Light Harvesting and Fuel Production in Artificial Photosynthesis"

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The design of bio-inspired molecular constructs that couple solar energy conversion to the oxidation of water and the subsequent use of the reducing equivalents to synthesize energy-rich compounds, such as hydrogen, are the main objectives of our present research.[1] The design principles used in the construction of artificial antennas[2] and antennas-reaction center complexes will be discussed, followed by a general description of photoelectrochemical cells for water splitting. We are assembling photoelectrodes that model photosystems I and II (PSI and PSII) of plants. The photoanode model of PSII contains nanocrystalline SnO_2 or TiO_2, high potential porphyrin or ruthenium complexes (mimics of P680), a benzimidazole-phenol pair (BiP) that mimics the Tyr_Z-His190 redox relay pair of PSII, and colloidal IrO_2 as a heterogeneous catalyst for water oxidation. Incorporation of the BiP redox mediator/relay considerably improves the quantum yield for transfer of electrons from the water oxidizing catalyst to the oxidized dye, which we interpret as more efficiently matching the slow electron transfer steps associated with the IrO_2 to the fast steps associated with electron injection and recombination at the dye-semiconductor interface.[3,4] The photoelectrode model of PSI is part of a Grätzel-type cell, designed to boost the potential provided by the photoanode. It is sensitized by relatively low potential porphyrins or phthalocyanines, which absorb light in the near IR region of the spectrum. Upon photoexcitation, these dyes are designed to inject electrons into semiconductors having sufficiently negative conduction bands to effectively drive the reduction of protons to hydrogen at a cathode.

References

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