TO GLOW AFTER OR NOT TO GLOW AFTER?

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Introduction

During last decade, afterglow phosphors have attracted considerable attention due to their potential applications in various fields, including emergency signs, light sources, luminous paints or optical data storage. Till now, the most efficient afterglow materials are based on strontium aluminates e.g. SrAl₂O₄:Eu²⁺,Dy³⁺, Sr₄Al₁₄O₂₅:Eu²⁺,Dy³⁺. These materials yield strong luminescence due to the interconfigurational 4f⁷ – 4f⁶5d¹ transition of Eu²⁺. The afterglow can be prolonged by co-doping additional ions like Dy³⁺ or Nd³⁺. Although extensive studies were conducted on afterglow phosphors, the mechanism underlying this phenomenon still remains unclear and existing theories are even contradictory.

This work deals with two afterglow materials based on strontium aluminates and aims at understanding the physics behind the persistent luminescence mechanism. Strontium aluminates easily generate the multi-phases compounds according to molar ratio of SrO to Al₂O₃. Among all aluminates only SrAl₂O₄:Eu²⁺ and Sr₄Al₁₄O₂₅:Eu²⁺ show persistent luminescence. The aim is to understand why aluminates are the most suitable host lattices for persistent luminescence and why two of them show stronger afterglow.

Aim

Results

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In this work it is demonstrated, that long persistent luminescence in Sr₄Al₁₄O₂₅:Eu²⁺ and SrAl₂O₄:Eu²⁺ phosphors can be amplified by co-doping with Dy³⁺ ions, which form additional electron traps. These two phosphors show afterglow even without co-doping. This phenomenon can be explained by the presence of defects in the host lattice. In case of Sr₄Al₁₄O₂₅:Eu²⁺ Self-Trapped Exciton (STE) emission was observed at 420 nm nm at low temperature. With increasing temperature thermally induced exciton diffusion occurs, resulting in energy transfer from the STE state to 5d levels of 10-coordinated Eu²⁺ which shows spectral overlap in this energy range. In case of SrAl₂O₄:Eu²⁺ at a low doping level and excitation via the band edge defect luminescence was observed at 350 nm. Both, Sr₄Al₁₄O₂₅:Eu²⁺ and SrAl₂O₄:Eu²⁺ phosphors have two strontium sites which increase the probability of the spectral overlap between the excited Eu²⁺ 4f⁵d states and the trap states.

Conclusions