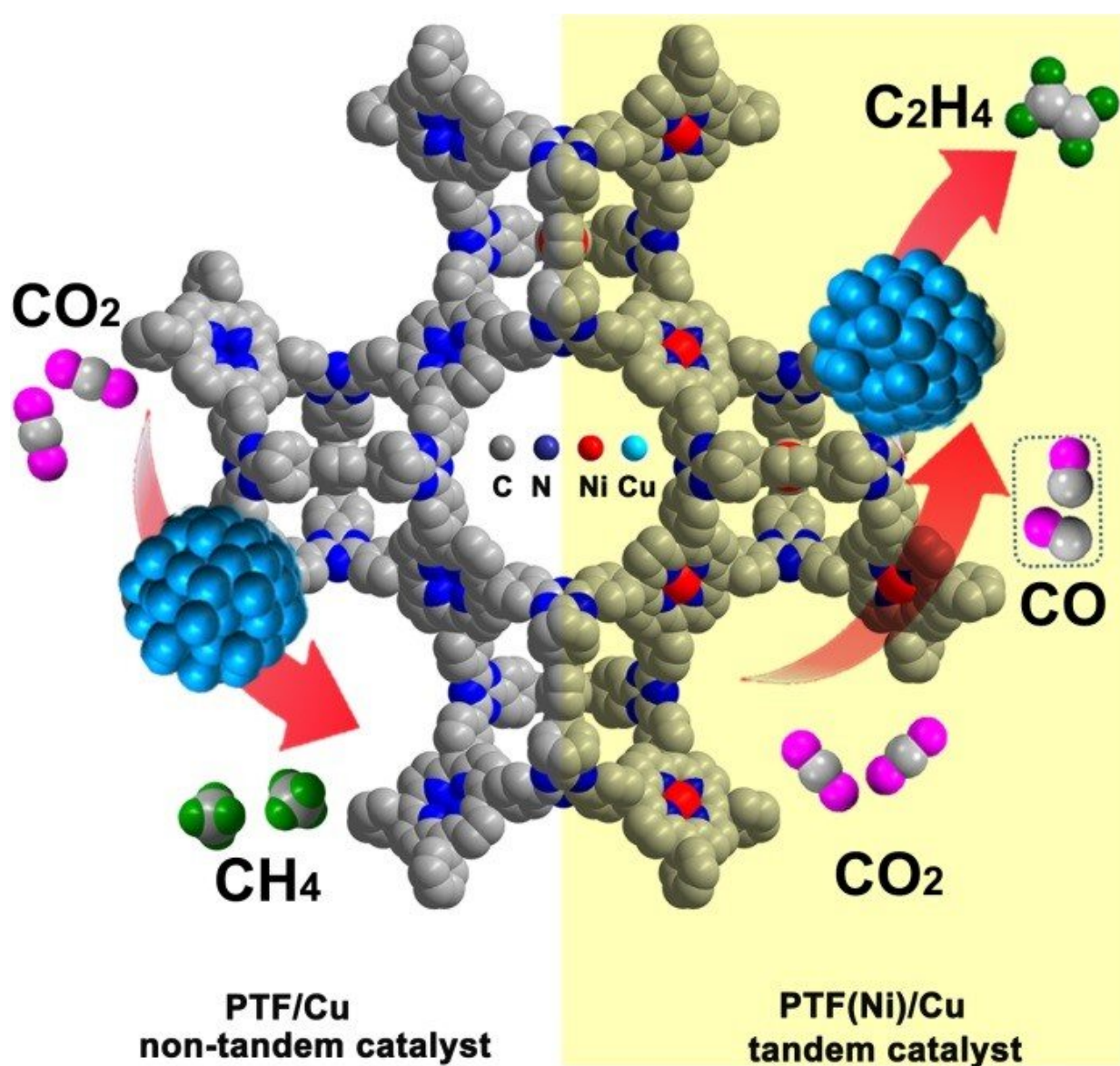


Nickel single atom and copper nanoparticles used for highly selective tandem electrocatalysis of CO₂ to ethylene

October 28 2021, by Liu Jia



The tandem electroreduction of CO₂ to ethylene over atomically isolated nickel-nitrogen site/copper nanoparticle catalysts. Credit: Prof. CAO's group

The electroreduction reaction of CO₂ (CO₂RR) into higher-value C₂₊ (C₂+) products such as C₂H₄ provides an environmental friendly technology to realize the cyclic utilization of carbon resources, but the activity and selectivity of higher-value C₂₊ (C₂+) products are largely limited by the multi-electron transfer process and sluggish C-C coupling step at one single active site.

In a study published in *Angewandte Chemie International Edition*, Prof. Cao Rong and Prof. Huang Yuanbiao from Fujian Institute of Research on the Structure of Matter (FJIRSM) of the Chinese Academy of Sciences (CAS) developed an effective tandem catalysis strategy to improve the selectivity of CO₂RR towards C₂H₄ by multiple distinct catalytic sites in local vicinity.

The researchers constructed an earth-abundant elements–based tandem electrocatalyst PTF(Ni)/Cu by uniformly dispersing Cu nanoparticles (NPs) on the porphyrinic triazine framework anchored with atomically isolated nickel-nitrogen sites (PTF(Ni)).

The Faradaic efficiency of C₂H₄ reaches 57.3 percent at -1.1 V versus the reversible hydrogen electrode (RHE) which is about six times higher than the non-tandem catalyst PTF/Cu (porphyrinic triazine framework anchored with no metal), surpassing most of the catalysts. PTF(Ni)/Cu shows good stability with continuous production of C₂H₄ over 11 h [electrolysis](#) as evidenced by the almost unchanged total current density and FE_{C₂H₄}. The electroreduction of CO (CORR) on PTF(Ni)/Cu and PTF/Cu proved the importance of the in-situ generated CO by

atomically isolated nickel-nitrogen sites, which can fast transfer to the nearby Cu NPs for the next C-C coupling reactions to form C₂H₄.

Besides, the operando ATR-FTIR and density functional theory (DFT) calculations elucidated that the high concentration of local CO on Cu sites increased *CO intermediate coverage on Cu surface and thus enhanced the C-C coupling probability, leading to the enhanced formation of C₂H₄, while a low CO concentration was favorable for the formation of CH₄.

This study proposed a facile and general synthesis strategy to design tandem catalyst based on single-atom active sites, which can guide the subsequent design of future generations of highly efficient CO₂RR catalysts to multicarbon products.

More information: Jun-Dong Yi et al, Conductive Two-Dimensional Phthalocyanine-based Metal–Organic Framework Nanosheets for Efficient Electroreduction of CO₂, *Angewandte Chemie International Edition* (2021). [DOI: 10.1002/anie.202104564](https://doi.org/10.1002/anie.202104564)

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