Electrochemical reduction of carbon dioxide over tin oxide nanocrystals

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The increasing carbon dioxide (CO_2) content in the atmosphere has been considered as one of major contributors to the greenhouse effect and global warming. The electrochemical conversion of CO_2 to liquid fuels could provide an attractive solution to both climate issues and help to satisfy both current and future energy needs. However, CO_2 reduction is relatively slow and occurs at high overpotentials[1]. Its reduction electrochemically into useful products remains an intriguing but difficult challenge. To date, many homogeneous and heterogeneous catalysts have been evaluated for electrochemical CO_2 reduction. Tin has been employed as an active electrocatalyst for the conversion of CO_2 to formate. However, a wide range of faradaic efficiencies for formate production on tin have been reported in different studies, suggesting that the electrocatalytic activity is largely dependent on structures and morphologies of the tin electrodes used and operating conditions.[2, 3]

In our present report, well-defined tin oxide (SnO_2) nanocrystals were prepared by heating ethylene glycol solutions containing $SnCl_2$ at atmospheric pressure. As shown in Figure 1, the obtained SnO_2 nanoparticles, ~ 5 nm in diameter were uniformly dispersed on carbon black substrates. In 0.1 M $NaHCO_3/CO_2$ electrolyte, the resulting SnO_2 nanocrystals gave high faradaic efficiencies and rates for formate production.

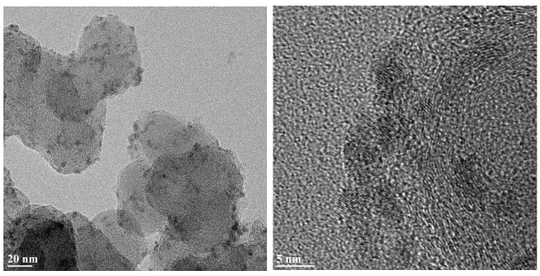

Figure 1 Transmission electron microscopic (a) and high resolution transmission electron microscopic (b) images of SnO_2 nanocrystals on carbon black.

References

[1] P. Kang, C. Cheng, Z. Chen, C.K. Schauer, T.J. Meyer, M. Brookhart, Selective Electrocatalytic Reduction of CO_2 to Formate by Water-Stable Iridium Dihydride Pincer Complexes, J. Am. Chem. Soc., 134 (2012) 5500-5503.
[2] Y. Chen, M.W. Kanan, Tin Oxide Dependence of the CO_2 Reduction Efficiency on Tin Electrodes and Enhanced Activity for Tin/Tin Oxide Thin-Film Catalysts, J. Am. Chem. Soc., 134 (2012) 1986-1989.
[3] J.J. Wu, F.G. Risalvato, F.S. Ke, P.J. Pellechia, X.D. Zhou, Electrochemical Reduction of Carbon Dioxide I. Effects of the Electrolyte on the Selectivity and Activity with Sn Electrode, J. Electrochem. Soc., 159 (2012) F353-F359.