

# Novel carbon-based catalyst developed for efficient photo-driven CO<sub>2</sub> cycloaddition

October 27 2021, by Liu Jia

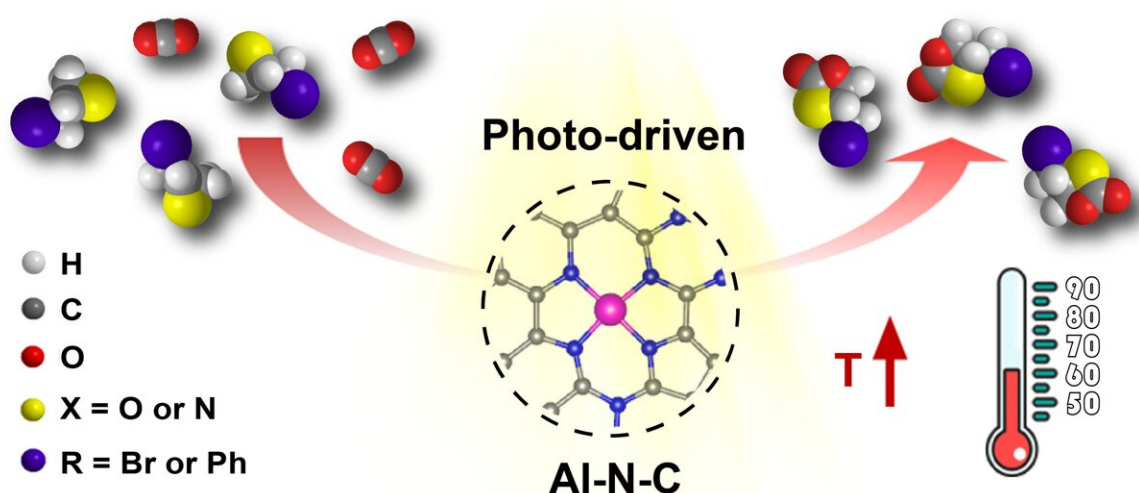


Photo-driven catalytic process based on the Al-N-C catalyst. Credit: NIMTE

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<sub>2</sub> cycloaddition effectively. The study was published in *Advanced Materials*.

In recent years, the increasing greenhouse gas (mainly CO<sub>2</sub>) emissions have exacerbated the global warming and ocean acidification. With the aim to peak CO<sub>2</sub> emissions and achieve carbon neutrality, the elimination of CO<sub>2</sub> based on the capture and conversion of CO<sub>2</sub> is urgently needed. The cycloaddition of CO<sub>2</sub> 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<sub>4</sub> 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<sub>2</sub> cycloaddition reactions. Under [light irradiation](#), the synthesized Al-N-C catalyst showed excellent catalytic performance ( $\approx 95\%$  conversion, reaction rate = 3.52 mmol g<sup>-1</sup> h<sup>-1</sup>) for the CO<sub>2</sub> 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<sub>2</sub> cycloaddition reaction.

This study has provided a novel approach for high-efficiency CO<sub>2</sub> 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<sub>2</sub> Cycloaddition, *Advanced Materials* (2021). DOI: [10.1002/adma.202103186](https://doi.org/10.1002/adma.202103186)

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