Nanomedicine & Biotherapeutic Discovery

Extended Abstract

Luminescent nanomaterials and their applications

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Abstract

Phosphors have many uses today in applications such as electronic information displays, solid state lighting, solar cells, advertising and theft prevention. By using urea-assisted solution combustion method, we prepared tunable multicolour and white light emitting rare-earths (Pr^{3+} and Dy^{3+}) doped oxyorthosilicate (R_2SiO_5) (R = La, Y, Gd) phosphors. We have investigated the photoluminescent properties of $LaYSiO_5:Dy^{3+};Pr^{3+}$, $LaGdSiO_5:Dy^{3+};Pr^{3+}$, $GdYSiO_5:Dy^{3+};Pr^{3+}$ and $La_{2-x}Gd_xSiO_5:Dy^{3+};Pr^{3+}$ (x = 0, 0.5, 1.0, 1.5 and 2.0) in powders and thin film forms. The films were ablation deposited onto Si (100) substrates using the pulsed laser deposition technique. Several deposition parameters were varied, including vacuum versus partial pressure of gas (O_2 or Ar), type of laser pulse, and substrate temperature. The samples were analyzed using X-ray diffraction, scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), energy dispersive X-ray spectroscopy and photoluminescnt spectroscopy. The photoluminescent (PL) data were collected in air under excitation by either a 325 nm HeCd laser or a monochromatized xenon lamp. The PL intensities were strongly dependent on the Pr^{3+} and Dy^{3+} dopant concentrations, the ratio of La to Gd, deposition condition and post-deposition annealing. Data from the scanning electron microscopy and atomic force microscopy showed that the major influence of the deposition conditions on the PL intensity was through changes in the morphology and topography of the films, which affects light scattering and out-coupling. The colour purity of the bands estimated using CIE coordinates confirmed that our samples were emitting tunable multicolour and white light. The elemental composition analysis indicated that there was a correlation among the EDS, XPS and TOF-SIMS data. The structure, particle morphology, surface chemical composition and electronic states, photoluminescent properties and possible applications of these materials in UV-pumped LEDs will be discussed.

the past two decades, luminescence nanomaterials have attracted a considerable amount of interest because of their unique physicochemical, structural, and spectroscopic characteristics. Apart from their applications in classic phosphor technologies such as in fluorescent lamps, light emitting diodes, emission displays, X-ray detectors, and tomography, luminescent nanomaterials continue to provide breakthroughs in the areas of security (banknotes, identification documents, etc.), biological labeling (e.g., in research and for non-invasive medical diagnosis), sensing, and photovoltaics. It is possible to finely tune their spectroscopic and physicochemical properties suiting specific requirements. Important examples of these materials include semiconductor quantum dots, carbon dots, metal-doped nanomaterials, metal nanoclusters, or organic–inorganic composites and hybrids.
Nanoparticles have recently emerged as an important group of materials used in numerous disciplines within the life sciences, ranging from basic biophysical research to clinical therapeutics. Luminescent nanoparticles make excellent optical bioprobes significantly extending the capabilities of alternative fluorophores such as organic dyes and genetically engineered fluorescent proteins. Their advantages include excellent photostability, tunable and narrow spectra, controllable size, resilience to environmental conditions such as pH and temperature, combined with a large surface for anchoring targeting biomolecules. Some types of nanoparticles provide enhanced detection contrast due to their long emission lifetime and/or luminescence wavelength blue-shift (anti-Stokes) due to energy upconversion. This topical review focuses on four key types of luminescent nanoparticles whose emission is governed by different photophysics. We discuss the origin and characteristics of optical absorption and emission in these nanoparticles and give a brief account of synthesis and surface modification procedures. We also introduce some of their applications with opportunities for further development, which could be appreciated by the physics-trained readers. Nanoparticles have recently emerged as an important group of materials used in numerous disciplines within the life sciences, ranging from basic biophysical research to clinical therapeutics.

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