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HYBRID P3HT:GRAPHENE NANOCOMPOSITE AS AN ACTIVE LAYER IN POLYMER BASED BULK-HETEROJUNCTION ORGANIC SOLAR CELLS

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ABSTRACT

This study was carried out to investigate and study the performance of P3HT:Graphene nanocomposite thin film for organic photovoltaic application. Organic photovoltaic has been widely researched nowadays but there is still more research needed to be done due to its low efficiency when compared to monocrystalline solar cells. Low efficiency is mainly caused by low electron mobility. Therefore, the objective of this research is to improve the electron mobility as well fabricating and characterize the thin film performance. Considering all of the novel characteristics, Poly(3-hexylthiophene-2,5-diyl) (P3HT) and Graphene have been chosen as the active material for the bulk-heterojunction film. Scope of this research is to improve the photocurrent by increasing the electron mobility. Due to many reports from previous research on organic photovoltaic, the thickness of the thin film will be fixed below 100 nm. Low cost and easy fabrication method such as spin coating was chosen to fabricate the thin films. Deposition conditions such as P3HT concentration, Graphene concentration, annealing temperature, annealing time and drying temperature were investigated to determine the best optimized condition for producing a high efficiency P3HT:Graphene solar cells. To determine the optimum parameter, characterization such as optical properties, electrical properties and surface morphology is measured. Optical properties such as absorbance, transmittance and photoluminescence was measured and analyzed. For electrical properties, current-voltage (*I-V*) is measured using solar simulator while surface morphology were characterized using equipment such as FESEM, Surface Profiler, AFM and XRD. It was found that the electron mobility of P3HT:Graphene nanocomposite is higher than P3HT alone. P3HT:Graphene nanocomposite also possess highest photocurrent when P3HT concentration is at 6 mg/mL, Graphene concentration at 2 wt %, dried at temperature of 65°C, anneal for 5 minutes at a temperature of 200°C. These parameter were used to produce the organic solar cell with the configuration of ITO/PEDOT:PSS/P3HT/Au and ITO/PEDOT:PSS/P3HT:Graphene/Au. PEDOT:PSS is used as a hole transport layer in this device. In the device characterization, the electrical properties such as open circuit voltage (V_{oc}), short circuit current (J_{sc}), fill factor (*FF*) and efficiency (η) of the organic solar cell is measured. The efficiency for ITO/PEDOT:PSS/P3HT:Graphene/Au organic solar cells is higher when compared to ITO/PEDOT:PSS/P3HT/Au solar cells. This is expected due to an increase in electron mobility in P3HT:Graphene layer. The effect of light intensity was also characterized ranging from AM 1.0 G until AM 1.75 G. It can be concluded that the efficiency increase as the light intensity increase. This is because as the light intensity increases, the number of photon also increases, which breaks the exitons more in the solar cell. As more exitons break, more electron will flow freely inside the circuit, resulting in a higher current.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Solar light is known as mankind's never-ending energy source where it has been reported that the annual energy input of solar irradiation on Earth surpasses the world's yearly energy consumption [1]. Therefore, the most promising tools nowadays to make solar energy is by converting sunlight into electrical energy in photovoltaic cells. Nowadays, the most common solar cells that is commonly used is monocrystalline solar cells which is made from silicon and currently possesses the highest efficiency out of all the solar cells. It has been reported that a company called Kaneka Cooperation from Japan has achieved the highest efficiency up to date which is 26.33% for crystalline silicon solar cells. Even though it has the highest efficiency, silicon solar cells has its disadvantages too, such as high cost and fragility. The monocrystalline solar panel circuit can breakdown when the solar panel is partially covered with dirt or snow.

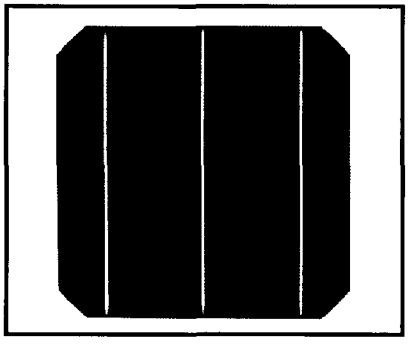

Figure 1.1: Image of monocrystalline solar cells [2]

Another type of solar cells that is widely researched these days is thin film solar cells. One of the types in thin film solar cells is organic solar cells. Organic solar cells is one of those semiconducting polymers has been proven to have an impressive optoelectronic properties. It is also cheap and is easy to process at large scale [3]. The main problem for organic solar cells is its low power conversion efficiency when compared to monocrystalline solar cells. Research on organic photovoltaic is also