

## Research Highlights

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### Selective Hybrid Photocatalyst Allows Oxidative Coupling of Methane to Ethane with Dioxygen

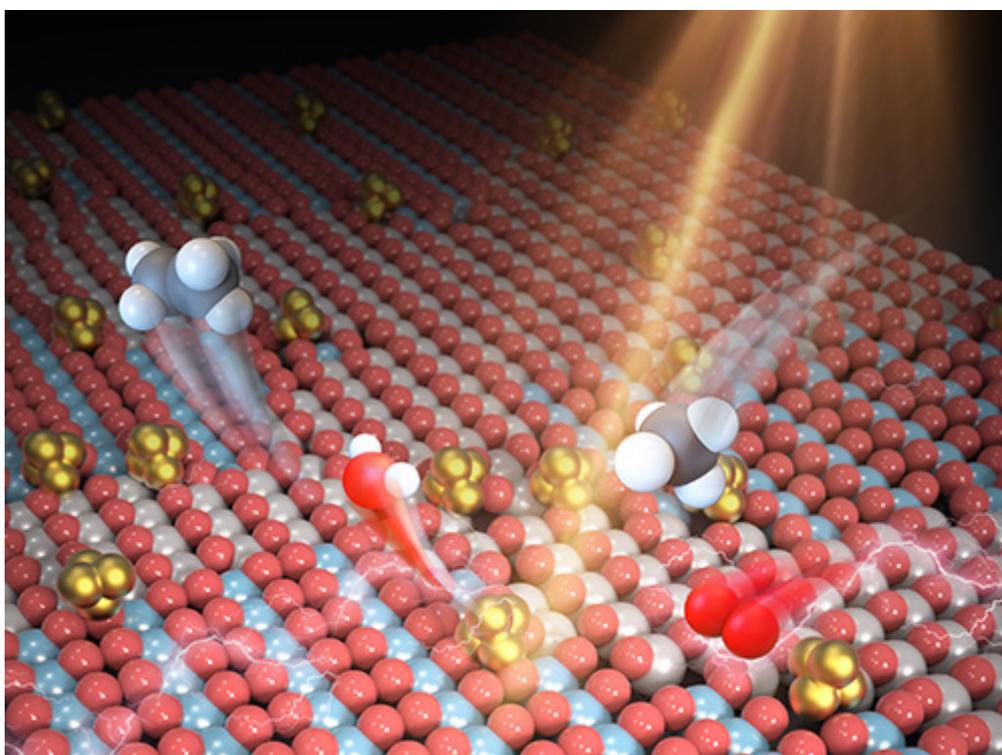
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A team at WPI-MANA has demonstrated that methane can be efficiently and selectively oxidized to ethane with oxygen under light irradiation over an Au-ZnO/TiO<sub>2</sub> hybrid. This achievement opens the door to cheaper and more efficient production of valuable chemicals using methane as a feedstock.



Methane (CH<sub>4</sub>), the main component of natural gas and shale gas, is not only an abundant and low-cost fuel, but also a powerful greenhouse gas with a potential 28-34 times that of CO<sub>2</sub>. Directly and selectively converting methane to value-added higher hydrocarbons or oxygenates has been attracting substantial interest from both academia and industry, and could reduce society's reliance on crude oil and contribute to carbon neutrality.

However, the high C-H bond dissociation energy and non-polar nature of methane, along with the higher reactivity of the desired products, make selective activation and conversion of methane challenging.

The WPI-MANA group designed an Au-ZnO/TiO<sub>2</sub> hybrid photocatalyst for selectively oxidizing CH<sub>4</sub> to ethane (C<sub>2</sub>H<sub>6</sub>) with oxygen (O<sub>2</sub>). This showed a high C<sub>2</sub>H<sub>6</sub> production rate with high selectivity and excellent durability, which were more than one order of magnitude higher than the state-of-the-art photocatalytic systems.

Mechanistic studies showed that the formation of ZnO/TiO<sub>2</sub> heterojunctions by precisely controlling the ratio and interface structure of ZnO/TiO<sub>2</sub> led to enhanced activity, while maintaining high selectivity owing to the weak overoxidation ability of the main component ZnO. Moreover, using Au nanoparticles as the cocatalyst not only promotes charge separation, but also facilitates methyl (CH<sub>3</sub>) species desorption to form methyl radicals, which promotes the formation of C<sub>2</sub>H<sub>6</sub> and inhibits the overoxidation of CH<sub>4</sub> to CO<sub>2</sub>.

These findings could guide the future design of photocatalysts that could transform methane to ethane with high activity and selectivity. This, along with other technologies such as new reactor designs, could provide an economically viable way to directly convert methane into ethane.

This research was conducted by [Jinhua Ye](#) (MANA Principal Investigator, Group Leader, Photocatalytic Materials Group, WPI-MANA, NIMS) and her collaborators.

## Reference

“A selective Au-ZnO/TiO<sub>2</sub> hybrid photocatalyst for oxidative coupling of methane to ethane with dioxygen”

Shuang Song, [Jinhua Ye](#) et al.

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