Synthesis of yttria nanoparticles using NIPAM/AAc copolymer

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Abstract
Purpose – The purpose of this paper is to evaluate the effect of copolymer and starting material concentrations in homogeneous precipitation synthesis of Yttria nanoparticles and red-emitting nanophosphors Y2O3:Eu3+. N-isopropylacrylamide and acrylic acid (NIPAM/AAc) and urea are used.

Design/methodology/approach – To optimise synthesis condition of Y2O3:Eu3+ nanophosphor NIPAM/AAc copolymer was used as a modifier and the effect of various concentration of yttrium ions, urea and precipitation time on size, morphology and emission spectra were investigated.

Findings – Using NIPAM/AAc copolymer shows significant improvement on size and dispersion of nanoparticles. It is found that yttrium concentration, varying between 0.006 and 0.03 M, has a profound impact on the average size of particles, which systematically increases from 65 to over 165 nm. The rate of precipitation reaction, however, is shown to be independent of yttrium concentration. In contrast, as urea concentration increases from 0.2 to 5 M, the average particle size exhibits a gradual decrease from 183 to 70 nm. At extremely high urea concentration such as 5 M, a significant level of inter-particle agglomeration is observed.

Originality/value – Based on this paper, the authors have successfully prepared some promising nanophosphors. The nanoparticles are studied by X-ray diffraction, transmission electronic microscopy, zeta sizer, Infra red and photoluminescence spectroscopy.

Keywords Polymers, Precipitation, Nanotechnology, Powders

Paper type Research paper

Introduction
Yttrium oxide has often been used as a host material for phosphors and other optical applications. It is one of the best hosts for lanthanide ions, because its ionic radius and crystal structure are very similar to many lanthanide oxides. Doping with a variety of lanthanide ions (Eu for red, Tb for green, Dy for yellow and Tm for blue) which can yield materials with a variety of lanthanide ions (Eu for red, Tb for green, Dy for yellow and Tm for blue) which can yield materials with different fluorescent spectra (Dosev et al., 2006). Red-emitting phosphor Y2O3:Eu3+ is widely used in industries because of its high brightness, acceptable atmospheric stability, reduced degradation under applied voltages and lack of hazardous constituents as opposed to sulphide phosphors (Kang et al., 2000).

Furthermore, nanosized Y2O3:Eu3+ is currently a great deal of interest in the production of novel types of flat panels, trichromatic fluorescent lamps, cathode ray tubes, field emission displays, and high-definition displays (Williams et al., 1999; Sharma et al., 2002; Feldmann et al., 2003; Kim Anh et al., 2003).

Some requirements for the successful application of such devices are the development of new types of phosphors, capable of being excited by low-energy (typically less than 2 kV) sources, and have high quantum efficiency with monodis per se crystalline fine particles (Schmechel et al., 2001). For good luminescence characteristic, phosphors must have fine size, narrow size distribution, nonaggregation and spherical morphology particles (Sun et al., 2001). Nanomaterials display novel, often enhanced properties compared to traditional materials (Kim et al., 2003).

A variety of methods such as sol-gel (Tanner and Wong, 2004; Sharma et al., 2000; Cannas et al., 2002; Subramanian et al., 2001), chemical precipitation of precursors in aqueous or organic solutions (Wakefield et al., 2001; Sun et al., 2004; Silver et al., 2007), spray pyrolysis (Kang et al., 2000), hydrothermal synthesis (Bai et al., 2005), combustion synthesis (Tessari et al., 1999; Vu et al., 2007) and gas phase condensation method (Williams et al., 1999) have been proposed for obtaining small, uniform, unagglomerated powders. Martinez et al. reported a novel preparation of very small spherical particles of Y2O3:Eu3+ precursors using a copolymer of N-isopropylacrylamide (NIPAM) and acrylic acid (AAc) (10 wt%). The physical properties of NIPAM microgel systems have received considerable attention due to their potential for application in a large variety of areas (Martinez-Rubio et al., 2001). It is possible to introduce specific groups on...