Photochemical activity of a key donor-acceptor complex can drive stereoselective catalytic α-alkylation of aldehydes

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INTRODUCTION

To harvest energy from light sources in catalytic asymmetric processes is a formidable challenge towards the development of sustainable methods. However, the design of such transformations is difficult due to the inherit hurdle of combining the short-lived nature of electronically excited states with the stereodefining event promoted by an enantiopure catalyst. Herein, we describe a highly enantioselective protocol for the α-alkylation of aldehydes through the use of a visible light source, which proceeds by means of chiral charge-transfer complexes. Mechanistic evidences are provided.

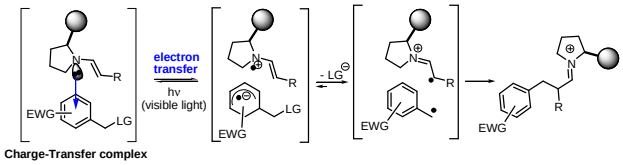
RESULTS AND DISCUSSION

The α-alkylation of aldehydes is an important reaction that allows the access to a great diversity of building blocks. Interestingly, such an important transformation cannot be accomplished through a more conventional catalytic termal process, because the homodimerization of the aldehyde (proceeding *via* an aldol mechanism) is much faster than the desired substitution pathway.

A solution to this fundamental problem can be devised by replacing a slow 2e ionic step by a faster SET event.[1]

In this regard, our group developed a new protocol based on the formation of a chiral charge-transfer complex, formed between a catalytic generated enamine and an alkylating agent.[2] An electron transfer occurs between the two partners promoted by the visible light irradiation, followed by the fragmentation of the leaving group, thus originating a di-radical pair that combines in the solvent cage to afford the alkylated substrate (Scheme1). To the best of our knowledge, this activation mode has never been used before in asymmetric aminocatalysis. A series of alkylated aldehydes carrying benzyl and phenacyl chains can be prepared in high yields and enantioselectivities (Scheme 2 and Figure 1).

Scheme 1. Proposed intermediates



Scheme 2. Our protocol for the enantioselective α-alkylation of aldehydes.

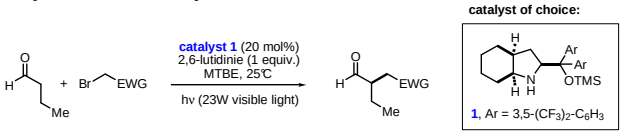
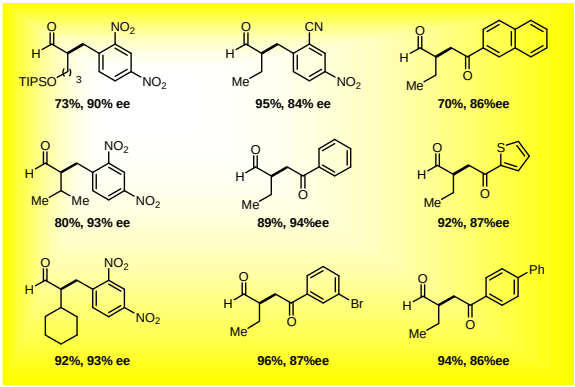


Figure 1. Selected examples



CONCLUSION

In summary, we developed a highly efficient protocol for the enantioselective α-alkylation of aldehydes, which involves the formation of photoexcited chiral charge-transfer complexes. This strategy dispenses the need for external photosensitizers, thus differing from, but complementing the photoredox catalysis approach, a rapidly developing field of modern chemical research.

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REFERENCES

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