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### Nanoparticles

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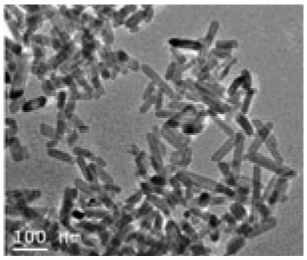

A nanoparticle is a microscopic particle whose size is measured in nanometers (nm). It is defined as a particle with at least one dimension <100nm. Nanoparticles made of semiconducting material may also be labeled quantum dots if they are small enough (typically sub 10nm) that quantization of electronic energy levels occurs. They have found their use as bulk and coatings on implants, drug delivery, and their biggest commercial success as sun screens.

Nanoparticles are of great scientific interest as they are effectively a bridge between bulk materials and atomic or molecularstructures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale this is often not the case. Size-dependent properties are observed such as quantum confinement in semiconductor particles, surface plasmon resonance in some metal particles and superparamagnetism in magnetic materials. Semi-solid and soft nanoparticles have been manufactured. A prototype nanoparticle of semi-solid nature is the liposome.

The properties of materials change as their size approaches the nanoscale. For example, the bending of bulk copper (wire, ribbon, etc.) occurs with movement of copper atoms/clusters at about the 50 nm scale. Copper nanoparticles smaller than 50 nm are considered super hard materials that do not exhibit the samemalleability and ductility as bulk copper.

The interesting and sometimes unexpected properties of nanoparticles are partly due to the aspects of the surface of the material dominating the properties in lieu of the bulk properties. The percentage of atoms at the surface of a material becomes significant as the size of that material approaches the nanoscale. For bulk materials larger than one micrometre the percentage of atoms at the surface is minuscule relative to the total number of atoms of the material. Suspensions of nanoparticles are possible because the interaction of the particle surface with the solvent is strong enough to overcome differences in density, which usually result in a material either sinking or floating in a liquid.

Nanoparticles often have unexpected visible properties because they are small enough to scatter visible light rather than absorb it. For example gold nanoparticles appear deep red to black in solution.

At the small end of the size range, nanoparticles are often referred to as clusters. Metal, dielectric, and semiconductor nanoparticles have been formed, as well ashybrid structures (e.g., core-shell nanoparticles). Nanospheres, nanorods, and nanocups are just a few of the shapes that have been grown. Semiconductor quantum dots and nanocrystals are types of nanoparticles. Such nanoscale particles are used in biomedical applications as drug carriers or imaging agents. Various types ofliposome nanoparticles are currently used clinically as delivery systems for anticancer drugs and vaccines.

Nanoparticle characterization is necessary to establish understanding and control of nanoparticle synthesis and applications. Characterization is done by using a variety of different techniques, mainly drawn from materials science. Common techniques are electron microscopy [TEM,SEM], atomic force microscopy [AFM], dynamic light scattering [DLS], x-ray photoelectron spectroscopy [XPS], powder x-ray diffractometry [XRD], and Fourier transform infrared spectroscopy [FTIR]. Nanoparticle research is currently an area of intense scientific research, due to a wide variety of potential applications in biomedical, optical, and electronic fields. TheNational Nanotechnology Initiative of the United States government has driven huge amounts of state funding exclusively for nanoparticle research.

Read more at: http://en.wikipedia.org/wiki/Nanoparticles