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Understanding the Light-Harvesting Photosystem II

The ability of plants to live, thrive, and survive on sunlight provides unsurpassed motivation to understand and mimic this process for solar energy production. Photosystem II has long been studied and admired by scientists eager to harness its energetic potential; absorbed sunlight produces a cascade of uphill, proton coupled electron transfer (PCET) events that funnel energy for plants to utilise to synthesise food. In this application note, Edinburgh Instrument's LP980 Transient Absorption Spectrometer is used to measure energy and electron transfer events.

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RESEARCH HIGHLIGHT
Understanding the Light-Harvesting Photosystem II; Utilising Transient Absorption to Study a Molecular Triad's Photoinduced Electron Transfer Reactions

PH_LP_006 03 Feb 2020 Ian M. Stanton, Ph. D.

Introduction
 The ability of plants to live, thrive and survive on sunlight provides unsurpassed motivation to understand and mimic this process for solar energy production. Photosystem II has long been studied and admired by scientists eager to harness its energetic potential; absorbed sunlight produces a cascade of uphill, proton coupled electron transfer (PCET) events that funnel energy for plants to utilise to synthesise food. The Edinburgh Instruments LP980 Transient Absorption (Flash Photolysis) Spectrometer is the world's only commercially available system to feature dual detector options for direct kinetic and spectral measurements required to measure such energy and electron transfer events, and is ideally suited for solar energy research.

(plastoquinone B) mimic. Photooxidation of the RuII sensitizer initiates the process much like P680 in PSII, and generates a metal-to-ligand charge transfer (MLCT) excited state (Figure 2). A PCET event then takes place on the phenol donor (PCET 1), generating a phenoxyl radical, and undergoing long-range electron transfer to the monooxyl, where a subsequent PCET event takes place (PCET 2). By varying the solvent, and utilising transient absorption spectra from the ICCD and PMT detectors to study the photogenerated radical spectra and lifetimes, respectively, and comparing these to the spectroelectrochemistry spectra to prove the radical species present in the photogenerated transient spectra, the researchers were able to prove multi-step PCET and long-range electron transfer events (Figure 3).

Figure 1: The Edinburgh Instruments LP980 Spectrometer.

Research
 Anelia Pinnau and Professor Oliver S. Wenger, who performs inspiring photochemical research into electron and energy transfer mechanisms at the University of Basel in Switzerland, utilised transient absorption to study, for the first time, a photo-induced long-range electron transfer coupled with acceptor protonation and donor deprotonation in a molecular triad designed to mimic Photosystem II (PSII).

Figure 2: The studied molecular triad designed to mimic Photosystem II (PSII) showing multiple proton coupled electron transfer (PCET) and long-range electron transfer. These researchers methodically designed a molecular triad to behave similarly to PSII: a phenol donor (pyrone 2 minus, linked to a RuII sensitizer P680 mimic), and additionally linked to a monooxyl acceptor.

Figure 3: (a) Photogenerated transient absorption spectra of the molecular triad, (b) spectroelectrochemistry of the monooxyl, (c) absorption of the phenoxyl radical, and (d) difference spectra showing the absorption of phenoxyls.

Conclusion
 This study highlights how designing unique molecular architecture can give insights into nature's ability to harvest and store solar energy efficiently and avoid the build-up of charge; these proton coupled electron transfer processes can be directly studied by the Edinburgh Instruments LP980 Transient Absorption Spectrometer.

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