Research Paper
Impact Factor - **2.262**
Peer Reviewed Journal

IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

MULTIDISCPLINARY APPLICATIONS OF SEMICONDUCTOR METAL SULFIDE NANOPARTICLES

T. Gayathri
Assistant Professor, Department of Chemistry, Dr. Ambedkar Government Arts College, Chennai.

Abstract
The multidisciplinary research of semiconductor nanocluster has witnessed exceptional growth during the past decade. A great deal of attention has been focused on nanostructured semiconductor systems because of their practical applications in solar energy conversion and photocatalytic degradation of organic contaminants. Other areas which are benefited by the nano structured semi conductor technology are chemical sensors, electro optics, micro electronics, imaging science and photo voltaics. Applications that make use of the unique properties of the metal sulfide nanoparticles such as PbS, ZnS and CdS are discussed briefly in this paper.

Key Words: Nanocluster, Photocatalytic, Sulfide.

Introduction

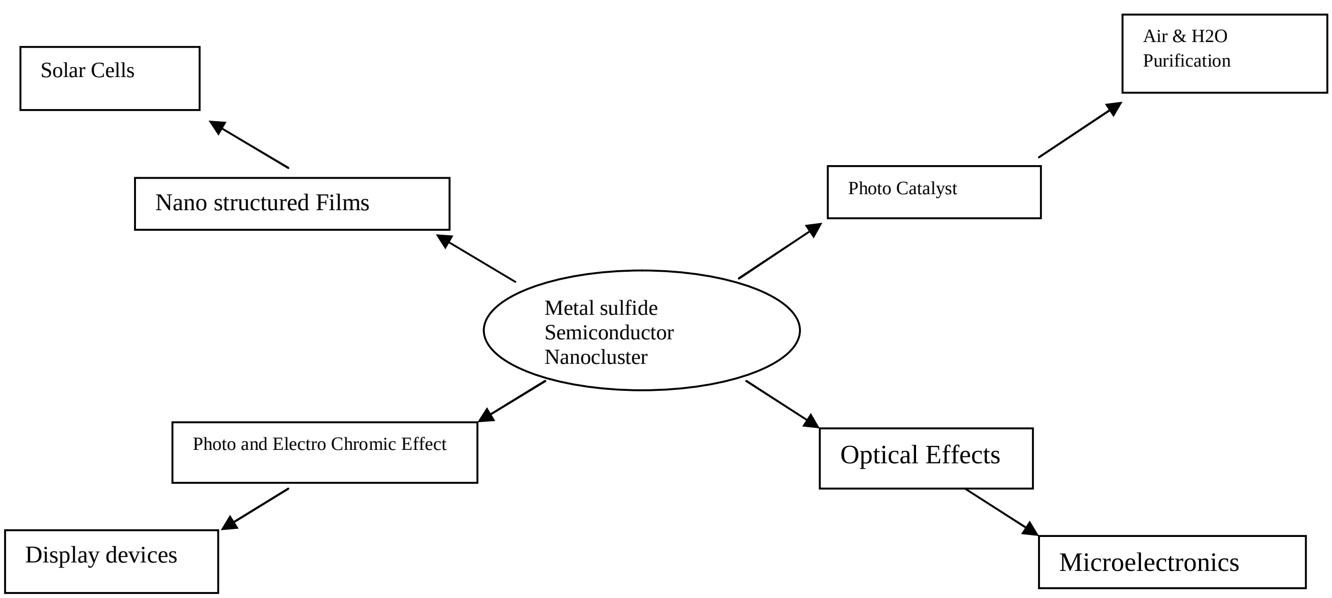
The applications of semiconductor systems in initating and controlling various photo catalytic processes have been reviewed recently by several researchers. Colloidal semiconductor nanocrystals have attracted a lot of interest in the field of physics, chemistry, biology and engineering. The ability to control the optical properties of these nanocrystals has made this field of materials science very interesting for fundamental understanding and technological applications. Most importantly these nanocrystals has an impact application in biological labeling, optic and optoelectronic devices such as optical switches , solar cells, LED, laser and gas sensor.

Metal Sulfide Nanoparticles

CdS nanoparticles, stabilized with cysteine and glutathione render the photo luminescent CdS nanoparticles which is soluble in water and additionally they provide functional groups like amino and carboxyl groups. This allows for example, covalent labeling of biological moieties such as antibodies and related molecules of biological interest.

Bulk PbS has an IR band gap of (0.41 eV) that shifts to the visible region of nanocluster. As a result, PbS nanoparticles may be useful in the electroluminescent devices such as LED.

Kane, R.S *et al.*, suggested that the PbS semiconductor nanoparticles are expected to have exceptional 3rd order non-linear optical properties and may be useful in optional devices such as optical switches. The metal sulfide nanoparticls are also useful in many areas and some of the examples are given below. This is indicated in the following diagram.



IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

Diversifying Area of Semiconductor Nanocluster Research

Photocatalytic Reduction of CO_2:

Metal chalcogenides especially metal sulfides are used as photocatalyst for CO_2 reduction. Although they are alternative as visible light catalysts, they suffer from the problem of photocorrection. Photogenerated holes if not scavenged efficiently, induces anodic corrosion. Kanemoto et al., has made efforts to overcome this problem using electron donors or organic reaction media.

The colloidal ZnS suspension effectively catalyse the photoreduction of CO_2 resulting in the formation of formate (HCOO) and a very small quantity of CO. The high efficiency of this system was attributed to the low density of surface defects on quantized crystallites.

Another system uses ZnS and CdS nanocrystallities prepared in N, N-dimethyl formamide of O^{o}C. The CO2 undergoes effective photoreduction in the presence of triethylamine as a sacrificial electron donar. This system show high quantum efficiency for the reduction of CO_2 under UV light irradiation ($\lambda > 290$ nm) giving formate and CO. This enhancement has been explained on the basis of stabilization of photogenerated electron in the conduction band of trap sites through the adsorptive interaction with CO_2 molecule on the ZnS surface. The addition of zinc ion to this system changes the product distribution without a significant decrease in the photoconversion efficiency or the emission behavior.

Similarly in the case of CdS, the CO_2 is reduced to CO on hexagonal CdS nanocrystallites in DMF under visible light irradiation. Addition of Cd2+ or H2S influence the emission behavior and CO production, thereby suggesting that the surface structures of CdS – DMF plays an important role in the photocatalytic reduction of CO_2. The adsorptive interaction of the CO_2 molecule with the surface of semiconductor nanocrystallite also plays a crucial role in determining their photocatalytic activity.

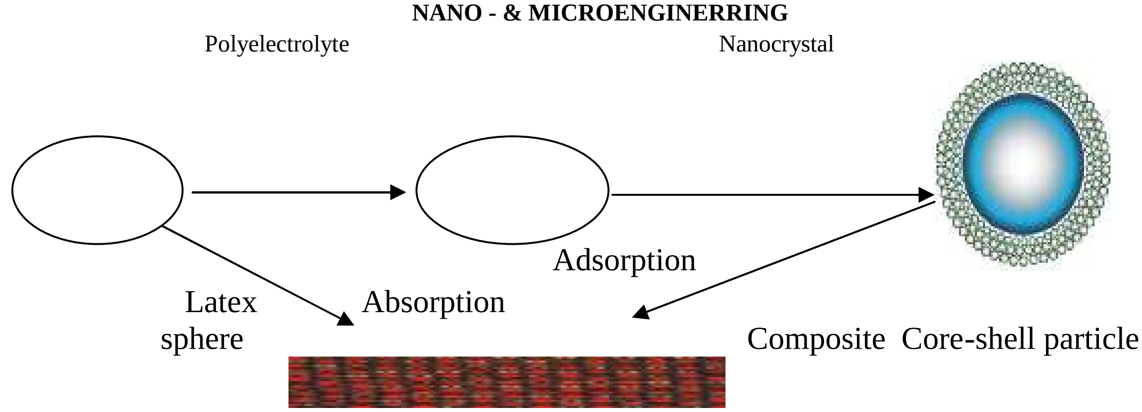
Decomposition of Nitrogen Oxides and their Anions

Metal sulfide also serves as a catalyst for the conversion of nitrogen oxide to less toxic compound. This conversion is important from the point of global environmental pollution. Nitrogen oxide can be converted to N_2 and other nitrogen compounds by reduction. Rajit, K.T et al have studied that Metal sulfide like CdS catalyst can reduce nitrate to ammonia using sodium sulfate and sodium sulfite as sacrificial agent.

Both the nitrogen fixation and decomposition of nitrogen oxide have just appeared on a new aim for research in the field of semiconductor photocatalysis.

The other advantage of the semiconductor has also been discussed. The first use involves in the fabrication of 3D colloidal photonic crystal by the self-organization of submicron – sized polystyrene (PS) latex sphere. The latex is covered by charged polyelectrolyte and luminescent semiconductor nanocrystal.

NANO - & MICROENGINERRING



IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

FIG 1.2 Schematic **illustration of the assembly of polyelectrolytes and luminescent nanocrystals on polystyrene latex sphere and the organization of monodisperse composite particles into a 3D colloidal crystal.**

The second example constitutes the use of semiconductor nanocrystals as potential amplifiers operating at 1.3 µ m and 1.5 µ m wavelengths for telecommunication devices.

Thirdly, for efficient laser amplification, the excited state must have a life time that is sufficiently long and the material must have high enough quantum efficiency. To put this in perspective, rare earth ions typically have 100µs-fs life times and in some cases, quantum efficiencies close to 100% while in semiconductor lasers, life time may be as short as ion. Cd-HgTe nanocrystal is one of the largest value obtained for the quantum dot class of materials at room temperature. The efficiency is comparable with those of rare earth ion in glasses, while the excited state life times are up to an order of magnitude greater than in semiconductor laser devices. These two features together suggest that this type of material is an ready candidate for laser amplifier application.

Conclusion

Thus the possible applications of the semiconductor nanoparticles are numerous, most of the effort being related to the development of electronic and optoelectronic device, for example, molecular – level quantum computer and the design of new high surface catalyst in chemistry.

Reference

1. Kittel, C. "Introduction to solid state physics", 6th edn., wiley, Newyork, 1986.
2. Tributsch, H: Ber Bunsenges Phys. Chem.. 1977, 81, 361.
3. Finklea, H.O, Semiconductor electrodes, "ed, flinklea HO Elsevier, Amsterdam 1988.
4. Size, S.M. " The physics of semiconductor devices; 2nd edn. Wiley, Newyork, 1981.
5. Nalwa, H.S; hand book of Nanostructured materials and nanotechnology Ist edn. Academic San diego, 2000, 135.