Transparent Reduced Graphene Oxide with Photosystem I for Photoconversion

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Introduction

Photosystem I (PSI) is a photoactive electron transport protein found in plants that participates in the process of photosynthesis.

Due to PSI's abundance in nature and efficiency with charge transfer and separation, we are interested in applying the protein in photovoltaic devices.

Reduced graphene oxide (RGO) is attractive for use in photovoltaic devisces because it is transparent and conductive, and it affords facile and inexpensive production through chemical processes.

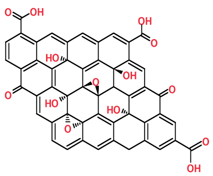
Objectives

Develop a transparent, conductive RGO electrode

Deposit PSI on the RGO electrode and determine the current densities produced in various mediator solutions

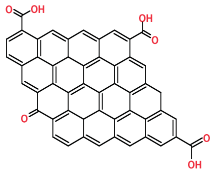
RGO Film Preparation

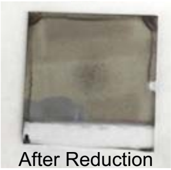
Spin coat GO onto functionalized glass



Before Reduction

Vapor Reduction:
1 mL hydrazine, 30°C, 3 hrs

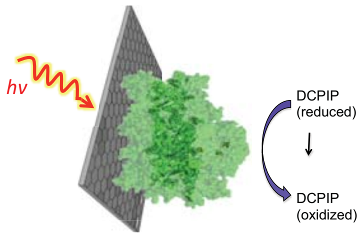




After Reduction

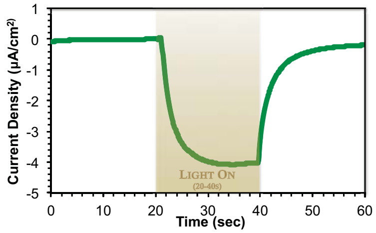
Characterize film using Raman, UV-Vis, and electrochemical techniques

Electrochemistry with PSI



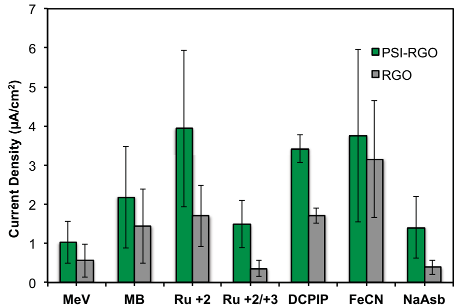
We deposited a multilayer of PSI on the RGO using a simple drop casting method.

When light shines through the RGO electrode, electrons flow from the mediator solution to the PSI-RGO electrode (left).



Photochronoamperometry is used to determine current density of our half cell (above).

Current Density Results

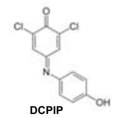


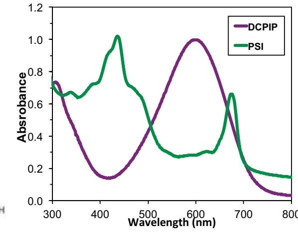
The current density varies depending on the mediator solution utilized (above).

Our PSI-RGO electrode demonstrates current densities comparable to a PSI-Gold electrode and significantly higher than a PSI-Graphene electrode.

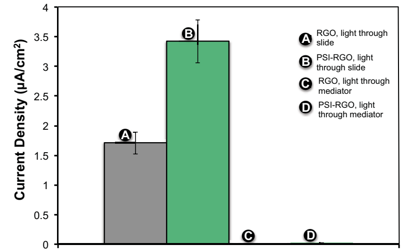
DCPIP Mediator Results

Dichloroindophenol (DCPIP) is an ideal mediator because it is organic, inexpensive, and non-toxic.





The transparency of RGO allows the use of an opaque mediator such as DCPIP, which absorbs in the same 600-700 nm range as PSI (above). Thus, when light shines through the mediator solution, the electrode is not photoactive (below).



The PSI-modified electrode demonstrates double the photocurrents of the unmodified RGO electrode.

Conclusion

We developed a transparent, conductive RGO electrode on which we deposited PSI. The resulting photoelectrode demonstrated significant photoactivity in a variety of mediator solutions. The relatively large photocurrents produced by integrating PSI with RGO and using an organic mediator can be applied to the production of more economic, easily produced, and completely organic solar cells.

References and Acknowledgements

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