

### Recent advances in photoredox catalysis with visible light<sup>1-7</sup>

Visible-light, a clean, inexpensive, and 'almost infinitely' available source of energy, has received increasing attention from the chemistry community. Actually, a hundred years ago Ciamician had already recognized that sunlight could be utilized as an inexpensive, abundant, clean and renewable energy source for organic chemistry. However, the inability of most common organic molecules to absorb light of visible wavelengths has attenuated the progress of the field of photoredox catalysis with visible light. It is until the year of 2008 when MacMillan's science paper appeared that the field started to explode. The purpose of this paper was to set a novel mode of action (implement photoredox catalysis in SOMO-related transformation) for reaction development. Later, the work from Yoon and Stephenson extended this concept to basic organic transformations. At this time period, [2+2]-cycloaddition, aza-Henry, and dehalogenation reactions were achieved. The concept was further applied to various radical reactions involving additions to arene, alkyne, and alkene. Due to its mild condition, several total syntheses also adopted this photoredox catalytic protocol as the key step in the synthetic routes. In addition, the use of organophotoredox catalyst instead of toxic and expensive transition-metal based photocatalyst also led some exciting results as very recently demonstrated by Nicewicz. The combination of photoredox catalysis with organocatalysis or metal catalysis has been also utilized for novel transformation development. Besides MacMillan's early example, Sanford has demonstrated a room-temperature C-H functionalization enabled by the palladium and ruthenium catalysts. Rovis also showed the NHC catalysis could be coupled with photoredox catalysis. Nevertheless, the reported photoredox catalytic cases always adopted either reductive or oxidative quenching cycle. Yoon very recently demonstrated that the third pathway, direct energy transfer, could also be operative. Overall, visible-light mediated photoredox catalysis has been emerging as one of the fastest growing fields in organic chemistry in the last past five years because of its low cost, easy availability and environmental benignness. Rapid progress in future in this future is therefore anticipated.

In the presentation, the recent research progress in novel methodology development and application in organic synthesis will be organized in terms of key reactive intermediates, instead of the type of reactions, or in a timeline.

Leading reviews:

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