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Study of Preparation and Structure of Nanoparticles

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Abstract

The term Nano means dwarf or incredibly little small. It is observed that the nanocrystal materials are characterized in number of ways in order to study their properties and potential applications. In some case these materials are characterized at any rate with size less than one hundredths nanometer. If we compare human hair, its size is bigger than a one nanoscale molecule. The study and estimation of nanoparticles is the very common characterization technique of nanoparticles that helps to decide the potential applications. Portrayal and control of individual nanostructures needs outrageous affectability and precision, in addition to nuclear level goals. The improvement of novel devices and instruments is perhaps the best suited challenge in nanotechnology.

Keywords: *Nanoparticles, nanocrystal & optical properties*

1. Introduction:

The term Nano means dwarf or incredibly little small. It is observed that the nanocrystal materials are characterized in number of ways in order to study their properties and potential applications. The nanomaterials are the materials with sizes of individual structure size is one millionths of a millimeter at any rate in one measurement. Nanoparticles can be divided into various types, according to their size, shape, and material properties. Some of them distinguish between organic and inorganic nanoparticles. The first one includes dendrimers, liposomes, and polymeric nanoparticles, whereas the latter one includes fullerenes, quantum dots, and gold nanoparticles (Kelly *et. al.* 2003 and Naisbitt *et. al.* 2006). It is observed that as we go to nanoscale the properties a material change remarkably. In many cases their properties are unbelievable (Karami *et. al.* 2010). It is observed that the nanocrystal materials are characterized in number of ways in order to study their properties and potential applications (Sivaram *et. al.* 2018 and Wolkenstein 1991**)**. In some case these materials are characterized at any rate with size less than one hundredths nanometer. If we compare human hair, its size is bigger than a one nanoscale molecule.

Now-a-days a good number of techniques for developing nanoparticles, nanowires and nanotubes have been used. Along these lines, nanotubes and nanowires of an assortment of inorganic materials likewise found other than of carbon, requested shows super cross sections of nanocrystals of metals and

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semiconductors have been read (Badran *et. al.* 2016 and Sivaram *et. al.* 2018**)**. The nanostructured polymers shaped by the arranged self-gathering of triblock copolymers and nanostructure high quality materials are recorded as different models (Wiley 2023). The reasonable control of the properties of nanometer scale structures can lead a new field of science & technology like a new and ultramodern gadget and advances also.

2. Review of Literature:

Kelly *et. al.* (2003) showed that the optical properties of metal nanoparticles have long been of interest in physical chemistry, starting with Faraday's investigations of colloidal gold in the middle 1800s. More recently, new lithographic techniques as well as improvements to classical wet chemistry methods have made it possible to synthesize noble metal nanoparticles with a wide range of sizes, shapes, and dielectric environments. In this feature article, we describe recent progress in the theory of nanoparticle optical properties, particularly methods for solving Maxwell's equations for light scattering from particles of arbitrary shape in a complex environment.

Karami (2010) showed that a novel CdO-ZnO nanocomposite has been synthesized by a sol-gel pyrolysis method based on polymeric network of polyvinyl alcohol (PVA). The prepared nanocomposites have been carefully characterized using scanning electron microscopy, X-Ray dispersive energy analysis, ICP-atomic emission spectroscopy and X-Ray diffraction. The obtained results showed that the synthesized nanocomposite at optimum conditions has excellent linear nanoclusters created from nanograins. Each nanograin was made of a CdO core that completely covered by ZnO layers. Each synthesized nanocomposite was used as sensing agent of CO gas. It was found that synthesized CdO-ZnO nanocomposite at 2%wt $Zn(NO_3)_2$, 2%wt $Cd(NO_3)_2$, 9%wt PVA, mixed solvent of 50:50 ethanol-water at pyrolysis temperature of 600°C can be used as CO gas sensing agent to exhibit the highest sensitivity for CO at 135°C.

Badran et al (2016) have shown that the CdO NPs was synthesized using the sol– gel method and the nanoparticles were characterized using an UV–Vis spectrophotometer, with shape and size were examined by SEM and XRD. The XRD analysis respects the Bragg's law and confirmed the crystalline nature of CdO nanoparticles. From the XRD, the average size of CdO NPs was found to be around 41 nm. The photoluminescence spectra of the CdO NPs, as recorded at room temperature, were excited at 300 nm wavelength. The broad emission peaks were between 600 and 650 nm (orange emission). The refractive index change, Dn, and effective nonlinear refractive index, n^2, were found to be 10^{-4} and 10^{-8} cm^2/ W, respectively. The effective nonlinear refractive index, n^2, was determined based on the observed number of rings. The threshold values of the CdO, CdO–2SiO_2 and CdO– 5SiO_2 nanocomposites are 7.1, 6.55 and 6.34 mW, respectively. This large nonlinearity is attributed to the thermal effect.

Sivaram *et. al.* (2018) reported that Lead Oxide (PbO) nanoparticles and the composite form of PbO with CdO and ZnO were prepared by the wet chemical method. The crystal structure, optical absorption and functional groups of the prepared materials were studied. The electrochemical studies indicate that PbO-ZnO nanocomposites possess the highest specific capacitance of 408F/g compared with that of PbO nanoparticles and the PbO-CdO nanocomposites. With promising structural, optical and electro-chemical properties, these nanocomposites can be effectively used for as double layer capacitors for energy storage applications.

Djearamane *et. al.* (2019) reported that Zinc oxide nanoparticles (ZnO NPs) are widely used in industrial and personal care products. The use of these nanoparticles (NPs) has created residues that contaminate the environment, thus cytotoxicity studies of the NPs in biological system is required. Most of the recent cytotoxicity studies has however focused on long-term exposure of the NPs to the biological system. The toxicity effects of ZnO NPs were then determined through the changes in fluorescence emission of chlorophyll, algal biomass and the viable cell count. The significant responses of the algal cells to ZnO NPs in a short duration of exposure reflect the potential of the algal cells to be used as bioindicators of ZnO NPs in the aquatic environment.

Sahoo (2022) showed the sensing and biosensing with optically active nanomaterials summarizes the potential sensing applications of optically (chromogenic and fluorogenic) active, nanosized, organic, and inorganic materials for the selective detection of ionic analytes (such as metal ions and anions) in various environmental and biological samples. Sections cover design, synthesis, sensing mechanisms and applications for detecting ionic analytes. It deals with the sensing applications of one kind of nanomaterial.

3. Technique Used:

The molecular approach known as chemical approach, in which the nanocrystal is build up atom by atom. It is treated as an increasingly larger molecular cluster which is eventually evolves into a bulk semiconductor crystal. The description of the band structure of semiconductors discussed above was based on an infinite crystal. When the dimensions of the semiconductor crystal are deceased to the nanoscale the electronic structure of semiconductor nanocrystals is strongly depending upon size. This effect is termed as the quantum confinement and shall be understood via two different approaches. The first one is known as top down approach. In this technique the nanocrystal is treated as small piece of semiconductor material. In this method the excitation is spatially confined. The second method is known as bottom up method. It involves a quantum crystal.

The work of the envelope is then to arrange the Schrodinger condition for a molecule in box issue. For a three-dimensional box with measurements L, the wave capacity would essentially be the result of sinusoidal capacities in x, y and z bearings. Not with standing, if the control is the equivalent every which the nanocrystal can all the more likely be spoken to as a circular potential box (i.e. a quantum spot, -D).

The work of envelope has a nearby similarity with the wave capacities portraying the electron of a hydrogen molecule. All things considered nonetheless the potential experienced by the electron is depicted by the emphatically charged proton [i.e. $V(r) \alpha 1/r$] while there is no decided charged center in a-D. However rather the electrons experience a circular potential well of distance across D for which $V(r)$ rises to V_o (limited) for $r = D/2$ and zero somewhere else case. The embedding equation in the Schrodinger condition gave the answer for the discrete vitality levels of a bound electron in a circle (Gaponenko 2010, Karim *et. al.* 2019 and Rossetti *et. al.* 1982).

4. Preparation of Nanomaterial:

The fundamental difference between the nanotechnology and traditional innovations are the approach involved in the development of nanomaterial. In the unique circumstance, synthetic union is the normal of the base up approach however quashing and processing are the systems which might be named as top down approach (Figure 1).

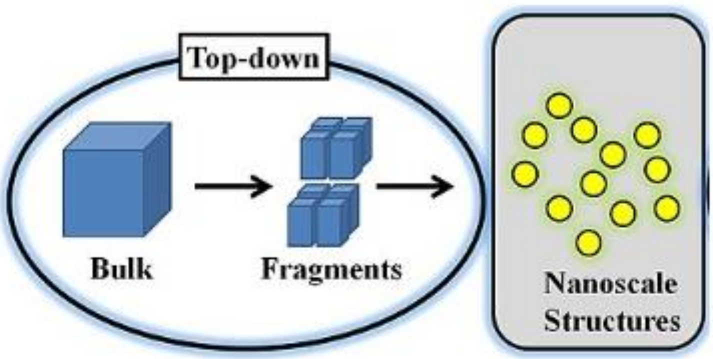

Figure 1: Top-down approach for the preparation of nanoparticles*

*Source: nanoscience.com

This approach involves the breaking down of the bulk material into nanosized structures or particles. The synthesis techniques are extension of those that have been used for producing micron sized particles (Rokesh *et. al.* 2016 and Tamri *et. al.* 2017). These approaches are inherently simpler and depend either on removal or division of bulk material or on miniaturization of bulk fabrication processes to produce the desired structure with appropriate properties (Djearamane *et. al.* 2019). The main problem with this approach is the imperfection of surface structure.

5. Types of Nanomaterial:

The nanomaterials may be classified as zero dimensional (0D), one dimensional (1D), two dimensional (2D) and three dimensional (3D). The zero-dimensional (0D) nanomaterials are the atomic clusters,

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filaments and cluster assemblies. One dimensional (1D) nanomaterials are the nanorods or nanotubes. Two dimensional (2D) nanomaterials are the sheet like structures, plates or stacks of plates. Three dimensional (3D) nanomaterials are not confined to the nanoscale in any dimension. These materials have three arbitrary dimensions above 100 nm. The bulk (3D) nanomaterials are composed of a multiple arrangement of nanosize crystals in different orientations (Figure 2).

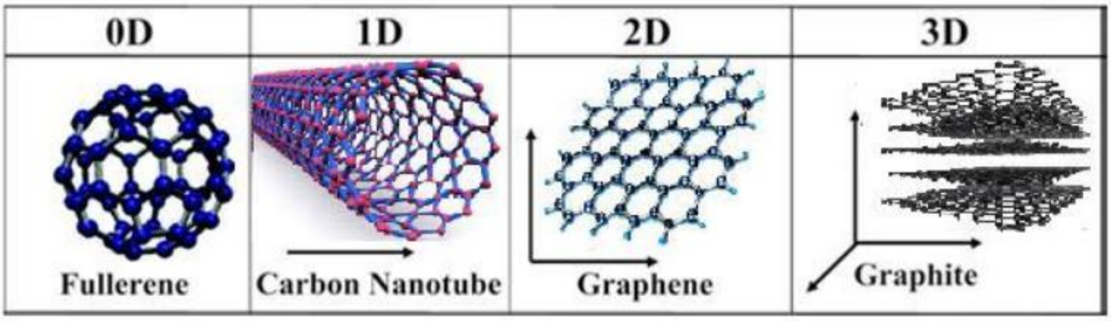

Figure 2: Different types of Nanomaterials*

*Source: researchgate.net

The advances are being made to control the creation and smoothness of surfaces. These are also having potential application for the development of movies. Graphene is the best model for the one-dimensional nanomaterial. Cylinders and wires such as carbon nanotubes are the best model for the two-dimensional nanomaterial. Three-dimensional nanomaterial includes dispersions of nanoparticles, bundles of nanowires and nanotubes and also multi nanolayers (polycrystals) in which the 0D to 2D structural elements are in close contact with each other and form interfaces also.

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