A Highly Efficient Bi-based Electrocatalyst for the Reduction of CO₂ to Formate

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The electrochemical reduction of carbon dioxide (CO₂) has received significant attention as a viable man-made carbon cycle able to replenish the natural carbon cycle. Although Bi-based materials are promising catalysts for the reduction of CO₂ to formate, the effects of the morphology and the structure of these materials on their properties remain unclear. In this work, a nano Bi₂O₂CO₃ (BOC) material was synthesized and subsequently calcined at 300, 400, and 500 °C to form three different Bi₂O₃ samples namely, Bi₂O₃-1, Bi₂O₃-2, and Bi₂O₃-3, respectively. Both the BOC and the calcined materials were decorated on glassy carbon electrodes and then reduced to metallic Bi to form r-BOC, r-Bi₂O₃-1, r-Bi₂O₃-2, and r-Bi₂O₃-3 samples. We compared the performance of the four reduced Bi-based catalysts towards the reduction of CO₂ in an attempt to study the structure–activity relationship of Bi-based catalysts. r-Bi₂O₃-3 showed excellent catalytic performance towards the reduction of CO₂ reduction to formate. Thus, this catalyst showed a faradaic efficiency (FE) for the electrochemical reduction of CO₂ to formate as high as 95% at an overpotential of 0.99 V and with a current density of 17 mA cm⁻². r-Bi₂O₃-3 outperformed the rest of the reduced samples and most of the catalysts reported in the literature.

Keywords: Carbon dioxide; Electrochemical reduction; Formate; Metal bismuth; Structure–activity relationship.

FULL TEXT

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