Platinum Nanoparticles Introduction

Introduction

Platinum (Pt) is one of a noble metal with high melting point (1769°C) and prevent the chemical attacks as well as corrosion. This metal acts as an efficient catalyst in different catalytic reactions like hydrogenation reaction. The catalytic activities of Pt can be maximized by the formation of nanoparticles with protective agents like dendrimers, PVP, triblock copolymers etc.

The study about Platinum nanoparticles has become an attractive field of research due to their high surface area (surface to volume ratio), unique surface plasmon resonance, uses in biomedical science (biocidal effects to bacteria, algae, and virus), photo thermal treatment, and tissue imaging etc. These effective nanoparticles can be prepared by the various methods such as physical, chemical and biological techniques. Platinum nanoparticles combine unique plasmonic optical properties with biocompatibility. In addition, Platinum nanoparticles possess remarkable catalytic activity, able to reduce the intracellular reactive oxygen species (ROS) levels and impair the downstream pathways leading to inflammation. These nanoparticles are useful in a broad range of applications from fuel cell technologies, therapies, catalysis, and more. Abvigen specializes in providing high-purity and monodisperse nanomaterials – delivering the quality you need for consistent results.

Abvigen can provide high quality Platinum nanoparticles. The product has high repeatability between batches, which can meet the needs of different personalized materials such as research and development, testing and production of various customers.

Preparation Method

Top-down approaches: In the top-down approach, a larger metal is used for the production of NPs by a physical method via the mechanical breakdown of the large metal structure. Its major advantage is the control of the size distribution and morphologies of NPs. The top-down approach begins with the bulk counterpart that leaches out systematically bit-after-bit, leading to the generation of fine NPs. Several physical methods are adopted for the mass production of NPs such as photolithography, electron beam lithography, milling techniques, anodization, and ion and plasma etching.

Bottom-up approaches: The bottom-up approach involves assembling atoms and molecules to generate a diverse range of NPs. Examples of the bottom-up approach include self-assembly of monomer/polymer molecules, chemical or electrochemical nanostructural precipitation, sol–gel processing, laser pyrolysis, chemical vapor deposition (CVD), plasma or flame spraying synthesis, and bio-assisted synthesis.

Physical methods: Synthesis of PtNPs involves the application of mechanical pressure, high energy radiation, thermal energy, or electrical energy to cause material abrasion, melting, evaporation, or condensation to generate NPs. Several physical methods are available, such as laser ablation, arc discharge, vapor deposition, melt mixing, ball milling, sputter deposition, and flame pyrolysis.

Chemical methods: Chemical synthesis of NPs follows the bottom-up approach. This process mainly involves the use of water-soluble cations as a precursor to trigger their reduction to metal monomers, and the process is called nucleation. The growth of particles where it assembled cluster of reduced metal atom automatically stop the growth controlled by reducing agent/capping. The particles reached a certain size which is stable thermally. Nanomaterials are synthesized by the interaction of atoms and smaller molecules. Various chemical synthesis techniques include the sol–gel process, pyrolysis, CVD, microemulsion, hydrothermal, polyol synthesis, and plasma-enhanced chemical vapor deposition. Chemical preparation involves synthesis of metal NPs in a chemical solution, and various chemical reactions and chemical compositions are used for these purposes. For instance, the chemical reduction of metal ions inside reversed micelles in a nonpolar solvent is the most commonly employed method for the preparation of metal nanoparticles (MNPs). For instance, first, a metal slat dissolved in water is confined in the reversed micelles and is reduced into MNPs by chemical reduction. Size control of the particles is important and is regulated by volume of reversed micelles and ratio of water.

Biological synthesis: Biological synthesis or biomolecule-assisted synthesis is commonly used for the production/fabrication of PtNPs. The advantage of biological methods is that they are simple, facile, and environmentally friendly, and the synthesized nanomaterials are nontoxic and biocompatible. NPs with definite size and shape can be produced by adjusting the concentration of reducing agent, temperature, and pH. A few plant species are used for the synthesis of PtNPs including Azadirachta indica, Diospyros kaki, Ocimum sanctum, and Pinus resinosa. Several studies have reported the biological synthesis of PtNPs using different microorganisms. For the synthesis of PtNPs, water soluble metal salts are frequently used, such as H_2PtCl_6, K_2PtCl_6, K_2PtCl_4, $PtCl_2$, $Pt(AcAc)_2$, $Pt(NH_3)_4$-$(OH)_2$, $Pt(NH_3)_4(NO_3)_2$, and $Pt(NH_3)_4Cl_2$. The potential benefit of biological method of synthesis was that the produced nanoparticles were soluble, biocompatible, sustainable, chemical free, cost effective, and eco-friendly. The disadvantage of this method is hard to control shape, size, crystal growth, stability and aggregation, and possible endotoxin and time-consuming purification processes.

Synthesis of Platinum Nanoparticle using bacteria: Single cellular and multicellular organisms are known to produce inorganic material either extracellularly or intracellularly. Generally, bacteria produce NPs by the reduction process. The conversion of metal ion to NP using intracellular signaling pathways involves bacterial enzymes. The major advantages of bacteria-based NP synthesis is the ease of handling. The synthesis can also be easily modified using genetic engineering techniques for specific purposes, to reduce toxicity, and to obtain sustainable NP production. This method also has some disadvantages like laborious method, high cost, downstream processing, and less control over their size and shape. Riddin et al. reported the successful synthesis of geometric PtNPs using cell-free, cell-soluble protein extracts from a consortium of sulfate-reducing bacteria compared to whole cells from the same culture, which produce amorphous Pt(0). Synthesis of PtNPs was carried out by sulfate reducing bacteria Desulfovibrio desulfuricans and Acinetobacter calcoaceticus. These bacteria can potentially reduce platinum (IV) ion into platinum(0) NPs within 24 h, and the maximum production was observed at pH 7.0 under 30°C. The NPs are 2–3.5 nm in size with a cuboidal structure. PtNPs are deposited by metal-ion reducing bacterium Shewanella algae, and the resting cells of PtNPs by reducing ion $PtCl_6^{2-}$ into elemental platinum at neutral pH and room temperature. NPs 5 nm in size have been reported to be located in the periplasmic space of S. algae. The biological process involves two main processes—uptake and deposition or assimilation.

Applications

Fuel cell technologies;

Catalysis;

Imaging;

Medical implants;

Drug delivery;

Photothermal therapy;

Antibacterial;

Antifungal

Advantages

Unique plasmonic optical properties;

Good biocompatibility;

High-purity;

Monodisperse;

Remarkable catalytic activity

Low toxicity;

High stability;

Less side effects

Ordering Information

Website: www.abvigen.com

Phone: +1 929-202-3014

Email: info@abvigenus.com