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Abstract

Deleterious effects of some methods used to harness energy from the environment today have garnered the exploration of safer and more reliable options, specifically solar energy conversion. Current solar cell technology has yielded quantum efficiencies commonly in the range of 10-20% but is limited by extensive processing methods, high cost, and need for rare materials. However, bio-derived solar cells containing Photosystem I (PSI) address these problems as PSI is highly abundant, very efficient, and low-cost. PSI acts as a biomolecular photodiode through rapid photoexcited charge separation, making it very promising for use as an integral element in solar cells. To further improve the efficiency of bio-derived cells, controlling the orientation of PSI films on gold substrates was explored. This was achieved by side-selectively modifying PSI to introduce terminal thiol groups to the protein complex thereby providing a vector of self-assembly onto the gold surface. Spinach thylakoid membranes containing PSI were extracted and chemically modified using the ligands: sulfo-N-succinimidyl S-acetylthioacetate and 2-iminothiolane. As a result, the functionalized PSI underwent direct surface coupling on gold electrodes in an inverted orientation. Fluorescence tagging was used to quantify ligand attachment to PSI. Additionally, photoelectrochemical analysis revealed an enhancement in photocurrent produced by the modified biohybrid electrodes.

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