

# Metal catalysts in tandem with carbon-based catalysts for CO<sub>2</sub> conversion to carbon-based molecules

Stanford researchers have developed a novel electrode composed of copper-based catalyst and a carbon-based catalyst to directly convert CO<sub>2</sub> into ethylene, a valuable carbon-based molecule. Ethylene (C<sub>2</sub>H<sub>4</sub>) is particularly attractive due to its major importance as a feedstock chemical for various applications.

The electrocatalyst is composed of copper-based material and a carbon-based catalyst which enables the formation of CO from CO<sub>2</sub>. The two materials are integrated into gas diffusion electrodes for direct conversion of vapor-fed CO<sub>2</sub> into ethylene. The carbon-based catalyst converts CO<sub>2</sub> to CO, and the copper surface converts CO to ethylene. The tandem electrocatalyst enables the high selectivity and formation rate of ethylene on a practical scale, achieving 40% faradaic efficiency (FE) at 150 mA cm<sup>-2</sup> and 3.2 V in a membrane electrode assembly electrolyzer. The catalytic performance of the tandem catalysts shows higher energy conversion and lower working voltages compared to any catalyst previously reported. Moreover, this strategy applied towards other catalyst-electrode geometries could be broadly applicable towards reactions for accessing other valuable carbon-based molecules from CO<sub>2</sub> like ethanol, acetate, etc.

**Figure:**

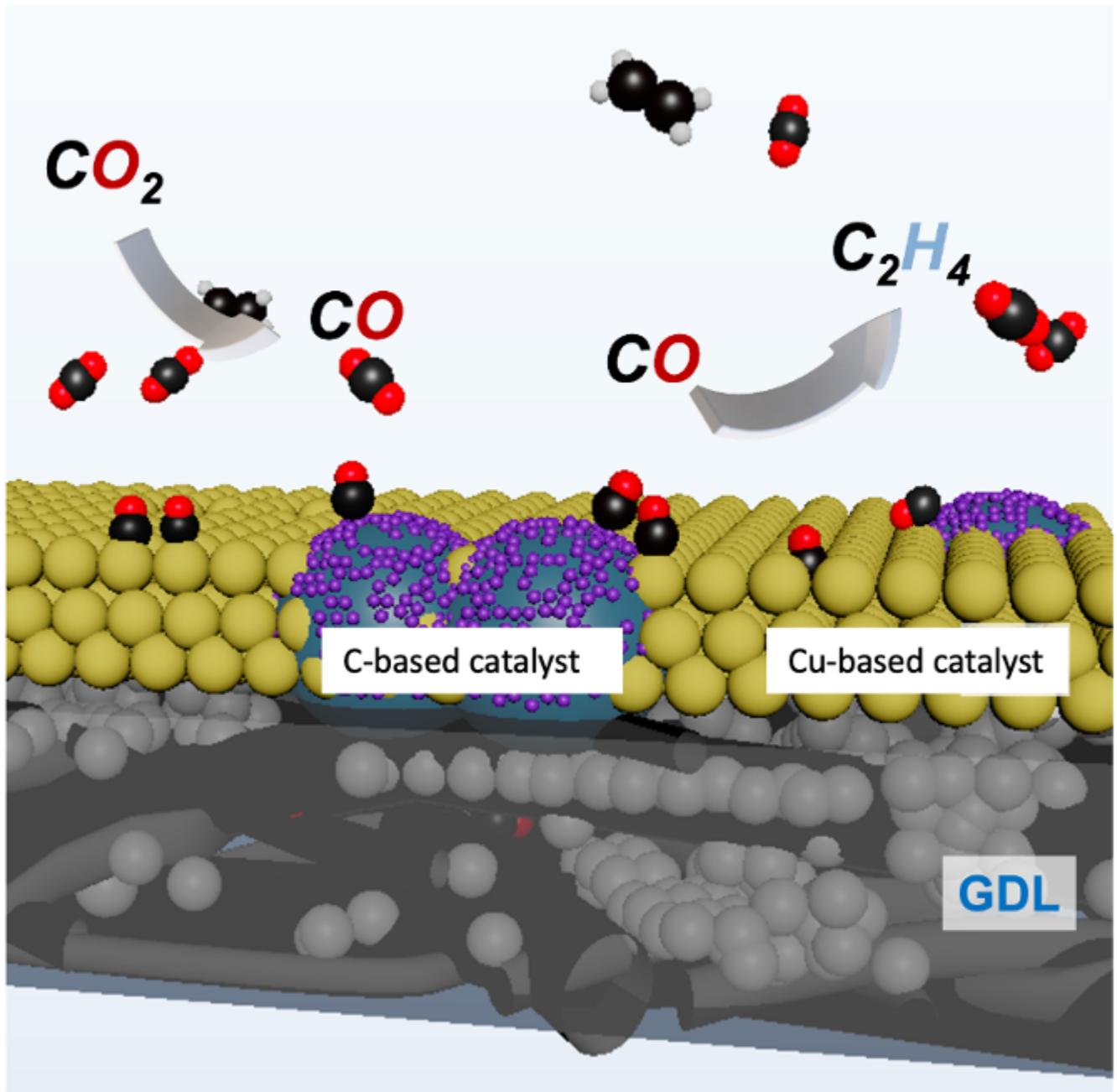


Figure description: An example of conversion of  $\text{CO}_2$  to ethylene ( $\text{C}_2\text{H}_4$ ) via a tandem electrocatalyst.

## Stage of Development

Prototype

## Applications

- Development of catalysts to convert CO<sub>2</sub> to valuable carbon-based molecules like ethylene
  - By tuning catalyst composition or morphology, can expand to other reactions to access other valuable carbon-based molecules

## Advantages

- Mild condition
- High conversion efficiency and ethylene selectivity
- Implementable on practical scale
- Best performance yet for direct conversion of CO<sub>2</sub> to ethylene
  - 40% faradaic efficiency (FE) at 150 mA cm<sup>-2</sup> and 3.2 V in a membrane electrode assembly electrolyzer

## Publications

- Lin, Y. R., Lee, D. U., Tan, S., Koshy, D. M., Lin, T. Y., Wang, L., ... & Jaramillo, T. F. (2022). [Vapor?Fed Electrolyzers for Carbon Dioxide Reduction Using Tandem Electrocatalysts: Cuprous Oxide Coupled with Nickel?Coordinated Nitrogen?Doped Carbon](#). Advanced Functional Materials, 2113252.

## Patents

- Published Application: [WO2023177710](#)
- Published Application: [20250161926](#)

## Innovators

- Thomas Jaramillo
- Yi-Rung Lin
- David Koshy
- Dong Un Lee
- Shunquan Tan
- Chris Hahn

# Licensing Contact

**David Mallin**

Licensing Manager, Physical Sciences

[Email](#)