Using visible light to drive catalytic reactions offers a simple, inexpensive, and green approach to functionalizing complex molecules under mild reaction conditions. Two new catalytic strategies could finally make visible-light photocatalysis practical for commercial use, particularly in the fine chemicals and pharmaceutical industries.

In one report, Eric Meggers of Philipps University, in Marburg, Germany, and coworkers coupled low-intensity visible light and the inherent chirality of an iridium complex to drive the enantioselective α-alkylation of carbonyl compounds with benzyl or phenacyl groups (Nature 2014, DOI: 10.1038/nature13892). The tasks of photoactivating the substrate and controlling the stereochemistry of the product are typically shared by two separate catalysts. Meggers and coworkers showed that their chiral catalyst can perform both tasks at the same time, via proposed enolate and radical intermediates.

In a second report, Burkhard König and coworkers of the University of Regensburg, in Germany, describe a perylene diimide organocatalyst that absorbs more light energy than typical photocatalysts. The catalyst can therefore functionize less-reactive chemical bonds, a feat that until now has required using higher-energy ultraviolet light or harsher reaction conditions (Science 2014, DOI: 10.1126/science.1258232). König’s team found that the perylene diimide undergoes a two-photon electron-transfer process to form an excited radical anion with enough energy to reduce aryl halides. The aryl radicals that form can then be trapped by hydrogen atom donors such as amines to form aryl derivatives or pyrroles to form substituted aryl derivatives.

In the past, chemists relied on single catalysts, UV light, auxiliary reagents, and special equipment to pull off light-driven enantioselective reactions, note Kazimer L. Skubi and Tehshik P. Yoon of the University of Wisconsin, Madison, in a commentary accompanying the Meggers paper. Chemists have more recently discovered dual chiral-photoredox catalyst systems that use lower-energy visible light supplied by simple household lighting for the same reactions, they add. “The discovery of a single transition-metal catalyst that fulfills both roles is a crucial conceptual step forward.”

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Matt Noel (December 11, 2014 5:09 AM)
I am interested in this technology for testing with our product. We are currently using a TiO2 product out of Japan on various substrates in the USA. For our interior products we are using TiO2 doped with silver. I would like some information on possibly testing this product on our interior substrates.

Sincerely,

Matt Noel
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Burkhard Koenig (December 20, 2014 8:57 AM)
I suggest using the commercially available dye N,N′-bis (3-pentyl)perylene-3,4,9,10-bis(dicarboximide) for a first try.

Best regards

Burkhard Koenig
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