Enhancing the Selectivity of Electrochemical CO₂ Reduction to Multi-Carbon Oxygenates

Atmospheric carbon dioxide (CO₂) is a potential source of renewable carbon for the production of fuels and chemicals. However, the hydrogen required to reduce CO₂ must be derived from water and the necessary energy must be supplied by a renewable source for this process to be sustainable. One approach to this goal is the utilization of electrical energy generated by photovoltaics to drive the electrochemical CO₂ reduction reaction (CO₂RR). Previous research has shown that the overall rate of CO₂RR and the distribution of products formed depend primarily on the electrocatalyst used as the cathode. Copper (Cu) is the only monometallic electrocatalyst capable of reducing CO₂ into potential fuels or multi-carbon chemicals with a total Faradaic efficiency (FE) greater than 1%. Unfortunately, the Faradaic efficiency of CO₂RR over Cu is limited by parasitic losses associated with the relatively facile hydrogen evolution reaction (HER). Thus, there is a contemporary interest in developing methods of suppressing HER and modifying the multi-carbon product selectivity typically observed over Cu. The latter is a daunting challenge because little is known about the mechanism by which CO₂ is reduced to multi-carbon products over Cu and alloying Cu with other metals generally inhibits its CO₂ reduction activity.