Docket #: S21-448

Metal catalysts in tandem with carbon-based catalysts for CO_2 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_2 into ethylene, a valuable carbon-based molecule. Ethylene (C_2H_4) 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_2. The two materials are integrated into gas diffusion electrodes for direct conversion of vapor-fed CO_2 into ethylene. The carbon-based catalyst converts CO_2 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^{-2} 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_2 like ethanol, acetate, etc.

Figure:

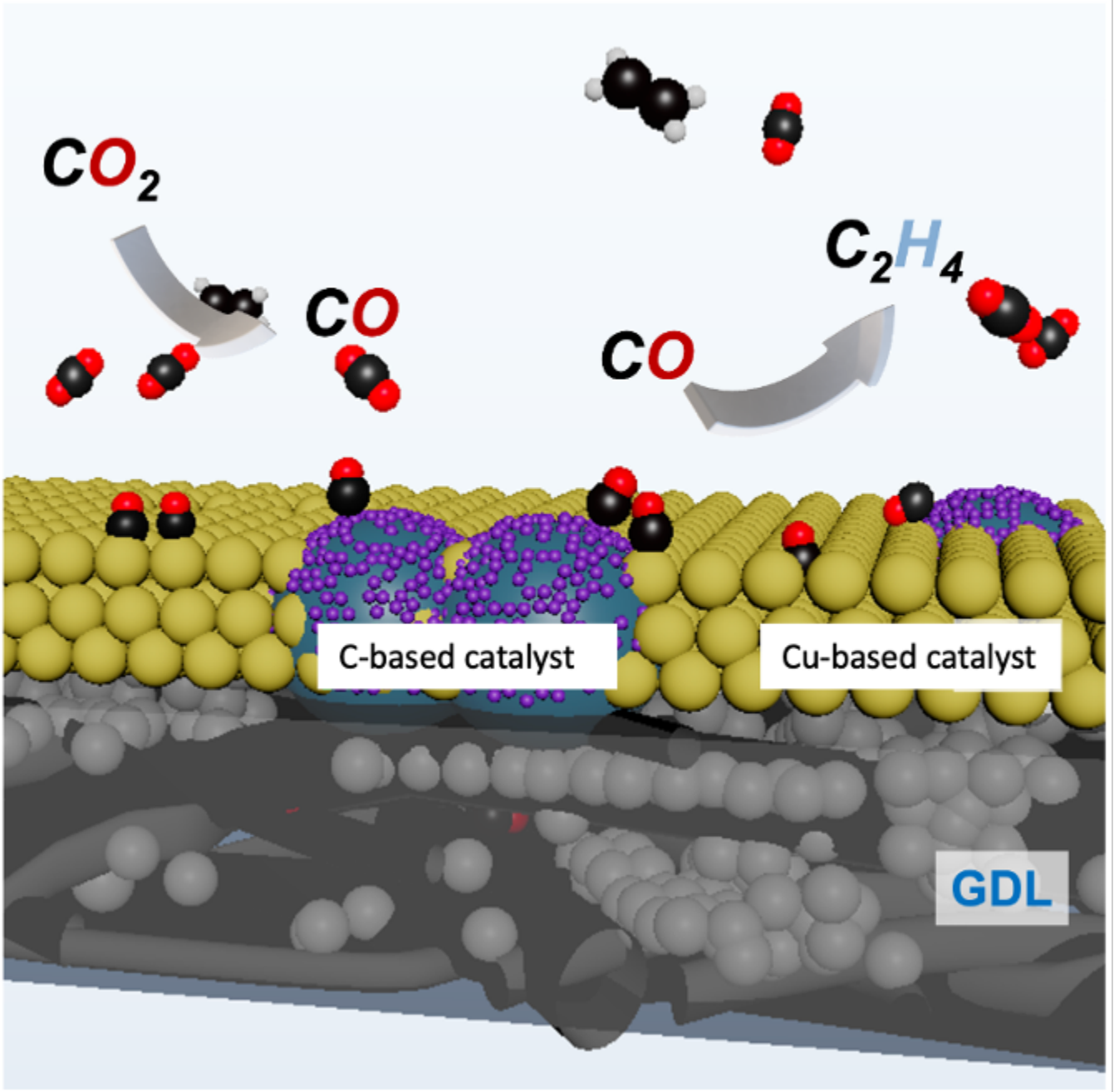


Figure description: An example of conversion of CO_2 to ethylene (C_2H_4) via a tandem electrocatalyst.

Stage of Development
Prototype

Applications

- Development of catalysts to convert CO2 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_2 to ethylene
    - 40% faradaic efficiency (FE) at 150 mA cm^{-2} 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

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