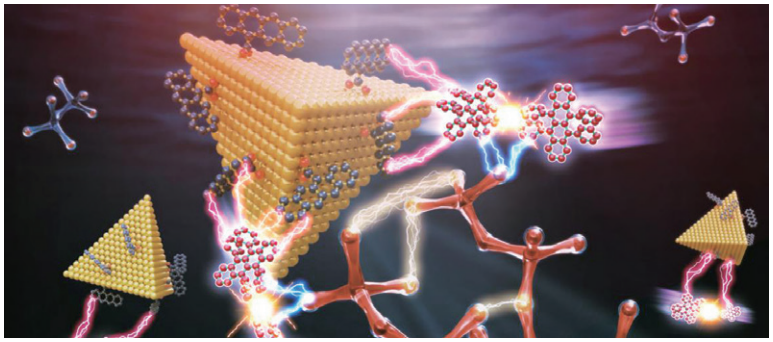
Life Sciences

Upconversion of Infrared Photons Enables Rapid Organic Synthesis under Sunlight

A research group led by Prof. WU Kaifeng from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has reported the efficient near-infrared photon upconversion sensitized by lead-free semiconductor nanocrystals and demonstrated its novel application in solar synthesis.

The study was published in *Nature Photonics* on February 6.



Near-infrared photon upconversion and solar synthesis using lead-free nanocrystals (Image by DU Jun)

Upconversion of near-infrared photons to visible photons can boost the performance of photovoltaics, photoredox-catalysis and phototheranostics. Sensitized triplet-fusion is a promising means for photon upconversion.

However, current photosensitizers capable of near-infrared absorption often contain either precious or toxic elements, for example, palladium- or platinum-complexes and lead chalcogenide nanocrystals.

In this study, the researchers reported zinc-doped $CuInSe_2$ nanocrystals as a low-cost and environmentally-benign sensitizer for near-infrared-to-visible upconversion, which achieved external quantum efficiency of 16.7% for this spectral range.

This upconversion system was further merged with photoredox catalysis, enabling reductive dehalogenation, amine oxidation, carbon-oxygen bond formation and photopolymerization efficiently driven by near-infrared photons.

More importantly, thanks to the broadband light capturing of the near-infrared nanocrystals, these reactions were remarkably rapid under indoor sunlight, enabling, for example, polymerization of acrylates within just 30 seconds.

"Organic synthesis under sunlight, or solar synthesis, has been a century-long idea, which was pioneered by Ciamician *et al*. But organic chemists' vision has been limited to utilizing visible photons in sunlight," said Prof. WU. "Our study extends the reach of solar synthesis to both visible and near-infrared photons abundant in sunlight, which is poised to strongly boost this technology."

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(Source: DICP)

Reference

Liang, Wenfei, Nie, Chengming, Du, Jun, Han, Yaoyao, Zhao, Guohui, Yang, Fan, . . . Wu, Kaifeng. (2023). Near-infrared photon upconversion and solar synthesis using lead-free nanocrystals. *Nature Photonics, 17*(4), 346-353. doi:10.1038/s41566-023-01156-6