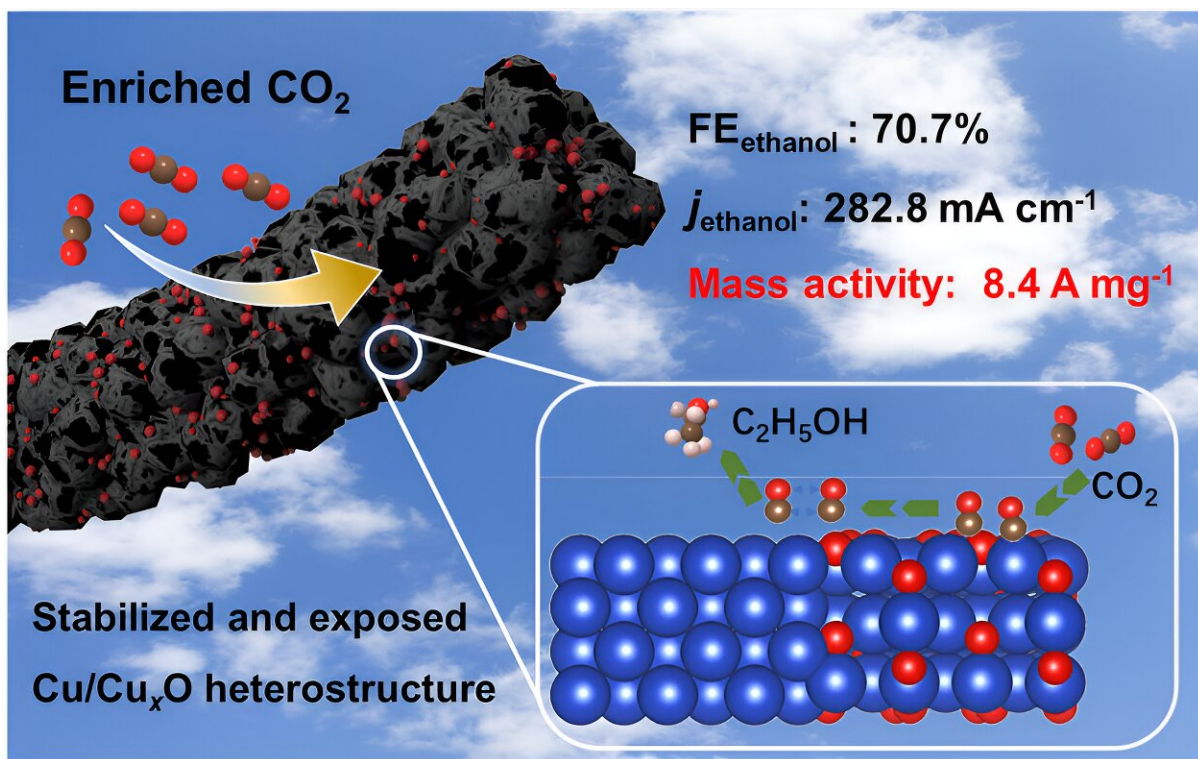


Adequately stabilized and exposed Cu/Cu_xO heterojunction on porous carbon nanofibers

April 29 2024



The Cu/Cu_xO heterostructure, encaged within porous carbon nanofibers, exhibits a 70.7% faradaic efficiency, a 282.8 mA cm⁻² partial current and an 8.4 A mg⁻¹ Cu mass activity for CO₂ electroreduction to C₂F₅OH production. Credit: *Chinese Journal of Catalysis*

Inexpensive and readily available copper-based catalysts are considered

ideal for the electrochemical CO₂ reduction reaction (CO₂RR) to produce multi-carbon products. The presence of copper oxides is crucial for generating high-value-added products in CO₂RR.

However, the inevitable side hydrogen evolution reaction and the easy self-[reduction reaction](#) of copper oxide under the negative potentials diminish the [catalytic activity](#) and selectivity of CO₂RR. Currently, designing a stable phase with both resistance to electrochemical self-reduction and high CO₂RR activity is challenging.

Recently, a research team led by Prof. Chuanxin He from Shenzhen University, China, sought to fully utilize the confinement effect and carrier effect of porous carbon nanofiber substrates on [metal nanoparticles](#), significantly enhancing the exposure of active sites Cu/Cu_xO heterojunctions at the catalytic reaction interface.

The catalyst could maintain the structural stability of copper oxides under a [current density](#) of 400 mA cm⁻² and achieve an excellent CO₂RR performance to ethanol with a Faradaic efficiency as high as 70.7% and a mass activity of 8.4 A mg⁻¹.

In this research, highly-dispersed copper nanoparticles within carbon nanofiber were firstly prepared via electrospinning, then the O₂-plasma treatment was introduced to simultaneously create Cu/Cu_xO heterostructure and opening mesopores throughout those carbon nanofibers.

Specifically, the opening mesopores throughout carbon nanofibers can fully expose the Cu/Cu_xO sites to the three-phase interface compared with untreated carbon nanofibers, leading to high and stable catalytic activity with low metal loading amount.

Combined with the physical characterizations and in-situ spectral

characterizations such as infrared and Raman spectroscopy analysis, a dynamic stabilized state of Cu_xO and the key signals of $^*\text{CO}$ and C–C bond are observed during the CO_2RR process. Additionally, DFT calculations show that the presence of Cu_xO promotes the spillover of $^*\text{CO}$ intermediate to the Cu/ Cu_xO interface, which can decrease the C–C coupling energy barrier to form $\text{C}_2\text{H}_5\text{OH}$ during the CO_2RR process.

The carbon substrate can enhance electron transport and act as an [electron donor](#) to neutralize the reduction of Cu_xO under a negative potential, which assists the stability of Cu/ Cu_xO heterostructure and maintains 213-h stability at high current densities. The results were published in [Chinese Journal of Catalysis](#).

More information: Xingxing Jiang et al, Adequately stabilized and exposed copper heterostructure for CO_2 electroreduction to ethanol with ultrahigh mass activity, *Chinese Journal of Catalysis* (2024). [DOI: 10.1016/S1872-2067\(23\)64604-2](#)

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