Protégé Topic: Electrocatalytic Conversion of Carbon Dioxide into Ethanol

Prof. Jingjie Wu,
Chemical Engineering Program
Email: Jingjie.Wu@uc.edu
Tel: (513) 556-2756
Lab: 593 ERC

The electrochemical conversion of carbon dioxide (CO_2) into liquid fuels is a technology to recycle carbon while also storing intermittent renewable energy (e.g. wind and solar) into chemical energy (**Figure 1).** The advancement of this technology is currently limited by the lack of **1)** efficient and stable catalysts, and **2)** operative electrode architecture for solid-state electrochemical cell employment. The traditional metal catalysts require high overpotential (low energy efficiency) for the electrocatalytic CO_2 reduction reaction (eCO_2RR) due to the "linear scaling relationship" between reaction intermediates adsorption energy. More importantly they are deficient in C-C coupling to produce ethanol (C_2H_5OH). Additionally, they face a serious durability issue. The current electrochemical cell for eCO_2RR includes a buffer layer through which liquid neutral or alkaline electrolyte flows.[1] The involvement of liquid electrolyte not only results in large Ohmic loss but also causes extra cost in modular assembly.

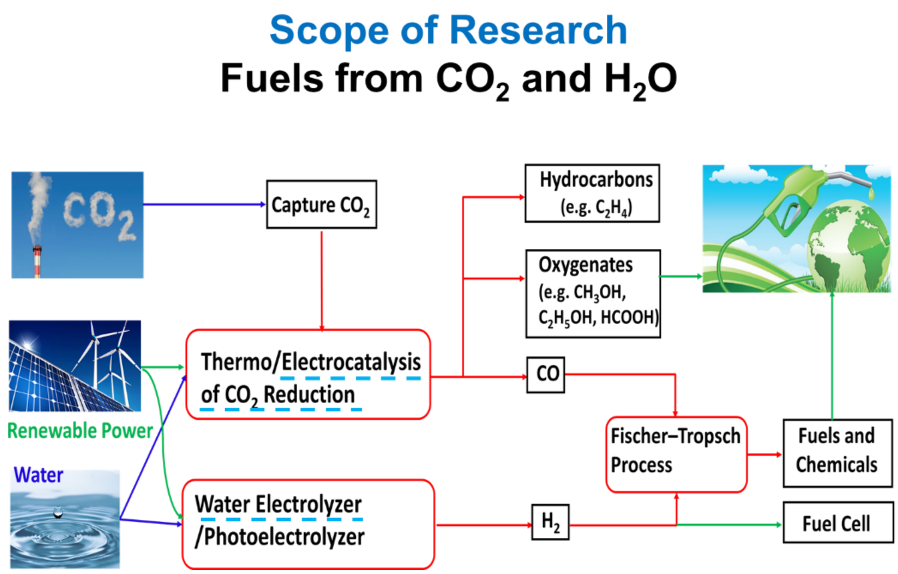

Figure 1. The catalytic approach for conversion of CO2 into fuels and chemicals.

This project dedicates to achieve direct eCO_2RR to produce C_2H_5OH in a solid-state electrolyzer by realizing the following objectives: **1)** develop carbon materials based catalysts through nanoscale design of topological structure; **2)** maximize the triple-phase interface boundary in the catalyst layer by percolating theory; **3)** design and manufacture a continuous flow solid-state electrolyze prototype by 3D printing. The refined electrochemical system targets eCO_2RR into C_2H_5OH with a Faradaic efficiency (FE) of 90%, energy efficiency of 50%, current density 600 mA/cm^2, and 1000 h stability. The students will be involved in a multidisciplinary team to learn: catalysis, nanomaterials, 3D printing, and mass transport simulation by COMSOl.