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The Effects of Annealing Temperature Dependence on the Doping of Titanium Dioxide (TiO_2) and Reduced Graphene Oxide (rGO) for Perovskite Solar Cell Application

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ABSTRACT

In the present study, reduced Graphene Oxide (rGO) was introduced to Titanium Dioxide (TiO_2) as Electron Transport Layer (ETL) in Perovskite Solar Cell (PSC). TiO_2 doped rGO (TiO_2/rGO) was prepared by doping Titanium (IV) Oxide nanopowder as a precursor for TiO_2 and chemically reduced Graphene Oxide (rGO). The TiO_2/rGO was varied with different annealing temperature and the effects of electrical, structural and optical on TiO_2/rGO of PSC were studied. The surface morphologies of TiO_2/rGO thin films were characterized via X-Ray Diffraction (XRD). Meanwhile, Ultraviolet-visible spectroscopy (UV-Vis) was used to characterize the optical properties of TiO_2/rGO thin films while current-voltage (I-V) analysis was measured by using Keithley Sourcemeter. Structural and morphological evidence from XRD results confirmed that the TiO_2/rGO samples changes from anatase phase to rutile phase as the annealing temperature increased and the average crystalline size of TiO_2/rGO thin films change with the TiO_2 crystalline phase accordingly. The annealing temperature of 550°C exhibits the larger grain size that results in better conductivity, higher light absorption and lower bandgap energy.

Keywords: Annealing Temperature, Doping, Perovskite Solar Cell, Titanium Dioxide, Reduced Graphene Oxide.

1. INTRODUCTION

Solar energy harvesting has been done substantially through photovoltaic devices as energy supply from the sun is reliable, renewable, and sustainable with no worry of depletion [1]. Thin-film based photovoltaics solar cell such as Copper-Indium-Gallium-Selenide (CIGS), Cadmium Telluride (CdTe), Dye-Sensitized Solar Cell (DSSC), Organic Solar Cell and Perovskite Solar Cell (PSC) have caught research attention whereas by 2030 photovoltaic are anticipated as the third of global electricity generation [2].

Perovskite solar cell has shown an increase in power conversion efficiency (PCE) at a phenomenal rate in just seven years as compared to other types of photovoltaics. Perovskite is an organic-inorganic material that has shown capabilities for the use in light-emitting diodes, sensors, field-effect transistors and photodetectors [3]. Despite that, further improvement is important to optimize and enhance the PSC devices operation, stability and device performance. The aim of this research is to construct a photovoltaic device, an organometal halide perovskite solar cell with $CH_3NH_3PbI_3$ as the absorber that coated upon the surface of mesoporous TiO_2/rGO.

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