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UNIVERSITI SAINS MALAYSIA

PROCEEDINGS

3rd MEETING OF MALAYSIA NITRIDES RESEARCH GROUP (MNRG 2016)

6 - 7 December 2016

Auditorium Murad Mohd Noor
sains@usm, Universiti Sains Malaysia
Persiaran Bukit Jambul
11900 Bayan Lepas
Penang, Malaysia

Editors:
Professor Dr. Zainuriah Hassan
Dr. Ouah Hock Jin
Dr. Lim Way Foong
Dr. Ng Sha Shiong
Dr. Yam Fong Kwong

Organized by:
Institute of Nano Optoelectronics Research and Technology (INOR)
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2 - (cover)
- ISBN

Published by:
Institute of Nano Optoelectronics Research and Technology (INOR)
Universiti Sains Malaysia
11800 USM,
Penang, Malaysia

Tel:04-653 5637/5638
Fax:04-653 5639

Editors:
Professor Dr. Zainuriah Hassan
Dr. Quah Hock Jin
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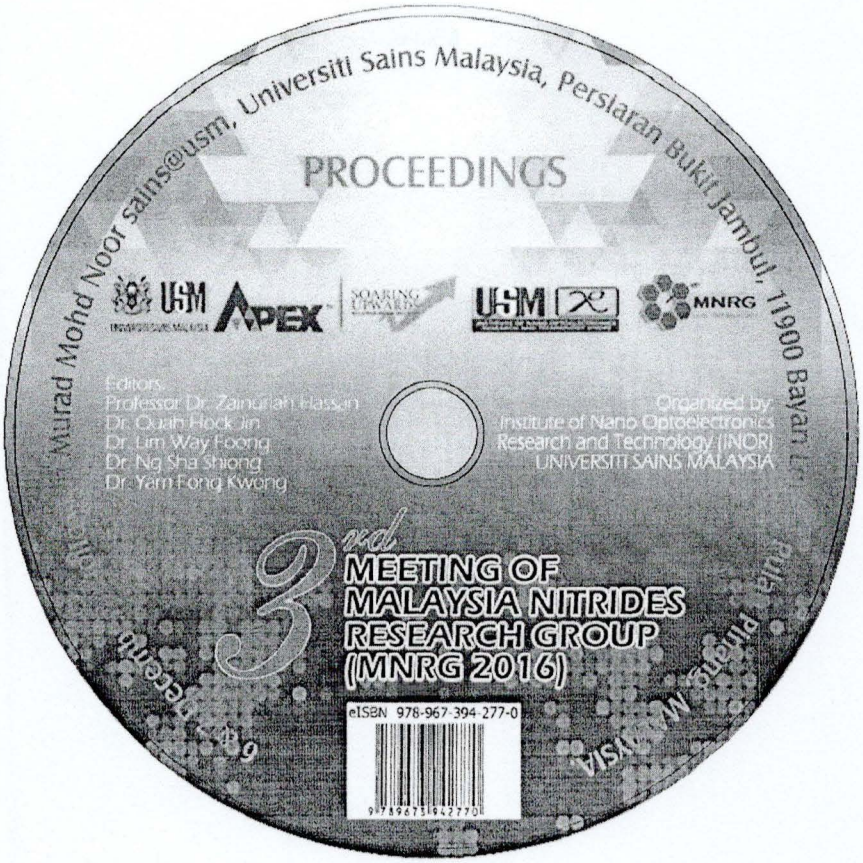
Printed by Creative Design House

Copies of this document may be obtained from Institute of Nano Optoelectronics Research and Technology, Universiti Sains Malaysia.

For bibliographic purposes, this document may be cited as:
Proceedings of the 3rd Meeting of Malaysia Nitrides Research Group (MNRG 2016)

eISBN: 978-967-394-277-0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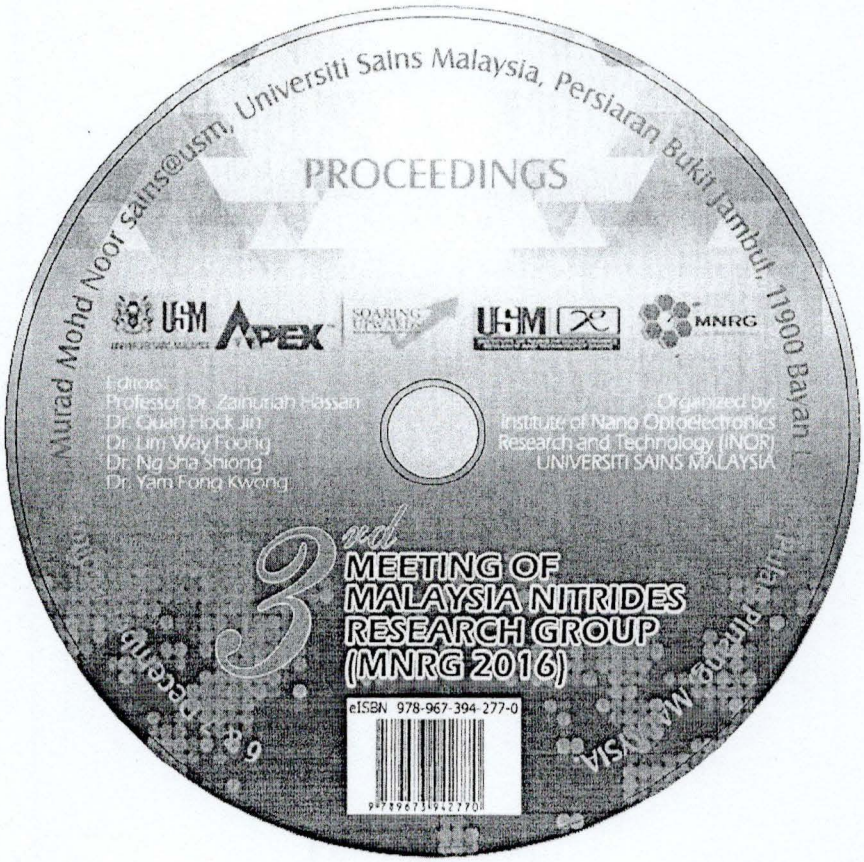
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Phosphors for White LED Conversion

Husnen R. Abd[1,*], Z. Hassan[2], Naser M. Ahmed[1], C. W. Chin[1], Ahmad Sauffi Yusof[1], Nabeel Z. Al-Hazeem[1]

[1]School of Physics, Universiti Sains Malaysia, 11800 USM, Penang, Malaysia
[2]Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia, 11800 USM, Penang, Malaysia.

Keywords: White LED; microwave-oven method; YAG: Ce; chromaticity

*Corresponding author's: husnen1978@gmail.com

ABSTRACT

White light emission from blue InGaN LED chip (WLED) was fabricated by converting blue colour using phosphor. Yttrium aluminium garnet (YAG, $Y_3Al_5O_{12}$) is an important phosphor having applications in various fields ranging from solid state lighting to scintillation detectors. Yttrium nitrate and aluminium nitrate phosphor doped with cerium nitrate (activator) according to the formula, $Y_{(3-0.06)}\ Al_5O_{12}:_{0.06}\ Ce^{+3}$ (YAG: Ce^{+3}) and mixed with urea (fuels) are synthesized by microwave-oven technique (M.W). The sintering temperature for enriching nanoparticles was achieved at 1050°C for 5 hours. The crystallinity, structure morphology, luminescent properties with fixed currents densities (20mA) and chromaticity parameters were characterized by X-ray diffraction (XRD), field emission-scanning electron microscope (FE-SEM), electroluminescence (EL) and standard CIE 1931 chromaticity diagram, respectively. By controlling the composition and chemical structures of YAG: Ce mixed with epoxy resin, white light with a broad band luminescent spectrum, best color rendering index (CRI), and tunable correlated color temperature (CCT) were obtained, offering cool-white.

1 Introduction

Phosphors are inorganic luminescent materials that absorb energy and re-emit this absorbed energy in the form of light [1]. WLEDs were generated by using near-ultraviolet (n-UV) or ultraviolet (UV) InGaN LED coated with different luminescent phosphors [2]. In general, phosphor such as YAG is considered inert host lattice, to circumvent these issues, YAG is doped with a small amount of lanthanide elements (activators), such as cerium (Ce), and europium (Eu) to emit light which is due to 4f to 5d transitions levels, [3]. Ce^{+3} activated $Y_3\ AL_5O_{12}$: Ce^{+3} (YAG: Ce^{+3}) has been widely utilized for luminescence conversion of blue light (blue LED) to white light (WLED), because a part of the blue light from the InGaN LED is absorbed by a layer of Ce^{3+} doped YAG and then it is converted into a yellow light. The combination of blue and yellow lights provides a bright white light LED.

There are many various methods used for preparation of inorganic phosphors (YAG: Ce^{+3}). The most common method is solid-state reaction [4]. However, the solid-state reaction method suffers from several shortcomings, such as the processing times are long and it requires a high sintering temperature (above 1800°C) to obtain the pure phase. To obtain pure phase YAG:Ce^{3+} at lower temperatures, researchers have investigated novel methods such as sol-gel/Pechini method (SG) [5], co-precipitation (CP) [6], hydrothermal (HT) [7], and combustion method (CS) [8].

High purity, homogeneous and small particle size powder, and low temperature synthesis were achieved in this study by using microwave-induced combustion synthesis method (M.W) to prepare YAG: Ce^{+3} phosphor powder. A main feature achieved in this method is that the high temperature was generated instantly by exothermic reaction and not from