Photonic Energy Use in Organic and Organometallic Materials

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Abstract:

Photonic energy conversions are critical to a host of interesting processes including solar-to-electric energy conversions, solar-to-fuel conversions and fluorescence biological imaging as well as telecommunications with near-infrared (NIR) emissive materials. Organic materials for use in dye-sensitized solar cells (DSCs) and NIR emissive materials will be discussed in addition to organometallic catalysts for solar-to-fuel conversion processes.

The exploration of organic building blocks capable of accessing the NIR spectral region is crucial for practically improving DSCs and NIR emissive materials. Given the plethora of available options, judicious selection of organic materials via physical organic principles is critical to efficiently evaluating synthetic targets. Several unique classes of organic materials are interesting for these applications including: (1) *proaromatic* building blocks which offer a unique platform for accessing relatively low molecular weight small molecules with substantial absorption breadths; (2) *cross-conjugated* building block scaffolds which offer uniquely tunable motifs for use in combination with existing organic building block materials through a summing of electronic properties; and (3) *electron-deficient thiophenes* that are capable of supporting dual electron-rich building blocks while maintaining energy levels for practical DSC devices with dual conjugated anchoring groups to solar cell surfaces. Additionally, these thiophene-based materials offer a healthy balance of sterically controlled bond twist angles versus planarized π-systems to introduce moderate stokes-shifts while maintaining NIR emissive properties. This delicate balance is critical for many fluorescence imaging applications.

The use of photonic energy to provide directly usable energy is a crucial step forward in securing humanities energetic future. Solar-to-electric conversion systems are great avenues toward electric production. The development of catalysts for *efficient* energy usage from these systems *or* the direct use of photocatalysts is necessary to meet our solar-to-fuel needs. Re-NHC-based photocatalysts will be discusses as potential systems for the conversion of CO_2 to more readily usable carbon-based fuels and fuel precursors.