Photoreduction of Graphene Oxide with Photosystem I

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Introduction

- Green plants have been the premier producer of solar energy for millennia. This is due to the presence of Photosystem I (PSI), a photoactive protein that excites an electron from the F\textsubscript{700} reaction center to an iron-sulfur complex (F\textsubscript{430}).
- Graphene (a single layer of carbon atoms) has shown potential in electronic devices due to its transparency and conductivity.
- Graphene can be produced through the oxidation of graphite, producing graphene oxide (GO) followed by thermochemical reduction to reduced graphene oxide (rGO).

Objectives

- Photoreduce prepared GO with PSI in solution.
- Combine PSI and rGO to produce an integrated.
- Deposit the composite film on various electrode materials.
- Characterize the composite using various techniques.

Methods

- Graphite (a single layer of carbon atoms) has shown potential in electronic devices due to its transparency and conductivity.
- Graphene can be produced through the oxidation of graphite, producing graphene oxide (GO) followed by thermochemical reduction to reduced graphene oxide (rGO).

For photoreduction, PSI and GO were mixed in solution and exposed to red light for various durations of time.

PSI-rGO aggregates were deposited into films on various electrodes and substrates. These films were characterized by UV-Vis spectrophotometry, Raman spectroscopy, and common electrochemical techniques, (chronoamperometry, cyclic voltammetry, and potentiometry).

Results and Discussion

- GO and PSI mix homogeneously in aqueous solutions prior to red light exposure.
- After 15 minutes of exposure, aggregation begins.
- Aggregations continue through 30 minutes of exposure.
- The contents of the mixture showed a decrease in solubility, which we attributed to the partial reduction of GO to rGO.
- The loss of oxygen functionalities (hydroxides and epoxides) that occurs in reduction from GO to graphene decreases aqueous solubility, due to the loss of hydrogen bonding sites.

Conclusion & Future Directions

PSI can be used to photoreduce GO in solution making a PSI-rGO bihybrid composite. This composite can be deposited on many electrode materials while still maintaining photoactivity greater than PSI alone. We were also able to use our own GO, which makes this a very low-cost, simple procedure. Our characterization methods show difference between starting material and the finished product. This composite has numerous applications, such as, photodetection devices and inexpensive solar energy conversion cells.

References and Acknowledgements


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