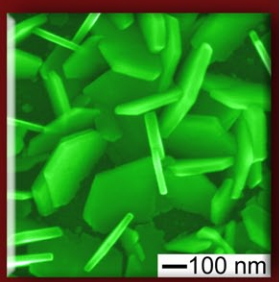
Flexible Silicon Nanoribbons

Fabrication of Semiconductor Nanostructures

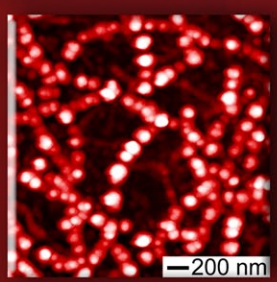
Nanostructures can be fabricated by slicing bulk materials in a controlled fashion with the assistance of chemistries. This image presents an example of single-crystal silicon ribbons (thickness of 100 nm) with buckled profiles derived from a bulk silicon wafer. This indicates their mechanical flexibility although the bulk silicon wafers are rigid and fragile. These semiconductor materials have been used to fabricate high-performance flexible electronics, which are critical in wearable electronic textiles for civilian and military applications.

Coupling Metals and Semiconductors on the Nanoscale

Coupling the unique properties between metals and semiconductors on the nanoscale leads to additional novel phenomena for new discoveries. These images show two examples: silver nanoplates on gallium arsenide wafers (left) and carbon nanotubes decorated with palladium nanoparticles on plastic sheets (right). These have been demonstrated to be excellent building blocks in devices for photoelectrochemistry, photocatalysis, and hydrogen sensing.



Ag Nanoplates on GaAs Wafer



Pd Particles on Carbon Tubes

Applications and Benefits

The methodologies developed in Dr. Sun's research have the capability to generate shaped nanostructures promising to applications in energy conversion, energy storage, photocatalysis, wearable electronic textiles, sensing, and medical therapy. Success of the research is beneficial to our nation's energy security, homeland security, environment and public health.

About Dr. Sun

Dr. Yugang Sun is an assistant chemist in the Center for Nanoscale Materials at Argonne National Laboratory. His world-leading breakthroughs in the synthesis and characterization of new nanoscale structures and composites have changed the landscape for next-generation optics and electronics. Dr. Sun's research interests focus on developing novel approaches for the synthesis of a wide range of nanostructures, including metal nanoparticles with well-controlled morphologies, single-crystal semiconductor nanostructures with mechanical flexibility, and metal/semiconductor nanocomposites with multiple functionalities. His interests also include development of novel devices that exploit the superb performance of the as-synthesized nanomaterials. Dr. Sun has also been active in scientific outreach and has played a leading role in building an active and robust user community at the Center for Nanoscale Materials.