Enhancement of the Efficiency of Perovskite Solar Cells

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Abstract

This project investigates the manufacturing process of perovskite solar cells with an added organic enhancer, known as Mangosteen. As a third-generation solar cell technology, perovskite cells have the advantage of being free from perishable liquids such as the ones found in their dye-sensitized counterparts. This project focuses on constructing and testing perovskite cells, this is done from primary components, such as photo-anode, active material and counter-electrode. The electron injection metal oxide layer is augmented by the addition of Mangosteen, which increases the electron donation activity of TiO_2, as demonstrated in the solar cell's improved performance and efficiency. The efficiency increased by a factor of 2.3 relative to the reference perovskite solar cell. This project explains the operation of the perovskite solar cell and how the addition of Mangosteen affects the competence of the cell.

Introduction

- Solar energy is the most feasible, applicable, and practical form of renewable energy.
- Current research aims to help understand the basic chemistry and physics behind perovskites, and the operational methods and materials that may further improve their efficiency.

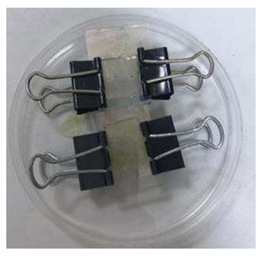

Figure 1: Assembled Perovskite Solar Cells

Figure 2: Mangosteen Fruit

Figure 3: Testing the Cells

Objectives

1. Learn how to construct perovskite solar cells.
2. Investigate the effect of adding carbonized Mangosteen peels on the output and efficiency of perovskite solar cells.
3. Evaluate the cost effectiveness of using carbonized Mangosteen peels to enhance perovskite solar cells.

Materials and Methods

- TiO_2 was deposited on FTO glass. The perovskite precursor was then spin coated onto the FTO glass at 3000 rpm.
- Mangosteen peels were then dried, crushed, and soaked in acetone before the filtered solution was spin coated onto one of the cells.
- Both cells were then spin coated with Spiro-OMeTAD at 3000 rpm.
- Platinum was added to the cells and adhered at 200 degrees Celsius for 10 minutes.
- Once cooled, the cells were tested and the required parameters were measured.

Results

	Perovskite Solar Cell	Mangosteen Enhanced Perovskite Solar Cell
Irradiance	1000 W/m^2	1000 W/m^2
Area	0.0000845 m^2	0.0000845 m^2
Maximum Power Voltage	0.0410794 V	0.0601528 V
Maximum Power Current	0.0270645 A	0.0419872 A
Maximum Power	0.00111179 W	0.0025156 W
Open Circuit Voltage	0.0639611 V	0.101883 V
Short Circuit Current	0.0328217 A	0.0438561 A
Fill Factor	0.53	0.56
Efficiency	**1.32 %**	**2.98 %**

Table 1: Required Parameters of Enhanced and Reference Perovskite Solar Cells

Figure 1: I-V Characteristics of the Solar Cells

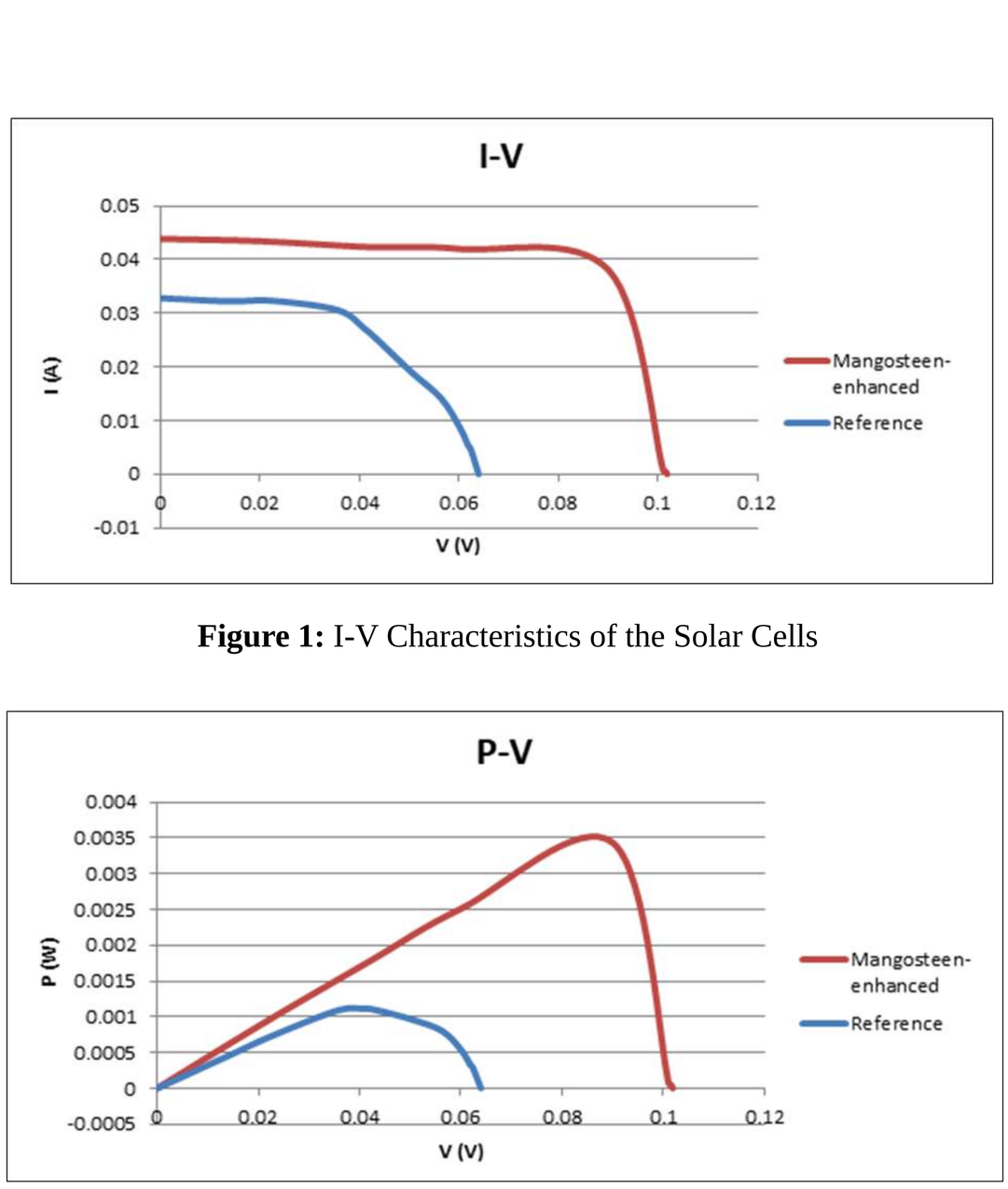

Figure 2: P-V characteristics of the Solar Cells

Conclusions

- The Mangosteen acts as an electron charge donor which enhances the flow of charge, leading to an increase in the efficiency of the solar cell.
- The increase in efficiency can also be explained by the different absorbance wavelengths that each of the cells (with and without Mangosteen) possess.
- The efficiency of the solar cell was doubled and the cost was reduced by almost 50 percent.

Forthcoming Research

Future efforts should focus on evaluating the output and efficiency of enhanced perovskite solar cells over a longer period of time, as the addition of carbonized Mangosteen peels may affect the cells' stability and cause them to deteriorate at a faster rate. Additonally, this project was conducted on two cells (a reference and an enhanced cell); while current results seem promising, next steps should involve taking a larger sample size into consideration.

References

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Acknowledgement

Our sincerest thanks are expressed to our supervisor Dr.Abdulhai Al Alami. We are grateful for his valuable guidance and encouragement.We grasp this opportunity to record our sincere thanks to all the faculty members of the Sustainable and Renewable Energy Engineering department. We'd also like to thank our parents for their ceaseless support.We also place on record, our sense of gratitude to all whom have lent their helping hand, directly or indirectly, in this project.