CO_2-to-CH_3OH Cascade Electroduction: Molecular Catalyst Can Do It

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Methanol is a high value-added alcohol widely used in industry. [1] Converting greenhouse-gas CO_2 into fuels using electricity is a promising solution to store renewable energies at very large scale. [2] Molecular electrocatalysis plays a significant role in CO_2-to-methanol conversion since molecular catalysts have controllable and well-defined active sites, generally resulting in better selectivity than solid materials. [3] However, electroreducing CO_2 beyond 2 electrons with a molecular catalyst remains a high challenge.

Recently, we have shown that cobalt phthalocyanine (CoPc) is highly active for CO_2-to-CO electro-conversion with a Faradaic Efficiency (FE) > 90%. [2] We have also discovered that using CO as a substrate instead of CO_2 led to the production of methanol when using the same CoPc catalyst. [4,5]. It opens the way to a cascade, efficient process with production of CO first and then its reduction into methanol. We have achieved a FE of 97% for CO_2-to-CO production with a current density of 600 mA/cm^2 in a flow cell. The system maintained a FE higher than 90% for more than 45 min with 500 mA/cm^2 current density and over 10 h at 200 mA/cm^2. Furthermore, we have successfully obtained a FE of 31% with 90 mA/cm^2 total current density for CO-to-methanol conversion, an excellent starting point toward high performances. Our recent results will be discussed. In particular, the reasons why CO_2 mainly produces CO, while CO itself could be transformed in CH_3OH will be uncovered.

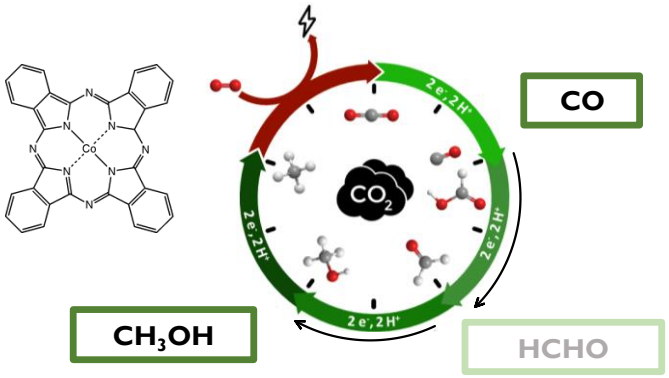

FIGURE: ***CASCADE CO_2 AND CO ELECTROREDUCTION TO METHANOL WITH A COBALT PHTHALOCYANINE CATALYST.***

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