別紙第１号様式　　　　　　　　　　No.1

博士論文の要旨

専攻名　　システム創成科学専攻
氏　名（本籍）　　陳政委（中国）　　印
博士論文題名
Epitaxial Growth and Characterization of Rare Earth doped Ga_2O_3 Films
（希土類元素ドープした酸化ガリウム薄膜のエピタキシャル成長と評価）
要旨

Wide-bandgap semiconductors, such as $Ga_xAl_{1-x}N$, $Zn_xMg_{1-x}O$ and Ga_2O_3, have attracted great attention due to their potential for use in solid-state lighting, high power devices, ultraviolet region optoelectronic devices and efficiency host materials for rare earth (RE) ions. In the past decade, RE ions doped wide bandgap semiconductors were promising materials for integrated optoelectronic applications due to their narrow emission line from the intra-4*f*-shell transitions in RE ions. It has been reported that the luminescence efficiency of dopant emissions could be highly improved with a wide bandgap host. Among all the materials, monoclinic Ga_2O_3 (β-Ga_2O_3) is considered as an emerging candidate for its larger bandgap (~ 4.8 eV) and chemical-physical stabilities. It is expected that RE ions doped Ga_2O_3 films have more efficient and stability light emission than other materials. However, up to now, there is few report available related to RE doped Ga_2O_3 luminescence thin films although this research is of vital importance for the future application. In this study, the purpose of this dissertation mainly includes: (1) Investigation of the growth parameter influence of the structure and optoelectronic properties of Eu and Er doped Ga_2O_3 deposited by using pulsed laser deposition (PLD) method. (2) Analysis of temperature dependence luminescence behavior of Eu and Er doped Ga_2O_3 to understand the energy transfer mechanism. (3) Fabrication of the green light-emitting devices (LEDs) based on Ga_2O_3:Er/Si heterojunctions.

In Chapter 1, we present the background of this study, including the properties of RE ions and the introductions of wide bandgap semiconductors. The purpose of this study was also presented.

In Chapter 2, we introduce the film epitaxy growth and characterization methods.

In Chapter 3, we investigate the Eu contents and substrate temperature influence on the structure and properties of Ga_2O_3 films deposited on sapphire substrate by PLD. Herein, (1) Eu doped Ga_2O_3 films are obtained at substrate temperature as low as 500 ℃. Moreover, the single crystal film can be obtained at 400 ℃. (2) Eu doping amount in the films can be controlled by

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専攻名　　　システム創成科学専攻

氏　名（本籍）　　　　陳政委（中国）

要旨

adjusting Eu contents in the target. (3) Intense red emissions at 613 nm are clearly observed for the Eu doped films and we demonstrate that intensity quenching is related to polycrystalline growth of Ga_2O_3. (4) Temperature dependence of luminescence spectra in Eu doped Ga_2O_3 films are investigated by using different light source. We also demonstrate that the variation of the emission intensity may be attributed to the thermal activated distribution of electrons among ^7F_j and thermal quenching effect.

In Chapter 4, we have investigated the Er contents influence on the structure and properties of Ga_2O_3 films deposited on sapphire substrate by PLD. In this Chapter, (1) we fabricate Er doped Ga_2O_3 films on sapphire substrates for the first time. (2) Intense pure green emissions at 550 nm were clearly observed for the Er doped films. (3) Temperature dependence of luminescence spectra in Er doped Ga_2O_3 films are investigated by using 488 nm light source. No peak shift at 550 nm is found with temperatures ranging from 77 to 450 K. (4) The intensity of the Er doped Ga_2O_3 films has a smaller variation with temperature compared to GaN.

In Chapter 5, we fabricate the Ga_2O_3:Er/Si LEDs. In this Chapter, (1) Bright green emission (548 nm) can be observed by naked eye from Ga_2O_3:Er/Si LEDs. (2) The driven voltage of this LEDs is 6.2V which is lower than that of ZnO:Er/Si or GaN:Er/Si devices. (3) The mechanism is demonstrated that Ga_2O_3 contain more defect-related level which will enhance the effects of recombination, resulting in the improvement of the energy transfer to Er ions.

In Chapter 6, the summary of this study is described.