Electrochemical Preparation of Polyaniline-Photosystem I Composite Films for Biohybrid Solar Energy Conversion

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Photosystem I (PSI) and Photosystem II (PSII) are the principle enzymes which drive the conversion of solar energy into chemical energy in plants and other autotrophs. The photoactivated charge separation, coupled with high internal quantum efficiencies, makes these enzymes very promising for use in biologically based solar energy conversion devices. In order to achieve this goal, enhancements in electron transfer kinetics and active lifetime of the enzyme are required. In previously devised immobilization methods, the resulting photocurrent yields are limited by the randomly orientated assembly of the protein on solid substrates,[1] as well as a reliance on redox mediators to shuttle away electrons from the stromal side acceptor sites of the protein. To overcome these challenges, redox active polymer networks have been explored as immobilization matrices. By enveloping the Photosystem enzymes in conductive polymer networks, electron transfer rates are vastly improved while at the same time deemphasizing the need for uniform protein orientation. In this research, polyaniline (PAni) has been shown for the first time to be an effective matrix for the creating photoactive PSI composite films. Thin, smooth films of the polymer can be prepared via electrochemical polymerization in aqueous media under mild conditions in the presence of the solubilized enzymes, resulting in a PAni-PSI composite films that exhibit higher photoactivity than PAni films alone. In addition, these PAni-PSI composite films are rapidly assembled with controllable film growth through the use of potentiostatic polymerization, and on a time scale significantly shorter than previously developed hand casting methods for PSI films.[2-4] This research serves as proof of principle and creates future avenues for further development of electrochemically-prepared photoactive composites on an array of traditional electrode materials as well as semiconductors.

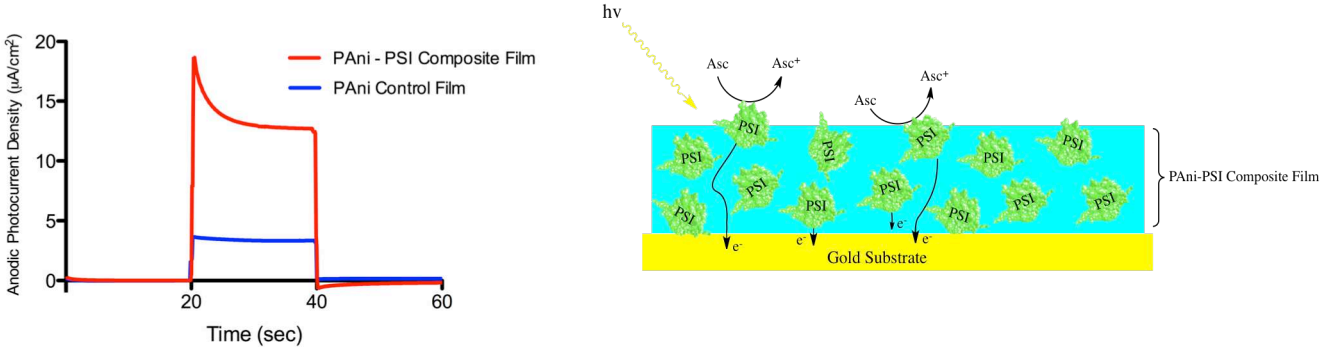

Figure 1. a) iT-amperometry curve for PAni-PSI composite film (red line) and PAni control film (blue line) tested in 100 mM KCl and 5 mM sodium ascorbate. Samples were illuminated (633 nm high pass filtered lamp) from 20 to 40 seconds, while biased at their respective dark open circuit potentials. b) Schematic representation for PSI protein complexes entrapped within conductive PAni network on gold substrate.

References:

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