# UNIVERSITI TEKNOLOGI MARA

# SYNTHESIS AND CHARACTERISATION OF DOPED-TITANIUM DIOXIDE STRUCTURES VIA AQUEOUS CHEMICAL ROUTE DEPOSITION TECHNIQUE

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# ABSTRACT

Titanium dioxide ($TiO_2$) became known as one of the most extraordinary nanoparticles in recent years, attracting the attention of researchers from all over the world. The introduction of dopants is a commonly employed technique for surface modification of $TiO_2$, with the aim of enhancing specific aspects of the material, including its structural and optical characteristics. The inherently low photocatalytic properties of $TiO_2$ can be effectively addressed by introducing dopants. Given the close ionic radii of Fe and Ni to $TiO_2$, these transition metals are suitable for substitutional doping, seamlessly replacing titanium atoms in the $TiO_2$ lattice without causing lattice distortions. Doping $TiO_2$ with GO results in synergistic effects, enhances photocatalytic activity. Fe/Ni/Graphene doped $TiO_2$ were prepared by an aqueous chemical route via deposition technique. The resulting samples were characterized by X-ray diffraction (XRD), FESEM and UV–vis. The results demonstrate that the incorporation of Fe as a dopant leads to an increase in the surface area of the structure, accompanied by the formation of flower-like structure. Therefore, the Fe-$TiO_2$ samples display enhanced light absorption characteristics, attributed to a reduction in the band gap.Ni doping is substantiated by a conspicuous reduction in the band gap when compared to pristine samples. 1 at. % showed to obtain the lowest energy band gap. The incorporation of Ni not only induces the formation of denser flower-like structures but also orchestrates a captivating red shift in the absorbance graph, affirming a notable decrease in the band gap value for the doped samples. GO-$TiO_2$ structures with varied GO dopant concentrations, revealing the emergence of a distinctive seaurchin-like morphology, with promoting efficient charge transport within the structures. Notably, the incorporation of 0.001g of GO dopant produces the most consistent morphology, exhibiting the lowest total tensile strain and the highest relative peak intensity orientation. GO-$TiO_2$ samples exhibit low transmission characteristics, indicating their opaque nature.

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# INTRODUCTION

## 1.1 Background of Study

### 1.1.1 Nanotechnology

The study of nanotechnology is a fascinating new branch of research that has a wide range of potential applications. The study, design, construction, synthesis, manipulation, and application of functional materials, devices, and systems on the nanoscale scale is what is referred to as nanotechnology [1]. Nanotechnology may be described as "technology on the nanoscale," which is a scale encompassing 1-100 nm, or, more succinctly, as "technology that is atomically exact." It can also be defined as "engineering with accuracy at the atomic level." Because of this, nanotechnology has grown to include a broader variety of technologies, such as those in medicinal, catalytic, sensor and electrical applications as well as those in environmental and biological applications Nanotechnology has a wide range of potential applications, some of which include illness detection, food processing, building, sensor application, transportation, and energy storage and production, as well as agricultural productivity increase, water treatment, and cleanup [2].

The use of nanotechnology in the production of the films carries with it the distinct possibility of increasing overall productivity while simultaneously reducing overall expenses. Investigations are now being conducted on a wide variety of structured materials to determine the photovoltaic uses that could be possible with them. Many significant benefits may be gained by using structured layers of thin film solar cells. Because of the many reflections, the effective optical path for absorption is far longer than the actual thickness of the film. Electrons and holes that are created by light have to traverse a route that is much shorter. As a result, there is a significant drop in recombination losses. Because of this, the absorber layer thickness in structured solar cells may be as low as 150 nm, while in conventional thin film solar cells it is often several micrometers. By adjusting the size of the particles, the energy band gap of the different layers may be fine-tuned to the specific value that is required for the design. Because of this, there is more room for creative freedom in the solar cells [3].