Artificial photosynthesis by light absorption, charge separation, and photoredox catalysis

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Abstract

Artificial photosynthesis has been recognized as a sustainable approach to utilize solar energy for chemical reactions and energy storage. Some of the critical functions of artificial photosynthetic systems include light absorption, charge separation, and multi-electron catalysis. In this presentation, I will summarize my team's early contributions to each of these elementary components using exclusively Earth-abundant elements. I will describe our efforts in the preparation of Cu(I) photosensitizers supported by bis(arylimino)acenaphthene ligands. The diamagnetic, homoleptic Cu(I) complexes exhibit panchromatic light absorption extending to the near infrared region. The transient absorption spectroscopic and photoluminescence measurements of some of the new Cu(I) complexes will be reported. In addition, we have developed new white light emitting materials as part of our team's overarching efforts toward sustainable energy storage and conversion. For the multi-electron reductive half-reaction, my team has recently reported new salicylaldimine nickel complexes bearing ether pendant arms that perform as hydrogen evolution electrocatalysts, even in seawater. Regarding the multi-electron oxidative half-reactions, I will discuss some of the mechanistic studies we have conducted on photoredox oxidative transformations. In particular, I will focus on our discovery of an unprecedented, selective, photoredox C-C activation reaction in lignin model compounds by vanadium photocatalysts, which occurs under ambient, atmospheric conditions using visible light as the energy source. We have further prepared a library of new catalysts and conducted kinetics studies that have provided valuable insights for the choice of more general substrates in our unusual C-C cleavage reaction.

References

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