Methods for Synthesising Metal–Carbon Composite of a Core–Shell Structure

Manufacturing

Buildings and Construction Technology

Nanotechnology and New Materials

Opportunity

Freestanding gold (Au) sheets of nanoscale thickness, which are also termed two-dimensional (2D) Au nanosheets, are composed of Au nanoparticles and have numerous useful applications. For example, 2D Au nanosheets are highly efficient catalysts of industrially important chemical reactions, and they have unique shape-dependent optical properties that make them suitable for use in biomedical diagnostic devices and biosensors. However, the properties of Au nanosheets are degraded by exposure to high temperatures or beams of electrons, which are used in many industrial processes. It has been found that the thermal stability of metallic nanoparticles (and thus that of metallic nanosheets) can be enhanced if they are encapsulated by a suitable protective shell (e.g., a silica or carbon shell) to form core–shell structures. However, the fabrication of such core–shell structures is laborious and complex. Thus, there is a need for a simple and scalable method for the encapsulation of metallic nanoparticles.

Technology

The inventors have developed a simple and efficient method of fabricating metallic nanoparticles encapsulated by carbon, i.e., metal–carbon composites with a core–shell structure. The process involves the fabrication of 2D freestanding carbon-coated metal nanosheets, which are subsequently processed to afford core–shell composites. Compared with traditional nanoparticles, these metal–carbon composites have five advantages: (1) they can be deposited in layers of controllable thickness on materials with flat, rough or porous surfaces; (2) their size can be tuned for a given application by appropriate adjustment of the synthetic procedure; (3) they exhibit enhanced thermal stability, and thus can be used under high temperatures (e.g., for catalysis or therapeutic applications); (4) their cores can comprise metals other than Au (e.g., silver or platinum); and (5) they are safe and inexpensive, and thus can be mass-produced.

Advantages

- The metal–carbon (core–shell) composites can be deposited on flat, rough or porous surfaces.
- The core–shell composites' size can be tuned as required.
- The core–shell composites have enhanced thermal stability.

IP Status

Patent filed

Technology Readiness Level (TRL) 4

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- The core–shell composites can contain different metals, such as silver or platinum.
- The core–shell composites are formed simply, efficiently, and inexpensively, so they can be mass-produced.

Applications

- Highly efficient catalysis of industrially important chemical reactions (e.g., oxidation and selective oxidation)
- Surface plasmon resonance-based applications in biomedical diagnostics and biosensors
- High-temperature biomedical therapeutics