Advanced Powder Technology xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Advanced Powder Technology

journal homepage: www.elsevier.com/locate/apt

Original Research Paper

Design of Bi-functional composite core–shell SiO_2@$ZnAl_2O_4$:Eu^{3+} array as fluorescent sensors for selective and sensitive latent fingerprints visualization protocol

F. Femila Komahal [a,b], H. Nagabhushana [c,*], R.B. Basavaraj [c], G.P. Darshan [d], B. Daruka Prasad [e], S.C. Sharma [f,g], D. Kavyashree [h]

[a] Department of Physics, Government Science College, NT Road, Bangalore 560 001, India
[b] Research and Development Center, Bharathiar University, Coimbatore 641 046, India
[c] Prof. C.N.R. Rao Centre for Advanced Materials Research, Tumkur University, Tumkur 572 103, India
[d] Department of Physics, Acharya Institute of Graduate Studies, Bangalore 560 107, India
[e] Department of Physics, B.M.S. Institute of Technology, Visveswaraya Technological University, Bangalore 560064, India
[f] Department of Mechanical Engineering, Jain University, Jain Group of Institutions, Bangalore 560 069, India
[g] Avinashilingam Institute for Home Science and Higher Education for Women University, Coimbatore 6410 43, India
[h] Department of Physics, HMS Institute of Technology, VTU Affiliation, Tumkur 572 104, India

ARTICLE INFO

Article history:
Received 5 December 2017
Received in revised form 29 April 2018
Accepted 2 May 2018
Available online xxxx

Keywords:
Core–shell
Latent fingerprints
Photoluminescence
J-O parameters
Sweat pores

ABSTRACT

Core–shell SiO_2@$ZnAl_2O_4$:Eu^{3+} (5 mol%) nanophosphor (NP) with coatings up to the level IV has been prepared by a facile solvothermal route, followed by heat treatment. Scanning electron microscopy studies of fabricated core–shell particles displays good spherical shape and non-agglomeration with a narrow size distribution. The thickness of the shell increased with increase in coating cycles. Photoluminescence (PL) studies exhibited strong red emission peaks at 612 nm corresponding to the $^5D_o \rightarrow {}^7F_2$ transition of the Eu^{3+} ions. PL intensity increased with calcination temperature and coating cycles. The color coordinates of the coated NP were turned towards intense pure red emission with color purity ~95%. Powder dusting method was used to visualize latent fingerprints (LFPs) by staining uncoated and coated NP on various porous and non-porous surfaces under UV light. It was clear that core–shell NP display high sensitivity, reproducibility, selectivity, reliability, and can obtain the complete three levels of friction ridge details. Judd–Ofelt (J-O) intensity parameters and radiative properties, namely transition probabilities, radiative lifetimes, branching ratios, and quantum efficiency were evaluated. The aforementioned results established that the SiO_2@$ZnAl_2O_4$:Eu^{3+} (5 mol%) NP can be used as an ideal candidate for multifunctional applications such as WLEDs, LFPs, anticounterfeiting etc.

1. Introduction

Inorganic nano/micro structured phosphors with diverse shapes namely wires, rods, tubes, belts, hollow spheres, core–shells have been a great interest owing to their outstanding applications [1,2]. Among all the inorganic materials, spherical core–shell phosphor shows improved functional properties and expands a broader range of potential applications in plasma display panels (PDPs) and field emission displays (FEDs) when compared to single-component phosphors. The phosphors used in a novel light emitting diodes (LEDs) required a perfect spherical shape, narrow size distribution and absence of agglomeration results high brightness, high spatial resolution, high packing density and low light scattering [3–5]. From the Stöber process, the size of each silica particles can be precisely controlled from nanometers to micrometers. These particles are generally used in core–shell materials either as cores or as shells. If the silica spheres can be coated with phosphor layers than a core–shell phosphor with spherical morphology can be achieved and the size of the phosphor particles can be controlled by the silica cores [6–8].

Recently, by changing the core materials' shape, size or the shell's thickness, morphology and the size of the core–shell materials can be tailored easily [9–11]. Silica is preferred as a core–shell structured materials because of their inexpensiveness, easiness to get spherical particles with narrow size distribution, chemical

* Corresponding author.
E-mail address: bhushanvlc@gmail.com (H. Nagabhushana).

https://doi.org/10.1016/j.apt.2018.05.004
0921-8831/