

Surface-sensitive Electrochemical CO₂ Reduction Reaction

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Very recently, the electrochemical reduction of carbon dioxide (CO₂RR) to CO, hydrocarbons and alcohols has emerged as very promising route for a sustainable supply of feedstocks for the chemical industry and of fuels to meet the energy needs in the society. [1-3] Comparing the other metals, Cu is the only metal which can convert CO₂ into hydrocarbons with sufficient amount. However, the reaction mechanism and kinetics of the CO₂RR are still unclear to date. In particular, the role of Cu oxide for the C₂ formation is very critical discussed in the literature. Thus, operando studies are required to elucidate the function of the different Cu species during the CO₂RR.

We studied the mechanism and kinetics for the CO₂RR on nanoporous copper (np-Cu) foams probed by operando X-ray absorption spectroscopy (XAS), X-ray diffraction (XRD), and Raman spectroscopy.[4] The np-Cu foams prepared by chemical dealloying of Cu-Zn alloys or by electrodeposition exhibit high surface area-to-volume ratios and improved catalytic performance and C₂ selectivity (C₂H₂, C₂H₄, C₂H₂) compared to a flat Cu surface. Operando XAS studies were performed on several oxidized Cu foams as function of the applied potential during the CO₂RR and hydrogen evolution reaction (HER). The products during the CO₂RR were analyzed by gas chromatograph and mass spectroscopy. Our results clearly show that the Cu oxide is already reduced in the cathodic potential region of the C₂ formation. In addition, the coarsening of the np-Cu foams is the main degradation process during the CO₂RR. Altogether, our data provide deeper insights into the mechanism of the CO₂RR on porous Cu surfaces and identify the role of the different Cu species for the C₂ production.

References

1. K. P. Kuhl, E. R. Cave, D. N. Abram, and T. F. Jaramillo, *Energy Environ. Sci.*, 5 (2012) p. 7050.
2. R. Reske, M. Duca, M. Oezaslan, K. J. P. Schouten, M. T. M. Koper, and P. Strasser, *J. Phys. Chem. Lett.*, 4 (2013) p. 2410.
3. A. Dutta, M. Rahaman, N. C. Luedi, M. Mohos, and P. Broekmann, *ACS Catal.*, 6 (2016) p. 2804.
4. A. Dutta, M. Rahaman, B. Hecker, J. Drnec, K. Kiran, I. Zelocualtecatl Montiel, D. J. Weber, A. Zanetti, A. Cedeño López, I. Martens, P. Broekmann, M. Oezaslan, *Journal of Catalysis*, 389 (2020) p. 592.