Exploiting the Full Potential of a Photocatalytic System by Changing Light Intensity

Christoph Kerzig and Oliver S. Wenger

University of Basel, Department of Chemistry

Abstract

Changing the light power density of a blue continuous-wave light source using an inexpensive lens allows one to selectively switch from one- to two-photon substrate activation chemistry and regulate redox potentials for difficult reductions.

This study demonstrates how adjusting the intensity of light from an LED source can lead to different main products from the same substrate under identical reaction conditions.

Using this novel technique for lab-scale photoreactions with three substrate classes resulted in high product yields and exceptional selectivity.

The findings from this study can be used for controlling reactivity of substrates in different solvents and designing photocatalytic redox reactions that yield valuable photochemical products.

Introduction

Photocatalysts with specific properties can be used to determine the yield and selectivity of photo-redox reactions.

Light-color or wavelength-dependent photochemical reactions are being explored to avoid the use of expensive photocatalysts. However, most laboratories do not have access to multiple high-powered pulsed lasers.

A rather lucrative, less explored alternative is modifying the intensities of light from a single source to control the outcome of a photochemical reaction.

Goal

To vary the properties of a photocatalyst
by changing the light intensity

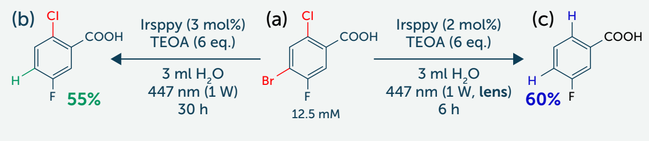
Methodology

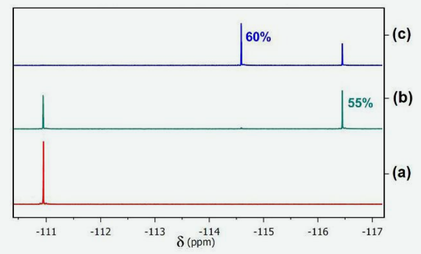
- **Irsppy as a water-soluble catalyst for dehalogenation and isomerization reactions**
- **A photocatalytic system with a continuous wave (cw) laser of 447 nm working at 1 W, collimated to a spot smaller than 1 mm² using a lens**

Results

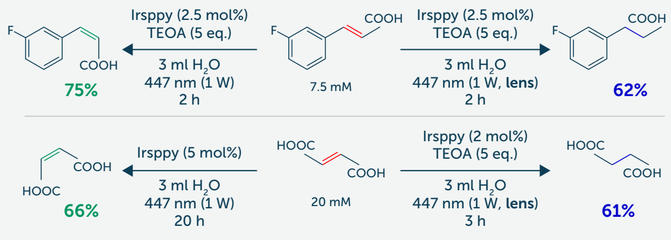
The results indicate that irradiation intensity can be used to control

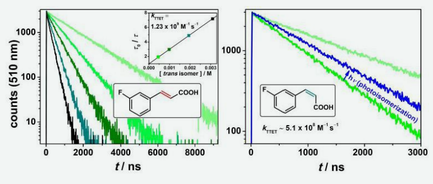
1. The redox potential for reductive dehalogenations



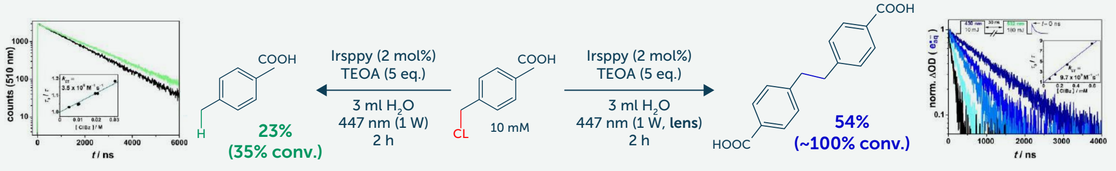


2. The photochemical cis-trans isomerization of olefins versus their photoreduction





3. The competition between hydrogen atom abstraction and radical dimerization processes



Conclusion

These findings show that combining a photocatalytic system involving a photocatalyst, solvent, and sacrificial reagent with a blue cw light source can be exploited to carry out a wide range of chemical reactions, such as selective photoredox reactions in which different main products can be obtained from the same substrates under similar reaction conditions.

References

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