UNIVERSITY TEKNOLOGI MARA

STRUCTURAL AND PHOTOLUMINESCENCE PROPERTIES OF Cr-DOPED AND Cr/Zn CO-DOPED Al_2O_3 SYNTHESIZED USING SOLUTION COMBUSTION METHOD

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ABSTRACT

The Cr-doped Al_2O_3 is the foundation of advancement of modern laser technology. It is potentially can be applied as phosphor materials and photoluminescence (PL) bio-probe in bioimaging applications. For these applications, high PL intensity sample is required. In this work, samples were prepared using solution combustion (SC) method and their properties in terms of structural and PL properties were investigated. Characterization techniques including X-ray diffraction (XRD), scanning electron microscope (SEM), energy dispersive X-ray (EDX) spectroscopy, PL and Ultraviolet-visible (UV-Vis) spectroscopy were employed. Fuel is one of main component in solution combustion method for obtaining high PL intensity sample. Different fuels usage including urea, sorbitol, and glycine were used and analysed. From the result obtained, the samples synthesized using urea showed the formation of highly crystalline single phase α-Al_2O_3 phase and produced highest PL intensity. While, the sample synthesized using sorbitol and glycine have lower PL intensity due to the existence of additional Al_2O_3 phase crystalline structure which are γ-Al_2O_3 cubic phase and θ-Al_2O_3 monoclinic phase. It can be concluded that, urea is the most suitable fuel which produced sample with high PL intensity. Next, the samples with different Cr^{3+} concentrations (0.2, 0.4, 0.6, 0.8, 1.0, and 1.2 wt.%) were prepared in order to find the optimum Cr^{3+} concentration. The obtained results show that the optimum Cr^{3+} concentration is 0.8 wt.%. Moreover, the sample with optimum Cr concentration was found to have the smallest energy band gap (4.20 eV). This finding suggests, for this sample the electrons are easier to jump to the conduction band, which makes the photon releasing process more efficient. Rietveld refinement revealed the increases in lattice parameter due to the replacement of aluminium atoms with chromium atom which has larger ionic radius. The cell volume also found to increase at higher Cr concentration. Next, zinc was added in order to further increase the PL of the sample. After zinc addition, the energy band gap was reduced from 4.31 eV to 4.23 eV. This reduction leads to the PL intensity enhancement by 34%. Furthermore, the enhancement is believed due to the modification in the crystal field environment by Zn^{2+} ions. The modification will decrease the crystal symmetry around the Cr^{3+} ions which is beneficial for enhancing up-conversion luminescence. Thus, it is proved that the PL intensity of Cr-doped Al_2O_3 can be enhanced by the addition of zinc elements.

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TABLE OF CONTENTS

CHAPTER THREE METHODOLOGY

CHAPTER FOUR RESULTS AND DISCUSSION