

**UNIVERSITI TEKNOLOGI MARA**

**CONTROLLABLE GROWTH OF  
ZNO-BASED NANOWIRES  
SYNTHESIZED VIA ULTRASONIC-  
ASSISTED SOL-GEL AND  
IMMERSION TECHNIQUE**

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## ABSTRACT

ZnO nanowires (NWs) were particularly fascinating due to their quasi one-dimensional (1-D) structures exhibiting quantum confinement effects and broad surface to volume ratios. ZnO NWs have attracted considerable attention over the last decade due to their various outstanding physical properties and potential applications in many emerging sectors such as optoelectronics for low and short wavelength, photonics, actuator and solar cells. However, there are some issues regarding ZnO NWs such as morphological size and thickness control, mass production, high temperature, complex experimental setup, and high cost, which are undesirable for an industrialized process. Besides, the non-homogeneous reaction of precursor and solvent during the mixing process will lead to the formation of large particles size and reduce the surface area of the nanostructures. This process leads to weak transport of electron and high recombination through defects state such as grain boundaries. Additionally, the uses of pure ZnO has a number of limitations such as high resistivity and low carrier concentrations, which restrict their potential applications. Besides, inability of pure ZnO to be directly used in optoelectronic devices is restricted due to its poor optical characteristics. Thus, to solve this issue, doping process is essential to improve optical properties of ZnO. Therefore, this current study was performed to synthesize ZnO-based NWs arrays via ultrasonic-assisted sol-gel immersion technique. In this study, several parameters were studied regarding the growth of vertically-aligned ZnO NWs arrays, including different molarity of precursor concentration (1-100 mM), different growth times (1-5 h) and different types of doping (Cr, Co, Ni, Er and Cu). The structural, morphological and optical properties of the synthesized films were characterized via Field-Emission Scanning Electron Microscope (FESEM), X-ray diffraction (XRD) and ultraviolet-visible spectrophotometry (UV-Vis), respectively. Results show that the optimization of ZnO NWs thin films at different molarity of precursor concentrations exhibited that the film at 25 mM possess the most uniform morphology, highly crystalline and has the lowest band gap than the other samples. Meanwhile, the optimum growth times was 3 hours due the growth of vertically-aligned ZnO NWAs with length of approximately 1.15  $\mu\text{m}$  were grown preferentially along the c-axis. Further study on the effect of different types of dopants on ZnO NWs were investigated. It was found that introducing Cr as a dopant for ZnO showed enhancement for ZnO NWs which prevented the fast electron-hole recombination revealed as best dopant due to lower band gap. These remarkable enhance the performance of ZnO NWs. Thus, vertically-aligned ZnO NWs arrays thin films are promising candidate which seems very useful for many emerging sectors such as optoelectronics.

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