Paper from Proceeding of the National Conference "Science in Media 2012" Organized by YMCA University of Science and Technology, Faridabad, Haryana (India) December 3rd -4th 2012 Published by
IJMRS's International Journal of Engineering Sciences, ISSN (Online): 2277-9698
www.ijmrs.com

Functions of nanostructure phosphors in future technology

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Abstract—**In 21st century it is observed that field of nano phosphors materials are hugely significant and dynamic. There has been a great agreement of interest for nanoscale electronic and photonic applications i.e. flat panel displays including plasma display panels, field emission displays and electroluminescence displays. In all displays panels, phosphors are the key materials and became a very interesting research topic. The oxide- based phosphors with excellent thermal and chemical stability have received increasing concentration. Phosphors materials are generally synthesized by chemical methods. Chemical precipitation, sol gel, reaction in micro emulsions and chemical vapour synthesis are commonly used techniques for fabrications of nanophosphors. These methods are simple, economical and environmentally mild. Nano - crystalline form exhibit different electrical, optical and structural properties to those in bulk form. There are so many reasons for this remarkable difference in their nano versus bulk form i.e. quantum confinement effect, increased relative surface area etc.**

***Index Terms*—Phosphors, Electroluminence**

I. Introduction

Nanostructured materials reveal different structural, optical and electronic properties as compared to those in the bulk form. Nanoparticles in general, have nearly half of their atoms contained in two top monolayers, which make their optical and electrical properties highly sensitive. Synthesize and study of nanostructured materials have become a major attractive interdisciplinary area of research over the past fast few decades. Recently, transition metal(TM) and rare earth ion doped II-IV semiconductor nanoparticles/ nanostructure phosphors materials have received much attention because such doping can modify and improve optical properties of II-IV semiconductor nanoparticles by large amount [1-5]. Rare-earth (RE) ions are better luminescent centres than the transition metal elements because their 4 f intrashell transitions originate at narrow and intense emission lines. Usually, semiconducting nanoparticles are known to exhibit exotic physico-chemical properties due to quantum confinement effect. Especially, nanostructure phosphors materials/ doped luminescent nanoparticles are predicted to show improved optical properties, viz., luminescence efficiency, and delay time and band edge emission with respect to particle size variation. Nanostructure phosphor materials, which has high efficiency and low degradation, is required for the development of lighting technology and for flat panel displays such as field emission displays (FEDs) and plasma display panels (PDPs) [6, 7]. The use of oxide phosphors in place of conventional sulphide phosphors has been preferred for FED applications due to higher stability in high vacuum environment and less emission of contaminating gases [8].

Luminescent materials have opened up a number of new areas of applications such as thin film electroluminescent (TFEL) devices, optoelectronic or cathodoluminescent devices [9, 10]. RE-doped insulators are used in telecommunications, lasers, amplifiers, medical analysis, DNA markers, biosensors, light emitting diodes, etc. as well as in spintronics and photocatalyst [6, 11].

The II–VI semiconductor nanomaterials are unique host materials for doping of highly optically active impurities, and semiconductor doped with luminescence centres exhibit efficient luminescence even at room temperature [12, 13]. High quality II–VI semiconductor nanocrystals and their luminescence properties have been studied recently both experimentally and theoretically [14-18].

CdSe and CdS are the most widely studied among the II–VI semiconductor nanoparticles [14-19]. However, these materials contain toxic elements such as Cd and Se. ZnO is an environmentally friendly material and is one of the suitable candidates for practical use as a nanodevice material. Zinc oxide (ZnO) is a wide bandgap (3· 3 eV) II–VI compound semiconductor with large exciton binding energy (60 meV) at room temperature. It has a stable wurtzite structure with lattice spacing, a = 0· 325 nm and c = 0· 521 nm. Most of the ZnO: RE^{3+} crystals have been synthesized by traditional high temperature solid state method which is energy consuming and difficult to control the particle properties [20-22]. Doping with rare earth elements leads to many interesting properties of ZnO. . Different routes to obtain doped ZnO materials have been studied namely, the incorporation of rare earth metal ions into a semiconductor photocatalyst by ion implantation or by co -precipitation [23].

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Fabrication Methods

Chemical Precipitation Technique

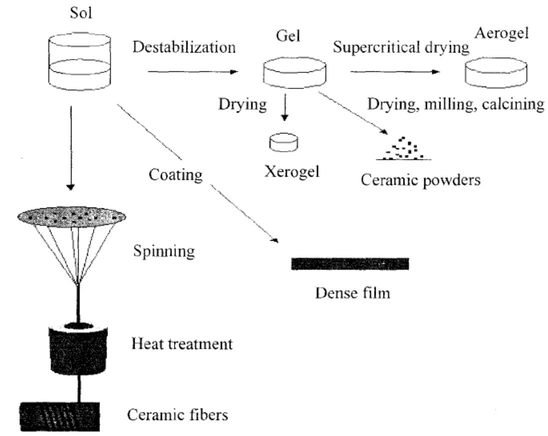
Precipitation is a chemical method whereby nanoparticles are deposited from solution. In this way, for example, metallic/ semiconductor nanoparticles can be produced. The material to be produced/ deposited is dissolved in a solvent, usually water. The addition of appropriate reagents initiates the precipitation. Either the composition of the solvent is modified in such a way that the substance to deposit then becomes less soluble or insoluble, or a new compound is formed that has a significantly lower solubility than the concentration in solution. The formation of nanoparticles proceeds step by step from crystalline/amorphous seeds (primary particles) to particulate agglomerates. It is crucial that the seed formation rate or nucleation rate, respectively, be faster than the growth rate of particles.

In a continuous precipitation process, the particle size distribution as well as the structure of the agglomerates can be fine – turned by process engineering, i.e. by choosing both the appropriate "flow conditions" and "particle – particle interactions"

Sol-Gel Process

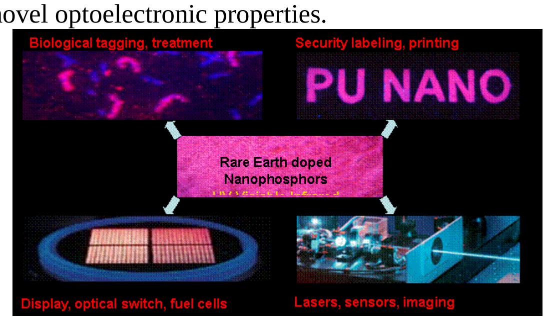
The sol-gel process is an exceptionally important wet chemical method for production of an assortment of nano-technogical products such as powders, thin – coatings, aero-gels and fibers.

In the first step, nano-scale colloids or nanoparticles are formed by reaction of liquid components. Subsequently, sol is converted into the gel state by one of two main methods: the molecule primarily formed in sol can either continue to grow and aggregate by chemical reaction until they form a single macromolecule filling all available space or particulate sols can coagulate until a gel is formed, which is then stabilized by electrostatic repulsion by destabilization of sols or gels, respectively, nanoparticles of defined sizes can be precipitated. One of the most promising possibilities offered by the sol- gel process is the combination of organic and inorganic components into tailor- made organically modified products. Another advantage is the simplicity of method: Production can be carried out in a test tube. On these preparation methods large numbers of research papers are reported [24-27].



Applications

Recently, nanophosphors have become a research focus in terms of both their fundamental and practical importance. They exhibit unique chemical and physical properties compared to their bulk materials. These properties are halfway between macroscopic and microscopic substances. For example, quantum confinement effect of a nanoparticle gives rise to novel optoelectronic properties.



The emission lifetime, luminescent efficiency, and concentration quenching of the phosphor strongly depends on particle size. Due to these unique properties, many potential applications in the area of optical, electrical, biological, mechanical can be developed. For example: Thin film electroluminescent devices, optoelectronic or cathodoluminescent devices, telecommunications, research and development of optical switch, biomarker, new laser, etc are under the way.

Conclusion

It is observed that field of nano structure phosphors materials are immensely booming and dynamic. Many processes such as chemical precipitation with and without capping agents, sol-gel, sol-gel with heating, microemulsion, solid state heating, chemical vapour synthesis, hydrothermal synthesis, etc. have been developed for synthesis of nanophosphors. . Due to the unique properties, these nano phosphors have many potential applications in the area of optical, electrical, biological, and mechanical.

Acknowledgements

The Authors are thankful to Prof. C. M. Batra (Head, Deptt. of AS & H., KIET, Gzb) and Dr. Vipin Kumar (Head, Deptt. Of Physics, KIET, Gzb.) for constant support and encouragement to carry out this work.

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