PROJECT TITLE:  Carbon–for–Carbon: Engineering Carbon Topological Nanostructures for Electrocatalytic Conversion of Carbon Dioxide into Ethanol

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Project Description

The electrochemical conversion of carbon dioxide (CO₂) into liquid fuels is a technology to recycle carbon while also storing intermittent renewable energy (e.g. wind and solar) into chemical energy at ambient condition. 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. The traditional metal catalysts require high overpotential (low energy efficiency) for the electrocatalytic CO₂ reduction reaction (eCO₂RR) due to the “linear scaling relationship” between reaction intermediates adsorption energy. More importantly they are deficient in C–C coupling to produce ethanol (C₂H₅OH). Additionally, they face a serious durability issue. This project dedicates to develop carbon-based catalysts by topological structure engineering to replace the traditional metal catalysts while electrochemically converting CO₂ into C₂H₅OH in a solid-state electrolyser. The refined electrochemical system targets eCO₂RR into C₂H₅OH with a Faradaic efficiency (FE) of 90%, energy efficiency of 50%, current density 500 mA cm⁻², and 1000 h stability.

Participating students will be able to learn the following scientific and technical knowledge throughout the project: 1) carbon nanotechnology; 2) electrochemical engineering; 3) heterogeneous catalysis; 4) mass transport; 5) 3D printing for a microfluidic-based electrolyser