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Opinion Article

Properties of Nanoparticles and its Applications

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ABOUT THE STUDY

This analysis provides a detailed overview of the synthesis, properties, and applications of various morphologies of Nanoparticles (NPs). NPs are small substances ranging in size from 1 to 100 nm and can be divided into various classes based on their properties, shape, or size. Various groups include fullerenes, metallic NPs, ceramic NPs, and polymeric NPs. NPs have unique physical and chemical properties due to their high surface area and nanoscale size. Their optical properties are size dependent and have been reported to give different colors due to absorption in the visible range. Their reactivity, toughness, and other properties also depend on their inherent size, shape, and structure. These properties make them good candidates for a variety of commercial and consumer applications, including catalysis, imaging, medical applications, and energy based study, and environmental applications. It has been reported that heavy metal NPs of lead, mercury, and tin are very hard and stable and therefore not easily decomposed, leading to many environmental toxicities.

Nanotechnology has been a well-known area of research during the last century. Development has taken place in nanotechnology has created a wide variety of materials at the nano level. Nanoparticles (NPs) are a broad class of materials containing particulate matter with at least one dimension less than 100 nm. Depending on their overall shape, these materials can be 0D, 1D, 2D, or 3D. The importance of these materials became apparent when study discovered that their size can affect their physicochemical properties and optical properties. 20 nm gold (Au), platinum (Pt), silver (Ag), and palladium (Pd) NPs have characteristic burgundy, yellow-gray, black, and dark black colors, respectively Au NPs with different sizes are synthesized. These NPs exhibited characteristic colors and properties with variations in size and shape that could be used in bio-imaging applications. As shown, the color of the solution changes with changes in aspect ratio, nanoshell thickness, and gold concentration. Changing any of the above factors affects the absorption properties of the NPs, thus different absorption colors are observed.

NPs themselves are not simple molecules, so they consist of three layers. The surface layer that can be functionalized with a variety of small molecules, metal ions, surfactants, and polymers. The shell layer, which is chemically distinct from the core in all respects. The core which is basically the central part of the NP and usually refers to the NP itself. Due to these extraordinary properties, these materials are of great interest to researchers in interdisciplinary fields. Scanning Electron Microscopy (SEM) nanoparticles are spherical shape with average diameter of around 35 nm and the morphologies of non-porous and mesoporous MA-SiO_2 nanoparticles were studied by using Transmission Electron microscopy (TEM). Mesoporosity confers additional properties to the NPs. NPs can be used for drug delivery, chemical and biological sensing, gas sensing, CO_2 capture, and other related applications.

Carbon-based NPs

Fullerenes contain nanomaterials composed of allotropic carbon-like spherical hollow cages. They are of significant commercial interest because of their electrical conductivity, high strength, structure, electron affinity, and versatility. These materials have well-ordered pentagonal and hexagonal carbon units, each carbon being sp^2 hybridized. We present some of the known fullerenes composed of C_{60} and C_{70} with diameters of 7.114 nm and 7.648 nm, respectively.

Carbon Nanotubes (CNTs) are elongated tubular structures with diameters of 1-2 nm and can be predicted to be metallic or semiconducting depending on their diameter. These resemble structures with sheets of graphite rolling over them and are therefore called single-walled, double-walled, or multi-walled carbon nanotubes.

Metal NPs

Metallic NPs consist only of metal precursors. Due to the known properties of Localized Surface Plasmon Resonance (LSPR), these NPs possess unique optoelectrical properties. NPs of alkali and noble metals are Cu, Ag, and Au has broad absorption bands in the visible region of the solar electromagnetic spectrum. Synthesis of metallic NPs with controlled facet, size and shape is for important materials. Due to their advanced optical properties, metallic NPs have been applied in many study fields. A coating of gold NPs is widely used in SEM sampling to

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improve the electron current, which helps in obtaining high-quality SEM.

Ceramics NPs

Ceramic NPs are inorganic non-metallic solids synthesized by heating and cooling. Therefore, these NPs have received much attention from study due to their use in applications such as catalysis, photocatalysis, dye photolysis, and imaging applications.

CONCLUSION

They are widely synthesized by depositing carbon precursors, especially atomic carbon, vaporized from graphite by laser or electric arc onto metal particles. Recently, they have been synthesized by Chemical Vapor Deposition (CVD). Due to their unique physical, chemical and mechanical properties, these materials are not only used in their pure form, but also as fillers, efficient gas sorbents for environmental remediation and carriers for various inorganic and organic materials. It is also used in nanocomposites for many commercial applications.