Contribution ID: **782** Type: **Poster Presentation**

CO2 Electroreduction on Nano-Cu-ZIF Grown inside Activated Carbon

Electrochemical reduction of CO2 (CO2RR) offers a sustainable approach to simultaneously lower atmospheric CO2 levels and convert it into useful chemicals. While noble metals are currently the most effective catalysts for this process, their expense limits large-scale use, driving the search for more affordable alternatives. Transition-metal sites incorporated within metal-organic frameworks (MOFs) show great catalytic promise; however, the inherently poor conductivity of MOFs remains a significant obstacle. The porous structure of activated carbon provides a high surface area for efficient electron transport and CO_2 adsorption, while the encapsulated MOF imparts catalytic sites with tuneable electronic properties and molecular selectivity. The synergistic interaction between the MOF and AC enhances the availability of active sites, conductivity, improves charge transfer kinetics, and suppresses competing hydrogen evolution. In this work, Cu-Ziolitic Imidazole Framework (Cu-ZIF) nanoparticles were grown directly within a hierarchically porous activated carbon matrix, rather than physically blended with conductive additives. This encapsulation strategy resulted in composites with enhanced conductivity, maintained Cu-ZIF crystallinity, and strong electronic coupling between the components. When applied to Electrochemical CO2RR, the Cu-ZIF@AC composite achieved low overpotential of −0.56V (vs. RHE) at 10mA/cm2 current density, surpassing the performance of usually reported MOF-based systems. Moreover, the catalyst selectively produced acetic acid (71.5% Faradaic Efficiency) at −0.3V (vs. RHE) onset potential demonstrating excellent potential for efficient and scalable CO2 electroreduction.

Country

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References

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Session Classification: Poster

Track Classification: (MS17) Electrochemical Processes in Porous Media