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Research Article

Brief Review on Photoluminescence and Persistent Luminescence of Rare Earth Activated $Sr_4Al_{14}O_{25}$ Phospho

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ABSTRACT

A Systematic scientific study of the subject of luminescence is of recent origin, from the middle of 19^{th} century. Due to excellent photo-resistance and chemical stability, great brightness, long-lasting time, no radiation and environmental capability, which resulted in their wide applications in many fields, are more appropriately focused by scientists and engineers. From this literature review we got to know that the tetra strontium aluminate phosphors could be synthesized by solid state reaction method and combustion method. By doping different rare earth in a host matrix the emission color could be changed.

INTRODUCTION

Luminescence is a science closely related to spectroscopy, which is the study of the general laws of absorption and emission of radiation by matter. The existence of luminous organisms such as bacteria in the sea and in decaying organic matter, glow worms and fireflies have mystified and thrilled man since time immemorial. A systematic scientific study of the subject of luminescence is of recent origin, from the middle of nineteenth century. In 1852 English Physicist G. C. Stokes identified this phenomenon and formulated his law of luminescence now known as Stoke's law, which states that the wavelength of the emitted light is greater than that of the exciting radiation. German physicist E. Wiedemann introduced the term 'luminescence' (weak glow) into the literaINTRODUCTION.

The phenomenon of certain kinds of substance emitting light on absorbing various energies without heat generation is called luminescence. Luminescence is obtained under variety of excitation sources. The wavelength of emitted light is characteristic of the luminescent substance and not of the incident radiation.

In the recent few years research on the field of the persistence Luminescence (aluminate-based phosphors) are more appropriately focused by scientists and engineers due to that showed excellent photoresistance and chemical stability, great brightness, long-lasting time, no radiation and environmental capability, which resulted in their wide applications in many fields, such as traffic signs, chemical sensors, optical recording device, biological imaging, emergency signs, military application, textile fibers & textile printing, exit signboards, electronic instrument dial pads, luminous point, ink, safety indicator, advertisement card, interior decoration, emergent lighting and display, etc. Sr4Al14O25 doped with rare earth element in 1996, research on efficient persistent phosphors has continuously gained much interest. However, the number and types of persistent luminescence material are still relatively limited to date, and the interest worldwide has mainly focused on rare-earth (RE) containing inorganic materials. Unfortunately, the high-cost and relatively complicated preparation methods (such as high temperature solid state processes) present a barrier to commercialization. Therefore, the development of new types of inexpensive, energy-efficient, eco-friendly, and RE-free afterglow material is highly desirable.

LUMINESCENCE

When the molecules of matters (says solid, liquid, gas) are raised to an excited electronic state by illuminating the matters with light of definite frequency, they may revert to their initial state with the emission of discrete radiation of frequencies smaller than the frequency of the absorbed light. This phenomenon is known as 'luminescence'.

The emission is may vanish almost immediately after the removal of the exciting radiation, or it may persist for an appreciable time. The formal is called 'fluorescence' and the later 'phosphorescence'. Their combination is name is luminescence .

Luminescence is any emission of light (electromagnetic waves) from a substance that does not arise from heating. This definition makes luminescence distinct from incandescence which is light emission due to the elevated temperature of a substance, such as a glowing hot ember. The word luminescence is derived from the Latin word for light, lumen, and the Latin, escentia, meaning 'the process of' and hence is the process of giving off light.

Photoluminescence from quantum dot semiconductors Upper Right: Chemiluminescence (bioluminescence) of jellyfish, Lower Left: radioluminescence of a tritium watch dial, Lower Right: electroluminescence of an OLED phone display.

LITERATURE REVIEW

Danuta Dacyl et al. (2009) investigated the effect of calcium substitution on the afterglow of tetrastrontium aluminate phosphors (Sr4Al14O25:Eu2+, Dy3+). A series of (Sr1-xCax)O•nAl2O3:Eu2+(1%), Dy3+(0.5%), with variation of calcium content (x = 0 – 1), were synthesized by a high temperature solid state reaction in a reducing atmosphere. The photoluminescence, persistent luminescence (afterglow), and lumen equivalents of these materials were studied and compared. It turned out that the afterglow properties of the phosphors were strongly dependent on the Sr/Ca ratio. As the Ca content increased, a phase transition and blue shift in emission spectra were observed.

Hitoshi Kanno et al. (2013) prepared new long afterglow phosphors of Sr4Al14O25:Yb2+, Dy3+ and SrAlxO(1+1.5x):Yb2+ (x = 3, 4, 5) by sintering the thermally decomposed precursors under reducing condition at 1200–1400oC. The thermally decomposed precursors were obtained by heating either hydroxide or nitrate mixtures at temperatures below 300oC. The phosphor Sr4Al14O25:Yb2+, Dy3+ showed long afterglow property comparable with the famous phosphor Sr4Al14O25:Eu2+, Dy3+ in phosphorescence life time though phosphorescence intensity is weaker than the latter.

Tao Jiang et al. (2014) reported the phosphorescence decays of the longafterglow materials of SrAl2O4:Eu, Dy, Sr4Al14O25:Eu, Dy, Sr2MgSi2O7:Eu, Dy, and ZnS:Cu, Co over long time (15h to 16h). The evaluation methods of luminescence decay are analyzed and summarized. The existing formulas are in accordance with the experimental decay data in the initial fast decay stage. However, the deviation is much larger and the accuracy is much lower in the slow decay stage. Therefore, the existing formulas cannot be used to accurately describe the luminescence decay of the samples with much longer afterglow time (480 min). Moreover, certain formulas do not match the actual decay situation of long- afterglow luminescence.

Zhao-Xin Yuan et al. (2004) discussed the effect of composition on the afterglow phosphorescence of Sr4Al14O25: Eu2+, Dy3+ phosphors. The different composition did not make any difference on the emission peaks of the phosphors. All the phosphors show a broad band emission peak at λ = 490 nm. However, long afterglow properties of the phosphors were influenced by the composition of starting materials. Al-rich phosphors have better long afterglow properties with high emission intensity and longer decay time than the phosphors rich in Sr, which can be ascribed to the different trap levels and trap concentrations formed in the hosts.

LI Qun et al. (2010) synthesized long lasting blue-green-emitting Sr4Al14O25:Eu2+ phosphors by solid-state reactions. The phosphors were investigated by X-ray diffraction (XRD) and fluorescence spectrophotometer. A pure phase of Sr4Al14O25: Eu2+ phosphor was obtained at 1250°C. There are two different types of Eu emission centers in Sr4Al14O25:Eu2+ phosphor. The effects of the Eu2+ concentration and the reducing temperature on the distribution of Eu2+ among different sites were investigated. The energy transfer mechanism between two different emission centers was elucidated via the investigation of thermal damage influence on the phosphorescence spectra, that is, the energy emitted from an Eu1 emission center could be reabsorbed by an Eu2 emission center.

CONCLUSIONS

In this review work we came to know that luminescence is a cold emission of light from a material. In luminescence light is emitted from a substance without raising its temperature. Luminescence is classified into different types depending upon the mode of excitation. Materials which exhibit the phenomenon of luminescence are known as phosphor materials. Phosphors are generally inorganic materials incorporated with impurity atoms in small amount.

From the literature review we got to know that the tetra strontium aluminate phosphors could be synthesized by solid state reaction method and combustion method. By doping different rare earth in a host matrix the emission color could be changed.

By analyzing the Photoluminescence emission spectra of a given material its emission color wavelength could be predicted. PL intensity is enhanced with increasing doping concentration in a host material at a certain point, increasing the doping concentration beyond this limit PL intensity decreases due to concentration quenching.

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