# 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 $Y_2O_3$:$Eu^{3+}$. *N*-isopropylacrylamide and acrylic acid (NIPAM/AAc) and urea are used.

**Design/methodology/approach** – To optimise synthesis condition of $Y_2O_3$:$Eu^{3+}$ 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 different fluorescent spectra (Dosev *et al.*, 2006). Red-emitting phosphor $Y_2O_3$:$Eu^{3+}$ 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 $Y_2O_3$:$Eu^{3+}$ 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).


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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 luminescent 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 $Y_2O_3$:$Eu^{3+}$ 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


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