Photo-oxidants with comprehensive visible spectral coverage for energy conversion and catalysis

Unmet Need

Photochemistry, or the use of light to promote chemical reactions, has only recently been adapted by pharmaceutical companies in the past 10 years due to the development of photoredox catalysts that utilize visible light. These advancements in photochemistry have enabled scientists to access brand new molecules that couldn't previously be created, which pharmaceutical companies are now utilizing to create new therapeutics and chemical companies are now supplying to researchers. However, there are many chemical reactions that remain inaccessible with the photoredox catalysts that are currently available. Photochemical challenges exist in areas such as low-cost solar cells, photodecomposition of chemical waste, and additional molecules for therapeutics. There have been many photo-reductants reported, but relatively little progress has been made for corresponding electron-deficient chromophores that would be required to achieve these new reactions. There is a need for technologies that can increase the applicability of photochemistry to address critical issues such as renewable energy and waste management.

Technology

Researchers at Duke University have developed novel photo-oxidants that increases the breadth of accessible photochemical transformations for applications such as energy conversion, chemical synthesis, and hazardous waste management. Specifically, these high-potential photo-oxidants have a supermolecular structure that includes a conjugated macrocycle linked to a metal complex. A supermolecule has been demonstrated in the lab using a highly electron-deficient Ru(II) complex

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Chemistry

Publication(s)

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External Link(s)

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that achieved comprehensive visible spectral coverage.

Advantages

- Novel photo-oxidant compounds that have substantial excited-state reduction potentials, high absorptive oscillator strength over the entire visible spectral range, and extreme photostability compared to existing photoredox catalysts
- Enables new opportunities in light-driven oxidation reactions for areas such as solar fuel cells, photodecomposition of harmful hydrocarbon waste, and new pharmaceutical compounds
- Exhibits ~8-fold greater absorptive oscillator strength over the 380–700 nm range relative to conventional Ru(II) polypyridyl complexes and impressive excited-state reduction potentials ($^{1}E^{-/*}$ = 1.59 V; $^{3}E^{-/*}$ = 1.26 V)
- Achieved electronically excited singlet and triplet charge-transfer state lifetimes more than two orders of magnitude longer than those of conventional light absorbing molecules