UNIVERSITI TEKNOLOGI MARA

SYNTHESISATION AND CHARACTERISATION OF ZINC OXIDE NANOWIRES VIA MICROWAVE-ASSISTED ULTRASONIC TECHNIQUE

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ABSTRACT

Nanometer sized particles (1-100 nm) are of considerable interest for a wide variety of applications, ranging from electronics via ceramics to catalysts, due to their unique or improved properties that are primarily determined by size, composition, and structure. Several processes have been developed to synthesise and characterise high-quality ZnO nanowires. Besides that, nanostructured materials commonly used would be zinc oxide (ZnO) which had been studied for decades due to its unique properties which boost excellent performances when applied to electrical devices. Additionally, the uses of pure ZnO has a number of limitations such as high resistivity and low carrier concentrations, which restrict their potential applications. ZnO NWs also are highly sensitive to the surrounding environment. Changes in temperature, humidity, or exposure to gases can influence the electrical and optical properties of ZnO NWs, making them less reliable for certain applications where stability is crucial. Other than that, ZnO NWs often exhibit a high density of structural defects, such as dislocations, stacking faults, and grain boundaries. These defects can affect the electrical and optical properties of the NWs, leading to reduced device performance and reliability. This thesis focuses on the synthesis and characterization of ZnO nanowires (NWs) using a microwave-assisted ultrasonic technique. It includes the deposition of a seed layer consisting of ZnO nanoparticles (NPs) through ultrasonic-assisted sol-gel spin-coating. The main objectives are to successfully grow ZnO NWs and comprehensively analyze their structural, optical, and electrical properties using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM), and ultraviolet-visible-infrared spectrophotometry (UV-Vis). The optimization of critical processing parameters, such as growth time, deposition power, and precursor concentrations, is a key aspect of this research. The outcomes will serve as a foundation for future studies and provide guidance for further advancements in this area of research. In summary, the analysis of ZnO nanowires revealed that increasing the growth duration did not affect the diameter of the nanowires. The highest transmittance was observed in the sample grown for 15 minutes in the visible region. Deposition at 600 W resulted in vertically aligned nanowires of smaller size, while increasing the deposition power led to an increase in diameter without changing the morphology. The optical band gaps varied with different precursor concentrations, with 25 mM being the optimal concentration for obtaining high-quality vertically aligned ZnO nanowires. This concentration exhibited a lower band gap, indicating improved light absorption and reduced electron-hole recombination. Overall, the results emphasize the importance of growth duration, deposition power, and precursor concentration in controlling the structural and optical properties of ZnO nanowires. These findings provide valuable insights for optimizing the synthesis process and enhancing the performance of ZnO nanowires in various applications.

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CHAPTER ONE
INTRODUCTION

1.1 Nanotechnology

The conceptual bases concerning nanotechnology have been first off found by physicist Richard Feynman. In 1959, Feynman observed the possibility of that atoms and molecules of materials may be changed completely. Norio Taniguchi, an academician from the University of Tokyo, specifies the capabilities of engineering substances having more than a few applications at the nanometer level. “Nano”, as a word, means one-billionth of a physical unit. There is no consensus on the definition of Nano. A nanometre is a unit of size that is equal to 1 billionth of a meter. Materials that have nanoscale dimensions (1–100 nm) in at least one dimension of three-dimensional space or are made up of them as building blocks are referred to as nanomaterials. The particle size of nanomaterials is on the order of nanometers when compared to regular materials. The crystal structure and surface electrical structure of nanomaterials change in direct proportion to the particle size. Nanotechnology deals with nanomaterials that have at least one size starting from 1 to a hundred nm. It could be effortlessly understood how small a dimension nanometre has when we remember that the hair strand of a human is about one hundred (100) nanometers. Beside that, nanotechnology can be described as applications of a scientific understanding to manipulate and manipulate be counted predominantly in the nanoscale (duration variety approximately from 1 nm to 100 nm) to make use of size and structure-dependent properties and phenomena distinct from the ones related to individual atoms or molecules, or extrapolation from larger sizes of the same material . Nanotechnology requirements may be crucial as they will outline how future products will adopt the dominant specifications described via the prevalent requirements. The nations which can be leaders in nanotechnology have additionally achieved a trendy development in research and improvement (R&D) and different subjects. In developing standards, worldwide our bodies, countrywide stakeholders, and the industry consortium are the three key stakeholders rising.