UNIVERSITI TEKNOLOGI MARA

NANOSTRUCTURED Mg AND Al OXIDES BY A COMBUSTION SYNTHESIS METHOD AND FABRICATION OF THE THIN FILMS BY PULSED LASER DEPOSITION

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CONFIRMATION BY PANEL OF EXAMINER

I certify that a panel of examiners has met on 28th April 2015 to conduct the final examination of Nurhanna Batar @ Badar on her Doctor of Philosophy thesis entitled "Nanostructured Mg and Al Oxides by a Combustion Synthesis Method and Fabrication of the Thin Films by Pulsed Laser Deposition" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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ABSTRACT

In this research, the novel properties and potential applications of some nanostructured metal oxides and thin film metal oxides were studied. This work consists of mainly two parts, firstly the nano and micron powders investigation and secondly the thin film characteristics. The characteristics of nano powders have to be investigated first before thin film nanostructures are being researched, that is why it is important to study the characteristics of Al_2O_3 and MgO nano powders first. MgO and Al_2O_3 nano powders and its doped materials, $Mg_{1-x}Cu_xO$ (x = 0.02, 0.04, 0.06) and $Al_{2-x}Cr_xO_3$ (x = 0.1, 0.2, 0.3) were synthesized using a combustion method. The study on doped compounds is to investigate band gap changes in the new materials. The synthesis conditions were optimized to obtain pure nanostructured metal oxides. In this work, it is found that the synthesis route using triethanolamine for the combustion synthesis is suitable in obtaining pure and single phase MgO, Al_2O_3, $Mg_{1-x}Cu_xO$ and $Al_{2-x}Cr_xO_3$ materials. The presence of substitutional elements in the MgO and Al_2O_3 lattice had caused changes in morphologies and crystallite size of the materials. The band gaps and electronic band transitions were studied and found to be quite intimately connected with their functionalities. The band gap energies of MgO and Al_2O_3 obtained from the synthesis exhibit lower band gap energies than the standard value of the bulk MgO and Al_2O_3 but these results agree with work done in recent findings using more modern equipment. It was also found that the presence of substitutional elements Cu and Cr in MgO and Al_2O_3 lattice, respectively modifies the band spectra causing band gap narrowing in the materials. For thin film fabrication, high quality ultra-thin MgO and Al_2O_3 films were fabricated via the Pulsed Laser Deposition (PLD) method using different process parameters. The purpose is to see the effects of reducing the thickness of the thin films to nano dimension on the I-V characteristics of the thin film samples and investigate the reasons behind the observed experimental results. It was also to see if reducing the length in 1-D scale will affect the band gaps of the thin films. Thin film characteristics such as phase, purity, crystal growth direction, morphology and thickness are measured and studied. It was observed that the band gap of the thin films increased as the thickness decreased due to quantum effects, however, turn-on voltage has the opposite effect. This can be seen for both MgO and Al_2O_3 thin films. The decrease of the turn-on as well as the tunnelling voltage of the thinner films despite their larger band gap is a direct experimental evidence of quantum tunnelling effects in the thin films. This also proves that the quantum tunnelling effect is more prominent in low dimensional structures. Valence band offset of the thin films seem to play an important role to the electron dynamics of quantum tunnelling. According to the experimental results, Al_2O_3 thin films were found to be more useful for MOS application compared to MgO thin films.

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