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Ceramic Materials - The Nano Phosphors

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Abstract

In recent years the phrase nano has become popular in several fields. It is a catch phrase for obtaining research funding, a hot topic for holding seminars and symposia. The popularity can be gauged from the fact that several consumer products, which include a car, use the phrase nano. However, promising and hoping for good results is one thing and achieving them is another. Several projects failed as these promises could not be kept and hopes dashed.

Keywords: Nano structured luminescent materials, Applications.

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I.INTRODUCTION

The work on the nanostructured luminescent materials received impetus with the discovery that luminescence efficiency increase due to quantum confinement. Nanoparticles, ribbons, rods, tubes, etc. were subsequently fabricated with the anticipation that phosphors with higher efficiencies and exotic properties will be obtained. Since the rapid advances in nanotechnologies, particularly, the development of new methods of materials synthesis, there have been growing interests in the spectroscopic erties and luminescence dynamic of activator ions in nanomaterials. Promising applications such as nano phosphors for high resolution display devices are driving forces of the research activities. In nanoparticles, particle size may affect emission lifetime, luminescence quantum efficiency, and concentration quenching.

At present a large fraction of the work on luminescent materials is related to the nano-structured materials. Synthesis and characterization of the nano materials, on the other hand, requires sophisticated instrumentation. Quite frequently, any new observation is assigned to the nano size without examining actual morphology of the phosphors. For nano-phophors one may anticipate modifications of emission and/pr excitation spectra, decrease in decay time, decrease in concentration quenching, decrease in non-radiative processes due to quantum confinement, increased quantum efficiency, tenability of host and activator energy levels for effective transfer, ease of dispersion for device fabrication, etc.

Majority of the phosphor community is focusing on obtaining nano phosphors with higher efficiencies. The efficiencies of nano phosphors seldom exceed those of the bulk, and researchers feel disappointed. However, apart from the high efficiencies there are several other aspects of the nano phosphors which can be exploited for the applications. Some of these are discussed here.

It is not uncommon to find huge reduction in TL output when phosphor size is increased. However, this decrease can be exploited for obtaining TL phosphors for high level dosimetry. Irradiation as a quarantine treatment of fresh fruits and vegetables and as a method to ensure the hygienic quality of food of animal origin is increasingly accepted and applied. The effectilveness of processing of food by ionizing radiation depends on proper delivery of absorbed dose and its reliable measurement. For food dosimetry, it is important that the dosimetry techniques used for dose determination should be simple and accurate. If the drop in the radiation sensitivity leads to the extension of the linearity range upto KGy, the phosphors will be useful for such applications.

Another aspect of the nano phosphors not much exploited by us is their dispersibility. Owing to the dispersibility in liquids, these can be easily applied on the surfaces. This can be immensely useful for obtaining luminescent solar concentrators in general and Silicon photocells for harnessing solar energy, in particular.[1] Crystal silicon (c-Si) solar cells most effectively convert photons of energy close to the semiconductor band gap. The mismatch between the incident solar spectrum and the spectral response of the c-Si have been estimated to be 29% by Shockley and Queisser.[2] However, this limit is estimated to be improved up to 38.4% by modifying the solar spectrum by a quantum cutting down converting phosphor which converts one photon of high energy into two photons of the lower energy.[3]

Applications in the field of biomedicine is perhaps the most important glamorous, but neglected by the Indian phosphor community- aspect of nano phosphor research. Size of biomolecules matches that of the nano phosphors. In principle, it is possible to attach nano phosphor particles to biomolecules. This fact can be exploited for applications in biomedical engineering. During the next decade this could be themost important application of nano phosphors. In vivo fluorescence imaging with near infrared (NIR) light holds enormous potential for a wide variety of molecular diagnostic and therapeutic applications. The recent emergence of infrared optical imaging systems has expanded the biomedical applications for infrared-emitting rare-earth doped naomaterials in diagnosis and imaging. Using conventional fluorescent probes with visible emissions to image deep organs such as liver and spleen are not adequate considering the low tissue penetration depth of visible light 9<1 cm). Tissue penetrating infrared light would be required for deep tissue imaging. By using near-infrared-emitting quantum dots and the tissue transparent regions centered at 840, 1110, 1320, and 1680nm to enable detection depths of (5-10) cm, tumor imaging sensitivity was reported to potentially improve by at least tenfold.[4,5,6]

These newly emerging applications are elucidated here. It is concluded that nano phosphor research may be directed to these profiting areas rather than competing with the bulk phosphors in the traditional applications.

Phosphors the ceramic materials should able to work in touch environment surrounded and bombarded by high energy Vaccum Ultra Violet (VUV) or electron beam radiations in any discharge tube. The plasma display panel(PDP) is increasingly gaining attention over conventional cathode ray tube(CRT)-based TV s as a medium of large format(60+") television(TV), particularly high definition TVs (HDTVs). Improvements have been made not only in size but also in other areas such as resolution. Luminescence efficiency, brightness, contrast ratio, power consumption and cost reduction. The performance of a PDP depends on a complicated set of factors, for instance, phosphors, gas mixture, dielectric layer, reflective layer, black matrix, electrodes, cell dimension and shape, nature, size and shape of electrodes, address waveforms and operational voltages. The performance and lifetime of a PDP is strongly related to the nature of phosphors and their resistance to energetic discharge ions and electrons and solarization from vaccum UV (VUV) arising from the Xe/Ne gas discharge. Compared with standard, the performance and lifetime of a PDP is strongly related to the nature of phosphors and their resistance to energetic discharge ions and electrons and solarization emissive display such as CRTs(5-6 lm/W), the efficiency of a PDP is low (1-2 lm/W).

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