Novel carbon-based catalyst developed for efficient photo-driven CO2 cycloaddition

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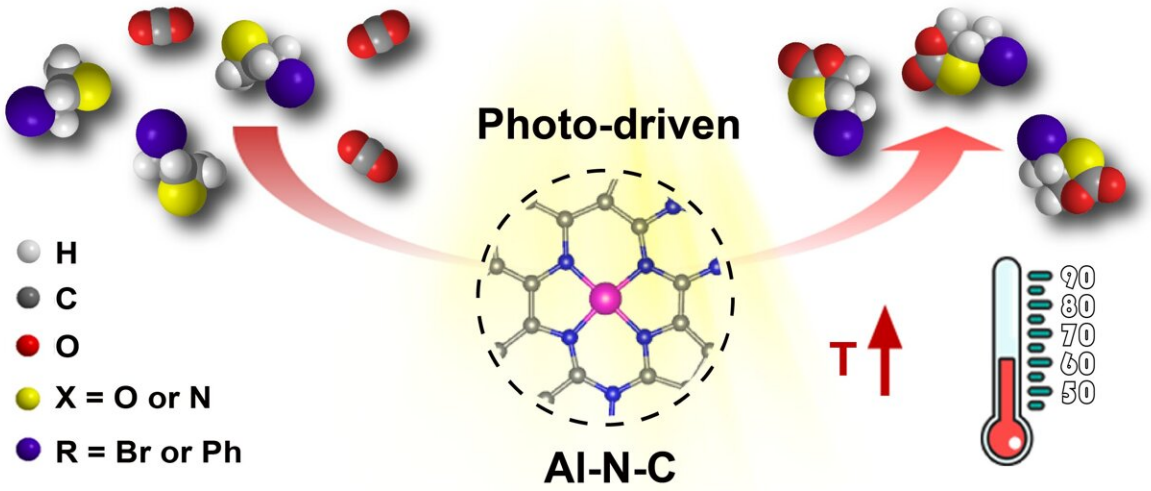

Photo-driven catalytic process based on the Al–N–C catalyst. Credit: NIMTE

Prof. Chen Liang's group and Prof. Lu Zhiyi's group at the Ningbo Institute of Materials Technology and Engineering (NIMTE) of the Chinese Academy of Sciences (CAS) proposed a highly-active carbon-based catalyst, which can directly utilize renewable energy (e.g., solar energy) to improve the efficiency of photo-driven CO_2 cycloaddition effectively. The study was published in *Advanced Materials*.

In recent years, the increasing greenhouse gas (mainly CO_2) emissions have exacerbated the global warming and ocean acidification. With the aim to peak CO_2 emissions and achieve carbon neutrality, the elimination of CO_2 based on the capture and conversion of CO_2 is urgently needed. The cycloaddition of CO_2 with epoxides to generate cyclic carbonates has attracted extensive attention thanks to the diverse application of products.

By virtue of a versatile molecule-confined pyrolysis strategy, researchers at NIMTE proposed and synthesized a semiconductive Al-N-C catalyst possessing high density of atomically dispersed Al-N_4 motifs.

The Al and N species serves as Lewis acid and base sites, respectively, which are combined to facilitate the substrate activation for the photo-driven CO_2 cycloaddition reactions. Under light irradiation, the synthesized Al–N–C catalyst showed excellent catalytic performance (≈95% conversion, reaction rate = 3.52 mmol g^{-1} h^{-1}) for the CO_2 cycloaddition reaction.

In addition, both experimental and theoretical analysis revealed that light irradiation facilitated the photo-generated electron transfer from the semiconductive Al–N–C catalyst to the epoxide reactant, contributing to the high-efficiency formation of a ring-opened intermediate through the rate-limiting step. This process constitutes a new activation mechanism for CO_2 cycloaddition reaction.

This study has provided a novel approach for high-efficiency CO_2 cycloaddition based on the integration of atomically dispersed Al species and photothermal effect, and shed light on the future design of advanced catalysts for diverse catalytic reactions.

More information: Qihao Yang et al, Atomically Dispersed High-Density Al–N 4 Sites in Porous Carbon for Efficient Photodriven

CO 2 Cycloaddition, *Advanced Materials* (2021). DOI: 10.1002/adma.202103186

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