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Role of Nano-Materials towards "Green" Society

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Abstract: ***Green Technologies rely on the use of new advanced materials. Materials science is an applied science concerned with the relationship between the structure and properties of materials, different combinations of molecules and materials result in different properties. Material science covers a broad range of sciences One of them is science of nano materials. In this paper the structure and properties of nanomaterials is described and the role of nano materials in green technology is reviewed briefly***

Keywords: Nano materials, nanotechnology, Green Society

1. Introduction

Semiconductor nanocrystallites have attracted considerable attention because of their strongly size dependent optical and electrical properties and potential applications for optoelectronics. [1, 2] Development of composites consisting of a continuous matrix with dispersed nanoparticles of II-VI sulphides like CdS, ZnS, PbS and studies of their optical properties are nowadays important activities in materials science [3-7], especially for solar cell, photoconductive materials ,optical detectors, photo-elctro chemical cells ,thin film transistors and optoelectronic devices. In this paper we are going to discuss unique properties and applications of various nano materials and their role in green society.

Role of nano materials

Nanomaterials are the building blocks of nanoscience and nanotechnology. Nanostructure science and technology is a broad and interdisciplinary area of research and development activity that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the ways in which materials and products are created. can be accessed. Fig. shows the growth of nanotechnology over the years. [8] It is already having a significant commercial impact, which will assuredly increase in the future Due to their small dimensions, nanomaterials have extremely large surface area to volume ratio, which makes a large to be the surface or interfacial atoms, resulting in more "surface" dependent material properties.

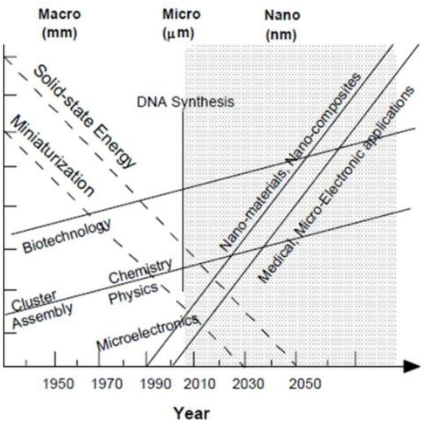

Figure: Growth of nanotechnology over the years

Optical Properties

One of the most fascinating and useful aspects of nanomaterials is their optical properties. In small nano clusters the effect of reduced dimensionality on electronic structure has the most profound effect on the energies of highest occupied molecular orbital which is valence band and the lowest unoccupied molecular orbital, essentially the conduction band. The optical emission and absorption occurs when the transition of the electrons occur between these two states. Semiconductors and many metals show large changes in optical properties such as colour, as a function of particle size.[9]

Table: Size-Dependent-optical-property of gold and silver

S. No.	Metal	Size in nm	Colour
01	Gold	2-5	Yellow
02	Gold	10-20	Red
03	Gold	>20	Purple
04	Silver	40	Blue
05	Silver	100	Yellow

Applications based on optical properties of nanomaterials include optical detector, laser, sensor, imaging, phosphor, display, solar cell, photocatalysis, photoelectrochemistry and biomedicine. The optical properties of nanomaterials depend on parameters such as feature size, shape, surface characteristics, and other variables including doping and interaction with the surrounding environment or other nanostructures. Likewise, shape can have dramatic influence on optical properties of metal nanostructures.

Electrical properties

Electrical Properties of Nanoparticles discuss about fundamentals of electrical conductivity in nanotubes and nanorods, carbon nanotubes, photoconductivity of nanorods, electrical conductivity of nanocomposites. The properties like conductivity or resistivity are come under category of electrical properties. These properties are observed to change at nanoscale level like optical properties. The examples of the change in electrical properties in nanomaterials are:

1) Conductivity of a bulk or large material does not depend upon dimensions like diameter or area of cross section and twist in the conducting wire etc. However it is found that in case of carbon nanotubes conductivity changes with change in area of cross section.
2) It is also observed that conductivity also changes when some shear force (in simple terms twist) is given to nanotube.
3) Conductivity of a multiwalled carbon nanotube is different than that of single nanotube of same dimensions.
4) The carbon nanotubes can act as conductor or semiconductor in behaviour but we all know that large carbon (graphite) is good conductor of electricity.

These are the important electrical properties of nanomaterials.

Mechanical Properties

Molecular dynamic study plays major importance for an understanding of the mechanical properties of these materials. Filling polymers with nanoparticles or nanorods and nanotubes, respectively, leads to significant improvements in their mechanical properties. Such improvements depend heavily on the type of the filler and the way in which the filling is conducted. Polymers filled with silicate platelets exhibit the best mechanical properties and are of the greatest economic relevance. The larger the particles of the filler or agglomerates, the poorer are the properties obtained. On the other hand, by using carbon nanotubes it is possible to produce composite fibers with extremely high strength and strain. Among the most exciting nanocomposites are the polymer- ceramic nanocomposites, where the ceramic phase is platelet-shape. This type of composite is preferred in nature, and is found in the structure of bones, where it consists of crystallized mineral platelets of a few nanometers thickness that are bound together with collagen as the matrix.

Magnetic properties

Bulk gold and Pt are non-magnetic, but at the nano size they are magnetic. Surface atoms are not only different to bulk atoms, but they can also be modified by interaction with other chemical species, that is, by capping the nanoparticles. This phenomenon opens the possibility to modify the physical properties of the nanoparticles by capping them with appropriate molecules. Actually, it should be possible that non-ferromagnetic bulk materials exhibit ferromagnetic-like behavior when prepared in nano range. One can obtain magnetic nanoparticles of Pd, Pt and the surprising case of Au (that is diamagnetic in bulk) from non-magnetic bulk materials. In the case of Pt and Pd, the ferromagnetism arises from the structural changes associated with size effect. However, gold nanoparticles become ferromagnetic when they are capped with appropriate molecules: the charge localized at the particle surface gives rise to ferromagnetic-like behavior. Surface and the core of Au nanoparticles with 2 nm in diameter show ferromagnetic and paramagnetic character, respectively.

2. Importance of Nano Materials

Nanomaterials having wide range of applications in the field of electronics, fuel cells, batteries, agriculture, food industry, and medicines, etc... It is evident that nanomaterials split their conventional counterparts because of their superior chemical, physical, and mechanical properties and of their exceptional formability.

Fuel cell-A fuel cell is an electrochemical energy conversion device that converts the chemical energy from fuel (on the anode side) and oxidant (on the cathode side) directly into electricity. The heart of fuel cell is the electrodes. The performance of a fuel cell electrode can be optimized in two ways; by improving the physical structure and by using more active electro catalyst. A good structure of electrode must provide ample surface area to provide maximum contact of catalyst, reactant gas and electrolyte, facilitate gas transport and provide good electronic conductance.

Microbial fuel cell

Mfc is a device in which bacteria consume water-soluble waste such as sugar, starch and alcohols and produces electricity plus clean water. This technology will make it possible to generate electricity while treating domestic or industrial wastewater. Microbial fuel cell can turn different carbohydrates and complex substrates present in wastewaters into a source of electricity. The efficient electron transfer between the microorganism and the anode of the microbial fuel cell plays a major role in the performance of the fuel cell. The organic molecules present in the wastewater posses a certain amount of chemical energy, which is released when converting them to simpler molecules like CO_2. The microbial fuel cell is thus a device that converts the chemical energy present in water-soluble waste into electrical energy by the catalytic reaction of microorganisms. Carbon nanotubes (CNTs) have chemical stability, good mechanical properties and high surface area, making them ideal for the design of sensors and provide very high surface area due to its structural network. Since carbon nanotubes are also suitable supports for cell growth, electrodes of microbial fuel cells can be built using of CNT. Due to three-dimensional architectures and enlarged electrode surface area for the entry of growth medium, bacteria can grow and proliferate and get immobilized. Multi walled CNT scaffolds could offer self-supported structure with large surface area through which hydrogen producing bacteria (e.g., E. coli) can eventually grow and proliferate. Also CNTs and MWCNTs have been reported to be biocompatible for different eukaryotic cells. The efficient proliferation of hydrogen producing bacteria throughout an electron conducting scaffold of CNT can form the basis for the potential application as electrodes in MFCs

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leading to efficient performance.

Rechargeable Betteries

Conventional and rechargeable batteries are used in almost all applications that require electric power. The energy density (storage capacity) of these batteries is quite low requiring frequent recharging. Nanocrystalline materials are good candidates for separator plates in batteries because they can hold considerably more energy than conventional ones. Nickel-metal hydride batteries made of nanocrystalline nickel and metal hydrides are envisioned to require far less frequent recharging and to last much longer.

Next Generation Computer Chips

The microelectronics industry has been emphasizing miniaturization, whereby the circuits, such as transistors, resistors, and capacitors, are reduced in size. By achieving a significant reduction in their size, the microprocessors, which contain these components, can run much faster, thereby enabling computations at far greater speeds. However, there are several technological impediments to these advancements, including lack of the ultrafine precursors to manufacture these components; poor dissipation of tremendous amount of heat generated by these microprocessors due to faster speeds; short mean time to failures (poor reliability), etc. Nanomaterials help the industry break these barriers down by providing the manufacturers with nanocrystalline starting materials, ultra-high purity materials, materials with better thermal conductivity, and longer-lasting, durable interconnections (connections between various components in the microprocessors).

Elimination of Pollutants

Nanomaterials possess extremely large grain boundaries relative to their grain size. Hence, they are very active in terms of their chemical, physical, and mechanical properties. Due to their enhanced chemical activity, nanomaterials can be used as catalysts to react with such noxious and toxic gases as carbon monoxide and nitrogen oxide in automobile catalytic converters and power generation equipment to prevent environmental pollution arising from burning gasoline and coal.

Sunscreen lotion

Prolonged UV exposure causes skin-burns and cancer. Sun-screen lotions containing nano-TiO_2 provide enhanced sun protection factor (SPF) while eliminating stickiness. The added advantage of nano skin blocks (ZnO and TiO_2) arises as they protect the skin by sitting onto it rather than penetrating into the skin. Thus they block UV radiation effectively for prolonged duration. Additionally, they are transparent, thus retain natural skin colour while working better than conventional skin-lotion

3. Conclusion

Nanomaterials are cornerstones of nanoscience and nanotechnology. Nanotechnology is an interdisciplinary field that has been growing explosively worldwide in the past few years. It has the potential for revolutionizing the ways in which materials and products are created and the range and nature of functionalities that can be accessed. It is already having a significant commercial impact, which will assuredly increase in the future. The novel properties of Nanomaterials are being used in evolving environment friendly products and technology which would contribute to building up GREEN Society.

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