# UNIVERSITI TEKNOLOGI MARA

# SYNTHESIS AND CHARACTERIZATION OF MgO NANOSTRUCTURES BY DIFFERENT SYNTHESIS METHODS

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# ABSTRACT

Magnesium oxide (MgO) is an interesting material and has unique properties which is applicable in many applications. In this research, novel MgO nanostructures of ultra-thin sheets were synthesized using three different synthesis methods which are solid-state reaction, sol-gel and combustion methods. The synthesis condition was optimized to obtain pure MgO compound. These pure samples were characterized using Simultaneous Thermogravimetric Analyzer (STA), X-Ray Diffraction (XRD), High Resolution Transmission Electron Microscopy (HRTEM) and UV-Vis spectroscopy. The results shows pure MgO nanostructures can be obtained at the temperature of 600 °C for all synthesis methods that gives the ultra-thin nanosheets as can be seen from high resolution TEM. Different synthesis methods can give surprisingly the same morphology but in different thicknesses. However, combustion method gives the thinnest nanosheets followed by the sol-gel and solid-state reaction methods. The band gap energy obtained for MgO samples synthesized by all methods have values of 5.825 eV to 5.955 eV which are much lower than the MgO bulk value of 7.8 eV. The characteristics of the band gap change with annealing time are different for the samples prepared by different preparation process. Therefore, the band gap energies of MgO nanostructures are sensitive to the different synthesis methods. Results show that the band gap energies of nanostructures can be tuned to a suitable value needed for various applications by controlling the annealing time. Sol-gel method is the best method for producing MgO nanostructures at a temperature of 600 °C and at the shortest possible time of 1 h and also capable of producing large amounts of final product compared to the other methods.

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# TABLE OF CONTENTS

# CHAPTER ONE
# INTRODUCTION

## 1.1 BACKGROUND OF STUDY

The basis of materials science involves the relationship between the desired properties and relative performance of a material in certain applications through the characterization of the materials. It is concerned about the internal structure, properties and the processing of the materials. For convenience, materials can be classified into metallic materials, polymeric materials and ceramic materials. In the world of nanomaterials, there have been considerable efforts done in finding new nanostructures and studying their properties [1]. In general, synthesis of the materials can be referred to the combination of the two or more entities that mixed together to form new products. This research involves chemical synthesis which involves the execution of chemical reactions to form new nanostructured materials from chemical precursors by using several methods.

Nanotechnology is the field of research concerning design, fabrication and applications of nanomaterials. It focuses on the preparation and study of the properties of the nanomaterials. The size of nanomaterials is less than 100 nm. Nanostructured materials that have unique properties such as have high surface area, high porosity and particle size in the range of 1 to 10 nm are becoming more available although they are difficult to prepare [2]. These kinds of characteristics have motivated the researchers to develop and produce nanomaterials with various properties using different methods. These nanostructured materials have various applications which can be used in different nanodevices.

Magnesium oxide (MgO) is a ceramic material that has attracted attention due to its unique properties and attractive for both fundamental and applicable research areas in chemistry, physics and biology as well. Although MgO is widely studied by many researchers, there are many areas that need to be studied deeper in term of structure, morphology and optical properties. Because of that, MgO is chosen as the target material to be studied in this research.