The Modification of Photosystem I with Carbon Nanotubes for Photocurrent Generation

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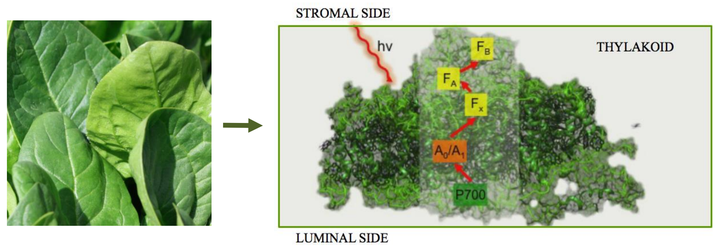
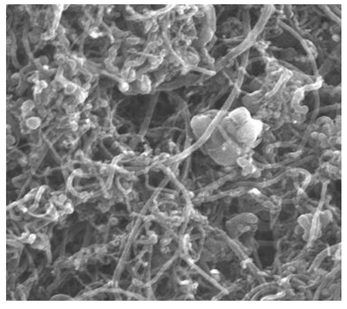
Introduction and Objectives

Spinach **PSI Protein**



- Photosynthesis is the biological process by which green plants utilize photons (hv) from sunlight to produce chemical energy.
- Photosystem I (PSI) is one of the two main protein complexes involved in photosynthesis. Upon light absorption, an excited electron is shuttled from the P_{700} site to the iron cluster, F_B.
- PSI-based solar cells mimic photosynthesis by generating current from the light absorbed by the protein.

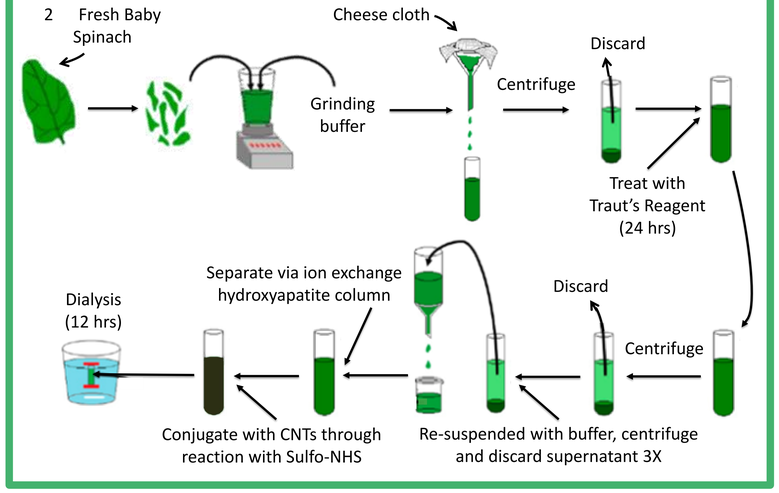
Scanning Electron Microscopy Image of CNTs



(SEM Image taken by Kody Wolfe and Dilek Dervishogullari)

- Carbon nanotubes (CNTs) are allotropes of carbon and can be used as conductive additives in solar cells.
- CNTs conduct electricity along the tubular axis.
- **OBJECTIVE:** Conjugate PSI protein to CNTs and construct a solar-state device that enhances the photocurrent generated from PSI via an improved conductive framework.

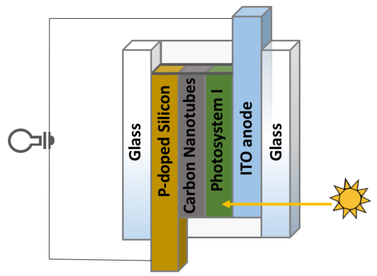
PSI Protein Extraction



Device Preparation

Device Type 1: PSI layered on top of CNTs

- CNT suspension was drop-casted onto lightly p-doped silicon and dried under vacuum to form a thin layer of CNTs. Dialyzed PSI extract was then drop-casted on top of the CNT film and dried.



Device Type 2: Covalent PSI-CNT Conjugation

- PSI was covalently conjugated onto the CNTs to enhance the electron transfer between the two materials and to ultimately improve the photocurrent generated from the solar device.

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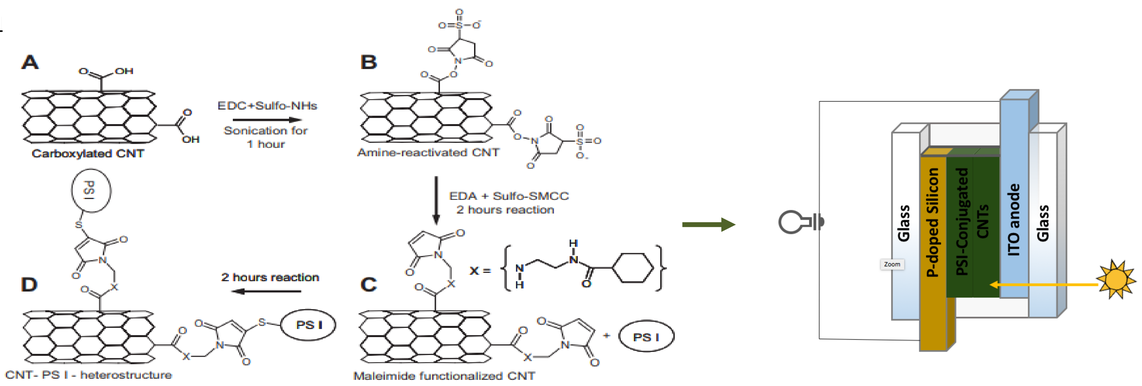
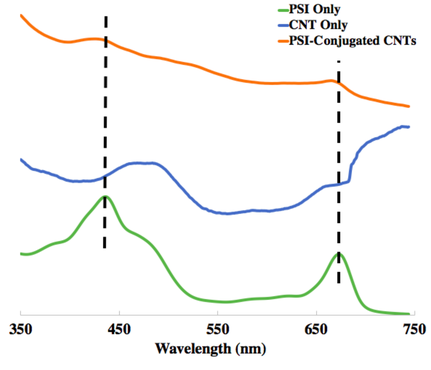


*Schematic for the covalent PSI conjugation to CNTs, Carmeli et al.

Results and Conclusion

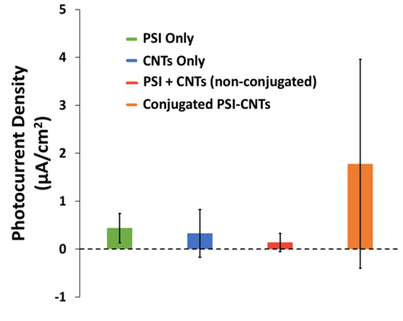
Overlaid UV-Vis Absorbance Spectra



- The absorbances were normalized to 1.
- PSI-conjugated CNTs demonstrate the characteristic PSI absorption peaks at around 430 and 670 nm, evidencing a covalent bond between the two.

Photocurrent Density Comparison of Different Solar Device Types and Control Devices

- The photocurrent density values presented are the average from multiple replicates of the same device type.
- Conjugated PSI-CNT device shows a higher average photocurrent density than the control devices, but also a higher standard deviation.



Future Directions

- Optimization of CNT deposition process may lead to increased uniformity of photocurrent between devices.
- Increasing the conjugation yield by increasing reaction times or optimizing reaction conditions should further improve device performance.

Acknowledgements

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References

1. Carmeli, I.; Mangold, M.; Frolov, L.; Zebli, B.; Carmeli, C.; Richter, S.; Holleitner, A. W. A Photosynthetic Reaction Center Covalently Bound to Carbon Nanotubes. *Adv. Mater.* **2007,** 19(22), 3901–3905.
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