CHITOSAN BASED IN ELECTRON TRANSPORT LAYER (ETL) FOR PEROVSKITE SOLAR CELL (PSC)

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DEDICATION

I dedicate this entire thesis to my family because they have always been there for me during my ups and downs and have supported me throughout the completion of this thesis. I also dedicate this thesis to my supervisor and co-supervisor who taught me that proficiency is not the most important aspect of finishing a project rather than diligence and enthusiasm are the pillars of success.

ABSTRACT

Perovskite Solar Cells (PSC) are a new phenomenon with high efficiency and have a simple fabrication process. PSC has a lengthy lifespan when compared to the other commercially available crystalline silicon solar cell. However, PSC is reported to have limited flexibility and a high testing cost, it is not fully equivalent to other commercialised solar cell. By varying the time and temperature to show their performance, structural, electrical conductivity, and optical properties, the synthetization of the chitosan from deacetylation process have been made. In this project, chitosan was synthesized from dried shrimp shell to be used at the electron transport layer (ETL) to analyse the performance of the perovskite solar cell. Particle size analyser, Fourier Transform Infrared Spectroscopy (FTIR) and 4-Probe testing were used to characterize the chitosan. A sample of white powder chitosan with the degree of deacetylation were obtained through FTIR spectra. Chitosan with the highest percentage of the degree of deacetylation was used to mix with graphene and zinc oxide. Through this mixture, the resistivity and resistance of the mixture achieved at 2.41k and 3.88k(ohm). Furthermore, a simulation of this PSC using OghmaNano software was also done by varying the electrical parameters. The highest efficiency of 5.86% with chitosan mixed with zinc oxide was obtained from this analysis.

ABSTRAK

Sel Suria Perovskite (PSC) adalah fenomena baharu dengan kecekapan tinggi dan mempunyai proses fabrikasi yang mudah. PSC mempunyai jangka hayat yang panjang jika dibandingkan dengan sel solar silikon kristal lain yang tersedia secara komersial. Walau bagaimanapun, PSC dilaporkan mempunyai fleksibiliti terhad dan kos ujian yang tinggi, ia tidak setara sepenuhnya dengan sel suria yang dikomersialkan yang lain. Dengan mengubah masa dan suhu untuk menunjukkan prestasi, struktur, kekonduksian elektrik dan sifat optiknya, sintesis kitosan daripada proses penyahetilasi telah dibuat. Dalam projek ini, kitosan telah disintesis daripada kulit udang kering untuk digunakan pada lapisan pengangkutan elektron (ETL) untuk menganalisis prestasi sel suria perovskit. Penganalisis saiz zarah, Fourier Transform Infrared Spectroscopy (FTIR) dan ujian 4-Probe digunakan untuk mencirikan kitosan. Satu sampel serbuk kitosan putih dengan tahap penyahetilasi diperoleh melalui spektrum FTIR. Kitosan dengan peratusan tertinggi tahap penyahetilasi digunakan untuk dicampur dengan graphene dan zink oksida. Melalui campuran ini, kerintangan dan rintangan campuran dicapai pada 2.41k dan 3.88k(ohm). Tambahan pula, simulasi PSC ini menggunakan perisian OghmaNano juga dilakukan dengan mempelbagaikan parameter elektrik. Kecekapan tertinggi iaitu 5.86% dengan kitosan bercampur dengan zink oksida diperoleh daripada analisis ini.

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First and foremost, I want to express my gratitude to Allah (SWT) for giving me all I needed to do this endeavor. I gave this project my all. However, this project would not have been able to succeed without the kind help and support of several people. I would like to sincerely thank each and every one of them.

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Last but not least, I want to extend my sincere gratitude to my family and friends for their patience, encouragement, and practical support as I wrote my report from beginning to conclusion.

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LIST OF SYMBOLS AND ABBREVIATIONS

PV	:	Photovoltaic Device
PSC	:	Perovskites Solar Cell
PCE	:	Power Conversion Efficiency
GO	:	Graphene Oxide
DOE	:	Design of Experiment
CO_2	:	Carbon Dioxide
Si	:	Silicon
CIGS	:	Copper Indium Gallium Selenide
CdTe	:	Cadmium Telluride
TCO	:	Transparent Conductive Oxides
ITO	:	Indium Tin Oxide
FTO	:	Fluorine-doped Tin Oxide
HTM	:	Hole Transporting Material
TiO_2	:	Tin Oxide
ZnO	:	Zinc Oxide
Au	:	Gold
Ag	:	Silver
Voc	:	Open Circuit Voltage

FF	:	Fill Factor
Jsc	:	Short Circuit Density
GO	:	Graphene Oxide
IPA	:	Isopropyl Alcohol
FTIR	:	Fourier-Transform Infrared Spectroscopy
UV-Vis	:	Ultraviolet-Visible Spectroscopy
PSA	:	Particle Size Analyzer
XRD	:	X-Ray Diffraction
SEM	:	Scanning Electron Microscope
HCL	:	Hydrochloric Acid
NaOH	:	Sodium Hydroxide
DA	:	Degree of Deacetylation
SDG	:	Sustainable Development Goals

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CHAPTER 1

INTRODUCTION

This chapter will briefly describe the project introduction, objectives, problem statement, scope of work and also thesis structure. In this chapter will be introduce about the project background of a perovskite solar cell and green technology of polymer.

1.1 Project Background

In order to convert solar energy into usable electricity, a semi-conductor device called a solar cell is used. Silicon is used in solar cell because of its ability to absorb the sun's rays. This method was first identified in the early 1800s, but the first solar cell was not manufactured until 1954 by Bell[1]. Solar power has the capacity to grow and meet future energy demands. Recent years have seen a lot of research and development into photovoltaic (PV) devices, which quickly respond to changes in ambient circumstances and have a high-power conversion efficiency. A photovoltaic cell is a type of electronic device that uses the photovoltaic effect to directly convert light energy into electricity. All photovoltaic cells convert light energy into electricity using semiconductors, the substances that lie between electrical insulators like glass and metallic conductors like copper. Photovoltaic cells, an established technology for producing solar energy, have seen tremendous growth during the past ten years[2].

The first generation of solar cells are created using thin-film solar panels, mono-crystalline silicon crystals, poly-crystalline silicon crystals, and silicon wafers. The most recent and promising generation of solar cells includes concentrated solar cells, polymer-based solar cells, dye-sensitized solar cells, nanocrystal-based solar cells, and perovskite-based solar cells[1].

Green technology, often known as "green-tech" or "green technology," is a relatively young field of study that focuses on creating environmentally friendly technologies in an effort to lessen the negative effects that humans have on the natural world[1]. Energy, atmospheric science, agriculture, materials science, and hydrology are only some of the many scientific fields that contribute to green technology. Green technology has many benefits, including being environmentally friendly which emitting no harmful gases into the atmosphere, being inexpensive to run, never running out lowering atmospheric concentrations of carbon dioxide (CO_2), and mitigating the effects of global warming [3]. Figure below show the differences between conventional and renewable energy.

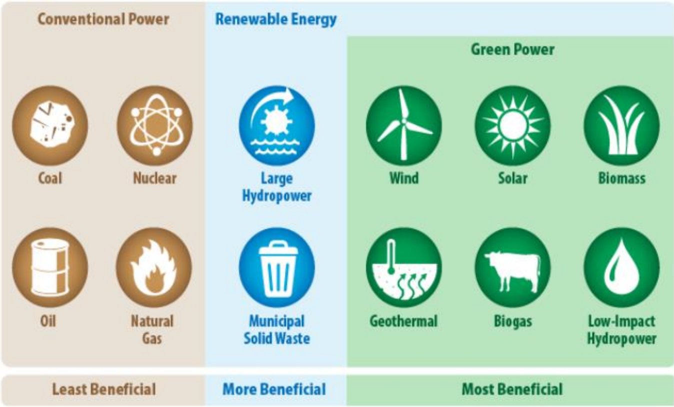

Figure 1.1: Definition of green power based on its relative environmental benefits[3].

1.1.1 Perovskite Solar Cell

Semiconductor materials have their electrons excited by sunlight, leading to electron flow into conducting electrodes and the generation of electric current. Perovskite solar cell (PSC) are highly sought after as a potential cost-effective and simple-to-manufacture component of the next generation of photovoltaic technology [4]. Changing or changing the solar cell's parameter might increase its efficiency as a PSC. Some examples of PSCs are the printed triple mesoscopic structure, as well as the mesoscopic formal (n-i-p) and inverted (p-i-n) structures same as figure 1.2 below.

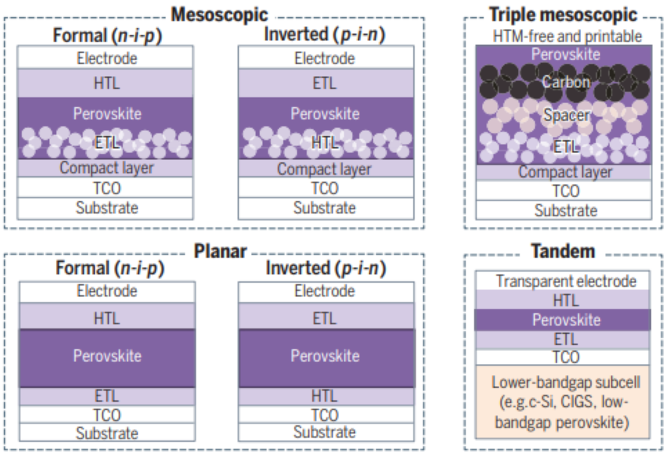

Figure 1.2: Configurations and Application Demonstration of PSC[4].

1.1.2 Chitosan

Chitosan is produced by N-deacetylating N-acetyl chitin. Chitosan is used in the food and bioengineering industries for a variety of purposes, including as the immobilization of enzymes, the controlled delivery of pharmaceuticals, and the stimulation of plant growth in agriculture[5]. Chitosan acts as an antibacterial and a defense elicitor. Chitosan's biodegradability, biocompatibility, bioactivity, non-toxicity, and polycation characteristics are all noteworthy. The physicochemical and structural features of chitosan are described in this work.

However, chitosan-based additives are expected to boost its efficiency even more by facilitating the binding of additional electrodes to the PSC photoanode. Several trial synthesis of nanoparticles were conducted to investigate and identify the growth of graphene oxide (GO) combined with the chitosan based. The method established by other researchers for synthesizing chitosan can be used. Numerous techniques can be used to examine the experiment's findings, and visuals of the samples can be viewed for inspection. This PSCs production process requires the following steps: paste preparation, glass deposition, counter electrode preparation, PSC synthesis, and