

## MASTER'S THESIS

### Vacuum ultra-violet (VUV) excited phosphors

Cheng, Pui Yan

*Date of Award:*  
2006

[Link to publication](#)

#### **General rights**

Copyright and intellectual property rights for the publications made accessible in HKBU Scholars are retained by the authors and/or other copyright owners. In addition to the restrictions prescribed by the Copyright Ordinance of Hong Kong, all users and readers must also observe the following terms of use:

- Users may download and print one copy of any publication from HKBU Scholars for the purpose of private study or research
- Users cannot further distribute the material or use it for any profit-making activity or commercial gain
- To share publications in HKBU Scholars with others, users are welcome to freely distribute the permanent URL assigned to the publication

# **Vacuum Ultra-Violet (VUV) Excited Phosphors**

**CHENG Pui Yan**

**A thesis submitted in partial fulfillment of the requirements**

**for the degree of**

**Master of Philosophy**

**Principal Supervisor: CHEAH Kok Wai**

**Hong Kong Baptist University**

**August 2006**

## Abstract

Phosphors in some new displays and lighting devices are excited by vacuum ultra-violet (VUV) radiation. The luminescence characteristics and the properties of phosphor under VUV excitation are an interesting area to investigate. In this project, different techniques to synthesize phosphor such as solid state reaction, microwave method, combustion and precipitation were used. The solid state reaction method can produce a relative brightness phosphor and the synthesizing condition is easy to control; the precipitation method can produce an evenly distributed elliptical phosphor. Several types of phosphor were fabricated from these different synthesizing techniques. The spectroscopic studies on red phosphor  $\text{YAl}_3(\text{BO}_3)_4:\text{Eu}^{3+}$  and on green phosphor  $\text{BaMgAl}_{14}\text{O}_{17}:\text{Eu}^{2+}, \text{Mn}^{2+}$  were carried out. The photoluminescence (PL) spectrums of the red and green phosphor are dominant by 617nm and 517nm respectively. From their photoluminescence excitation (PLE) spectrums, they have an excitation peak in the VUV region (150nm) due to the host lattice absorption. Moreover, under VUV excitation, the effect of the  $\text{Eu}^{3+}$ -doping concentration in the red phosphor and  $\text{Eu}^{2+}$ -doping concentration in the green phosphor are different from UV excitation. The optimum concentration in red phosphor under VUV and UV excitation is 20% while that under UV excitation is 100%. The optimum concentration changes with the excitation energy. The optimum concentration levels of europium in green phosphor under VUV and UV excitation are 4% and 10%. Lastly, the CIE chromaticity coordinate of green phosphor is closer to the standard coordinate by mixing two green phosphors with different chromaticity.

# Contents

<b>Declaration</b>	i
<b>Abstract</b>	ii
<b>Acknowledgement</b>	iii
<b>Contents</b>	iv
<b>List Of Tables</b>	vii
<b>List Of Figures</b>	viii
<b>Chapter 1 Introduction</b> .....	1
<b>Chapter 2 Basic Theory</b> .....	2
2.1 Composition Of Phosphor .....	2
2.1.1 Host Lattice .....	2
2.1.2 Luminescence Center .....	3
2.2 Luminescence Process .....	5
2.2.1 Absorption And Emission Processes .....	6
2.3 Criteria For Electronic Transition .....	7
2.3.1 Transition Probability .....	7
2.3.2 Selection Rule .....	8
2.4 Electronic Transition .....	9
2.5 Energy Transfer .....	10
2.6 Concentration Quenching .....	11
2.7 Lifetime .....	11
<b>Chapter 3 Experiment</b> .....	12
3.1 Introduction .....	12

3.2	Sample Preparation .....	12
3.2.1	Solid State Reaction Synthesis.....	12
3.2.2	Microwave Synthesis .....	14
3.2.3	Combustion Synthesis .....	14
3.2.4	Precipitation Synthesis .....	16
3.3	Sample Measurement .....	17
3.3.1	XRD And SEM Measurement .....	17
3.3.2	Photoluminescence (PL) Measurement Under UV Excitation .....	18
3.3.3	PL and Photoluminescence Excitation (PLE) Measurement Under VUV Excitation .....	19
3.3.4	Commission Internationale De l'Eclairage (CIE) Measurement ...	22
3.3.5	Lifetime Measurement .....	23
<b>Chapter 4</b>	<b>Results And Discussion .....</b>	<b>24</b>
4.1	Comparison Of Different Synthesis Techniques .....	24
4.1.1	Morphology Of Phosphors .....	24
4.1.2	Luminescence Intensity .....	28
4.1.3	XRD Spectra .....	29
4.1.4	Properties Of Different Synthesis Techniques .....	30
4.2	YAl <sub>3</sub> (BO <sub>3</sub> ) <sub>4</sub> :Eu Red Phosphor .....	31
4.2.1	PL And PLE Results .....	31
4.2.2	Concentration Effect Under Different Excitation Energy Levels ....	34
4.2.3	Concentration Effect On Lifetime .....	39
4.3	BAM:Eu <sup>2+</sup> ,Mn <sup>2+</sup> Green Phosphor .....	40

4.3.1	BAM:Eu <sup>2+</sup> Blue Phosphor .....	41
4.3.2	BAM:Mn <sup>2+</sup> Green Phosphor .....	43
4.3.3	BAM:Eu <sup>2+</sup> , Mn <sup>2+</sup> Green Phosphor .....	45
4.3.3.1	Luminescence Characteristic Of BAM:Eu <sup>2+</sup> , Mn <sup>2+</sup> .....	46
4.3.3.2	Eu <sup>2+</sup> -doped Concentration Effect On The Emission Intensity .....	48
4.4	Mixed Green Phosphor .....	53
4.4.1	Luminescence Characteristics And CIE Chromaticity Coordinate Of YAB:Tb <sup>3+</sup> .....	54
4.4.2	Emission Spectrum And CIE Chromaticity Coordinate Of Mixed Green Phosphor .....	56
<b>Chapter 5</b>	<b>Conclusion</b> .....	<b>60</b>
<b>Appendices</b>		
	Appendix I Dieke Diagram .....	62
	Appendix II Calculation Of Molar Ratio .....	63
	Appendix III Lifetime Estimation .....	66
	Appendix IV Calculation Of The Mixing Ratio Of Green Phosphor .....	68
	<b>References</b> .....	<b>70</b>
	<b>Curriculum Vitae</b> .....	<b>72</b>