Chapter 5

Upconversion Luminescence Behaviour of Er\(^{3+}/Yb\(^{3+}\) Doped MY\(_2\)O\(_4\) (M=Ba, Ca, Sr) Phosphors: Upconversion Study of MY\(_2\)O\(_4\):Er\(^{3+}/Yb\(^{3+}\)

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ABSTRACT

The upconversion (UC) of the rare earth doped MY2O4 (M=Ba, Sr, Ca) has been extensively investigated due to their potential applications in many fields, such as color display, high density memories, optical data storage, sensor and energy solar cell, etc. Many series of them, especially the Er\(^{3+}/Yb\(^{3+}\) doped MY2O4 were studied in this chapter, due to the thermal and mechanical toughness, high optical trans-

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INTRODUCTION

It is widely known that some rare earth ions can convert the wavelength of incident light to a shorter one via a multiphonon absorption mechanism. This phenomenon is of great interest because it can be used to build a new laser system, in particular, a light amplification in the visible to ultraviolet region. It is an anti-Stokes process defined as upconversion. In recent decades, the upconversion (UC) materials have been extensively investigated due to their potential applications in many fields, such as color display, optical data storage, sensor energy solar cell, etc.

The whole field of the UC in ion-doped systems can be traced back to an idea of Bloembergen in 1959. Many reports described the UC emission phenomenon in different matrix environments like phosphors, glasses, crystals, nanoparticles, photonic crystal, and so on Zhou et al. (2015), Zhou et al. (2009), Cao et al. (2015), Yang et al. (2011) and Ye et al. (2014). Among various optical systems, rare-earth doped halide glasses, such as fluoride Kawamoto et al. (1993), Takahashi et al. (1994) and Zhang et al. (1993), Hirao et al. (1993) chloride Shojiya et al. (1997) and Shojiya et al. (1994), bromide Kawamoto et al. (1995), iodide Shojiya et al. (1995), and chalcogenide glasses Kadono et al. (1997) are considered to possess remarkably greater potentiality than optical devices. Some of the reasons are described as follows:

1. Doped rare-earth ions are confined in crystalline environments of low phonon energies.
2. Consequently excited state lifetimes and optical absorption cross sections of the doped rare earth ions become large compared with those in vitreous environments Qiu et al. (2016).

Upconversion luminescent materials can convert infrared radiation into visible light. In the last few decades, much attention has been paid to study of upconversion phosphors since near-infrared (NIR) pump lasers with high power are easily obtainable. Now a days upconversion phosphors play a significant role due to their excellent luminescent properties in many areas such as all-solid compact lasers, NIR quantum counting devices, two-photon confocal microscope, optical data storage and fluorescent labels for sensitive detection of bimolecular Downing et al. (1996), Maciel et al. (1997), Hebert et al. (1990), Bhargava et al. (1994), Guo et al. (2004), Chen et al. (2007), Chen et al. (2007), Shalav et al. (2005), Zhang et al. (2010), Zhou et al. (2010), Chen et al. (2011), Chen et al. (2010), Dutta et al. (2011). Capobianco et al. (2002) reported the enhancement of red emission in Er-doped nanocrystalline yttria. Among all the rare earth ions, the Er$^{3+}$ ion can efficiently emit photons in the green and red regions of the spectrum and has the ability to convert infrared light to visible one. Er$^{3+}$ ion provides intermediate electronic energy levels ($^4I_{15/2}$, $^4I_{11/2}$) with long lifetimes, which can be conveniently pumped by low-cost commercial diodes. As an upconversion active ion, Er$^{3+}$ ion is widely used in upconversion phosphors Lin et al. (2003) and Riseberg et al. (1968). Upconversion efficiency is principally governed by nonradiation process of host materials Vetrone et al. (2003). The upconversion performance could be enhanced significantly by suitable selection of host matrix. Numerous rare earth oxides such as yttrium oxide, gadolinium oxide, and cerium oxide have been selected as a