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Diminution in photoluminescent intensity of SrS: Ce^{3+} phosphor due to increased milling time

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ABSTRACT

Cerium doped strontium sulfide [SrS: Ce^{3+} (0.5 mol%)] nanophosphor is synthesized by solid state diffusion method. Effects of high-energy ball milling on morphological and optical properties of SrS: Ce^{3+} (0.5 mol%) are reported. The effects of reduced particle size on the structural and photoluminescent properties of as-prepared nanophosphor due to milling (3 h, 6 h and 10 h) have been investigated. The XRD results confirm the cubic structure of SrS: Ce^{3+} nanophosphor showing wider diffraction peaks due to increased milling time. Ultraviolet (UV-375 nm) excited SrS: Ce^{3+} nanophosphor exhibits two photoluminescent emission peaks at 459 nm and 551 nm in blue and green regions respectively due to 5f→4d transitions of Ce^{3+} ions. The loss in photoluminescent intensity with increasing milling time and afterglow are discussed and interpreted.

1. Introduction

Nanostructure materials are not only in the forefront of the newest fundamental materials research nowadays, but they have regularly intruded in our daily life also [1–3]. The famous statement of legendary Richard Feynman made in 1959 in which he predicted plenty of possibilities at nano scale, has been realized in less than half a century by consistent efforts and significant contributions from the scientific community across the globe [4]. These materials are a new class of materials having dimensions in the 1–100 nm range, that provides one of the greatest potentials for improving performance and capabilities of products in a number of industrial sectors completely [5]. Recently, these materials have been paid great attention owing to their unique optical properties that can be tuned not only by changing the particle size but also by changing the composition of the alloy [6–8]. Because of their smaller size, nanophosphors exhibit novel properties, which differ considerably from their bulk counterparts [9]. This is due to the presence of a large number of atoms located at the grain boundaries of the small crystallites and in low dimensional systems, electrons and holes are spatially confined causing quantum size effects (QSE) [10]. Luminescence of nanophosphors has provided new opportunities in material science related research such as enhancement of magnetic, optical and electronic properties of materials [11].

Semiconductor nanostructures, also known as quantum dots have gradually gained more prominence as materials for optoelectronics, photonics, spintronics, catalysis, and biomedical applications. Because of these applications, and unique size-dependent properties many research groups have pursued the synthesis and characterization of nanoparticles with various compositions, sizes, shapes, and properties [12]. After an important report on photoluminescence (PL) properties of Mn doped ZnS nanophosphor [13], much attention has been paid to explore optical properties of nanostructure materials. Many articles are published on the optical properties of rare earth (RE) ions doped ZnS [13–15], CdS [16,17] and CaS [18,19] nanostructures, but studies on SrS nanostructures are still limited.

RE ions and transition metal (TM) ions are the most frequently used phosphor activators [20–22]. Benefiting from abundant energy levels of 4f configurations, trivalent lanthanide ions (Ln^{3+}) are endowed with unique and fascinating optical properties. Possessing real intermediate energy levels, Ln^{3+} can give out desired emissions via various energy transfer pathways. Inheriting their native intra-configurational transitions, Ln^{3+} activated luminescent materials have been receiving regular attention due to their

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