

Optical Properties of Rare Earth Doped SrS Phosphor: A Review

AYUSH KHARE,^{1,4} SHUBHRA MISHRA,¹ D.S. KSHATRI,²
and SANJAY TIWARI³

1.—Department of Physics, National Institute of Technology, Raipur 492 010, India. 2.—Department of Physics, Shri Shankaracharya Institute of Professional Management and Technology, Raipur 492 015, India. 3.—School of Studies in Electronics and Photonics, Pt. Ravishankar Shukla University, Raipur 492 010, India. 4.—e-mail: akhare.phy@nitrr.ac.in

Rare earth (RE) doped SrS phosphor has attracted a lot of attention on a wide range of photo-, cathodo-, thermo-, and electroluminescent applications. Upon doping with different RE elements (e.g., Ce, Pr, Eu, Yb), the luminescence from SrS can be varied over the entire visible region by appropriately choosing the composition of the strontium sulfide host. The main applications include flat panel displays and SrS-based powder electroluminescence (EL) for back lights. Sulfide materials known for providing Eu²⁺ based red emission band and preferred as a color conversion material in white light emitting diodes are discussed. Especially, the applications of RE doped SrS are described in light of their utility as conversion and storage phosphors. The effect of energy level splitting, EL efficiency, post-annealing, milling time, and impurity on luminescence properties for SrS are also discussed.

Key words: Optical materials, SrS:Ce, luminescence, indirect band gap, nanostructures

INTRODUCTION

Luminescence is a phenomenon that has captivated mankind for a long time. Light, emitted by glow worms, the Aurora Borealis, rotting fish, luminescent wood, and meat belongs to the family of naturally occurring luminescence. The first study of luminescent materials started in 1603. Although it is not clear which dopant or dopants are actually responsible for persistent luminescence, BaS was a largely investigated host material.¹ BaS, made accidentally, is supposed to be the first-ever synthesized sulfide phosphor. The name phosphor was already in use in ancient times, even though the chemical element phosphorous was only isolated in 1669 by the German alchemist Hennig Brand.² Phosphorous becomes luminescent under moist conditions upon oxidation. Thus, phosphorous is a chemiluminescent (CL) material, and the name phosphorescence, generally used for persistent

photoluminescence, is inaccurate.³ In the subsequent centuries, many scientists synthesized and investigated glowing materials, but it was too untimely for a systematic study. However, the amalgamation of CaS as a phosphor in 1700 by Friedrich Hoffmann and of SrS in 1817 by J. F. John are important to mention. Curiously enough, the luminescent properties of ZnS, which was going to become one of the largest investigated luminescent hosts in the twentieth century, were not acknowledged until 1866, when the so-called Sidot blend (hexagonal ZnS) was developed by Theodor Sidot.⁴ In 1888, Eilhard Wiedemann was the first to classify different phosphors according to the type of excitation and is credited for introducing the terms luminescence, photoluminescence (PL), electroluminescence (EL), thermoluminescence (TL), chemiluminescence, triboluminescence, and crystalloluminescence.⁵

Luminescence is a spontaneous radiative recombination process involving electrons and holes.⁶ The excitation of carriers prior to recombination requires an excitation source, which can be

(Received December 20, 2015; accepted September 23, 2016; published online October 24, 2016)