Enhanced Electrocatalytic Selective CO2 to Syngas Production: Road to the Carbon-Neutral Future

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The significant increase in carbon emissions since the Industrial Revolution has disrupted the natural carbon cycle, and establishing a new carbon cycle pathway is crucial to address this problem. However, previous methods like photocatalysis and electrocatalysts with copper or gold nanoparticles have had low efficiency and/or poor selectivity, making the CO2 Reduction Reaction (CO2RR) challenging. In this study, we propose a new electrocatalysis method that involves producing metal atomically dispersed electrocatalysts by coordinating iron, cobalt, or nickel ions onto precursors such as Zeolitic Imidazolate Framework (ZIF) or Graphene Carbon Nitride (NC). To improve the efficiency of electrolyzing CO2 into CO, we use a gas diffusion electrode system. Additionally, our CO product can be converted into valuable materials like syngas, which creates economic incentives and reduces reliance on fossil fuels. Our results show that the CO Faraday Efficiency of NC catalysts with well-dispersed nickel ions (Ni SACs@NC) can reach 99% at a cathode potential of -0.52V and a current density of 120mA/cm2, indicating high selectivity and activity. Furthermore, the Faraday Efficiency of Ni SAC@NC remains at 90% with a full potential of 2.5V and a current density of 400mA/cm2 when the electrode is scaled-up to 5cm2. The profits from our process can offset the cost of electricity with CO's output value, resulting in a net profit of 0.04 USD per hour. Consequently, our proposed method has the potential to contribute to carbon neutralization efforts in the future by improving the efficiency and selectivity of the CO2RR process, converting CO into valuable materials, and generating a net profit.