Chapter 4
Synthesis and Characterization of Lightweight Beryllium Chloro Silicate Phosphor

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ABSTRACT

In this chapter, low weight barium-based cholorsilicate Ba5Cl6Si2O6:Eu2+ is prepared through a solid-state reaction. To confirm the structure of the synthesized phosphors, powder photographs were obtained using an x-ray diffractometer. Photoluminescence spectra and FTIR spectra were recorded. Photoluminescence spectra are studied. The emission peak is observed at 407 nm at excitation 275 nm. The intense violet-blue emission is obtained. The broad excitation band and strong emission indicate that Ba5Cl6Si2O6:Eu2+could be a good phosphor candidate for blue LED and white LEDs. Decay curve indicates the phosphor has a long afterglow feature.

INTRODUCTION

Various kinds of phosphors are already commonly used in many lighting devices, including common fluorescent tubes, electroluminescent wires, strips and surfaces, and LEDs. In a ubiquitous fluorescent tube, the inside is coated with phosphors of light weight .Electricity excites the gas-filled tube to produce shortwave light, which in turn causes the phosphors to become fluorescent and produce visible light. White LEDs, with their characteristics of compact size, high efficiency, long lifetime, low power requirement, light weight and energy savings (Zhu, 2012) can be widely used in various applications such as liquid crystal display backlighting, full-color displays, cell phones, and traffic signals. White LEDs are expected to replace conventional incandescent and fluorescent lamps in the near future (Du,2009). Eu2+-activated silicate phosphors, which have broad emission band through 5d–4f energy transition of Eu2+ activator ion, are suitable for the application of white LEDs. Eu2+ doped chlorosilicates give intense emission and which may be useful for many applications.

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Silicate materials are useful in many applications of technological importance. Zeolites, a type of microporous aluminosilicates, are widely used as molecular sieves and catalysts. The zeolites have received less attention as potential luminescence materials. However, increasing interest in the study of guest-host composite materials has heightened research in these well-defined periodic microporous structures that are almost UV transparent and inexpensive. The lithium ceramics are promising breeder materials for fusion reactors. Rare-earth-containing silicate glasses have attracted great attention as potential materials for optical and magneto-optical devices such as an upconversion laser, a hole burning memory, and an optical switch. Though silicate-based phosphors are widely used as described in 1.6, there are some problems with synthesis and long-term use of silicates. Silicates need temperatures higher than 1000 C, even up to 1400 C for synthesis. They may get converted to glassy form. At high synthesis temperatures they can also react with low-cost crucible materials such as porcelain and china clay. During recent years, scientists have turned their attention towards chlorosilicates to get over these problems. In silicate lattices, an introduction of chloride ion can induce a red shift of excitation and emission bands of Eu2+ and Ce3+ ions because Cl ions with strong coordination effect can strengthen the crystal field splitting. Moreover, Chlorosilicates can be easily prepared by solid state reactions at temperatures below 1000 C, often as low as 700 C. They have good chemical, physical and thermal stability. Availability of cation sites with varying coordination and symmetries results in tunability of activator emission and excitation spectra. Variety of Chlorosilicates are known in chemistry and mineralogy.

Luminescence that persists after the removal of the excitation is called afterglow or persistent phosphorescence. Long-lasting phosphorescence is a phenomenon due to the thermal stimulated recombination of holes and electrons at traps which leave holes or electrons in a long-lived excited state at room temperature (Kuang, 2006). The first record of persistent phosphorescent material is in the Song dynasty of China (11th century A.D.). In the miscellaneous notes by a Song monk, of which the title is Xiang-Shan Ye-Lu, there is a story about a long-lasting phosphorescent painting. On the painting was a cow that appeared during the daytime as eating grass outside the pen, but at night as resting in it. The ink that was shown in the dark for a given duration after absorption of light is long lasting phosphorescent material. As novel functional materials, the long afterglow phosphors are drawing more and more attention in recent years because of their applications in traffic signs, emergency signage, watches and clocks, textile printing etc. As a new generation of long afterglow phosphors, lanthanide ion doped alkaline earth silicates or aluminates yield much better characteristics, such as longer duration time of the phosphorescence, brighter luminosity and improved chemical stability, than the conventional sulfide materials used earlier (Chen, 2006). Among the newly developed long afterglow materials, which have already found commercial use, akermanite structure based alkaline earth silicates R2MgSi2O7 (R = Ca, Sr, Ba) codoped with Eu2+ and Dy3+ are of special interest because of their excellent persistent luminescence combined with an easy process ability (Murayama, 1996). CaMgSi2O6: Eu, Dy, Nd and CaMgSi2O7phosphors activated by Eu2+, Dy3+ and Nd3+ with afterglow characteristics were prepared by Jiang et al. through solid-state reaction in a reducing atmosphere.

In this chapter light weight barium based chlorosilicates Ba5Cl6Si2O6:Eu2+ Phosphor is prepared. The existence of three phases $Ba_5SiO_4Cl_6$, $Ba_7Si_2O_7Cl_8$ and $Ba_5Si_2O_6Cl_6$ in the system BaO-SiO_2-$BaCl_2$ was established by Garcia et al. Winkler et al confirmed the crystal structures reported by Garcia et al., for these compounds. Later Garcia et al reported X-ray excited luminescence for $Ba_5SiO_4Cl_6{:}Eu^{2+}$ also. Tecotzky et al developed X-ray storage phosphors based on Eu^{2+} activated $Ba_5SiO_4Cl_6$ and $Ba_5Si_2O_6Cl_6$, Fan obtained green emission in $Ba_7Si_2O_7Cl_8{:}Eu^{2+}$ and suggested its use as a green emitting phosphor for solid state lighting (Fan, 2014). VUV excitation also led to similar emission which could be relevant

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