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Physical basis of persistent luminescence: the case of europium doped $Ca_{1-x}Sr_xS$

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ABSTRACT

The physical basis of persistent luminescence in terms of the color of emission as well as the useful afterglow time is discussed for a commercial red-emitting $Ca_{1-x}Sr_xS$:Eu phosphor. The discussion is based on the results of excitation/emission spectra and critical analysis of thermoluminescence (TL) data. The work focuses on: (i) the well known tuning of emission in $Ca_{1-x}Sr_xS$:Eu phosphor (ii) control of intrinsic trapping parameters that decides the lifetime (τ) of charge in traps relevant to the phenomenon of persistent luminescence. XRD data is used to characterize the commercial phosphor. The emission spectra (λ_{ex}=275nm) reveals the prominent well known broad emission (FWHM= 0.20eV) at 1.92eV/647nm of Eu^{2+} along with weak transitions at 1.63 eV/761nm, 1.75eV/710nm, 2.13eV/581nm and 2.56eV/485nm indicating presence of europium in Eu^{3+} state. Rigorous analysis of TL shows that non-first order TL peaks having $\tau_{300}\approx$mins to hours are key to persistent luminescence in $Ca_{1-x}Sr_xS$:Eu.

Keywords: Persistent Luminescence, Thermoluminescence, Phosphors, $Ca_xSr_{1-x}S$:Eu.

1. Introduction

Modern industrial materials are essentially designed ones for specific purpose. Luminescent materials (phosphors) are no exception. Phosphors are designed for various colors by an appropriate selection of host materials and activators. They are chemically stable and cost effective; in addition to being weather and heat resistant. Persistent luminescent materials (also called Afterglow Phosphors or Glow-in-the-Dark phosphors), although satisfy the above