Docket #: S24-130

Plasmonic gas diffusion reactor for CO2 conversion to high-value chemicals

Industry, government, and private investment in CO_2 capture is growing to address climate change. Without carbon utilization, however, high costs impede large scale capture efforts. Alexander Al Zubeidi, a Stanford post doc in the D-Lab, has developed an inexpensive, scalable gas flow cell based system to convert atmospheric CO_2 to other hydrocarbon based chemicals (like ethylene) using light and excess renewable electricity.

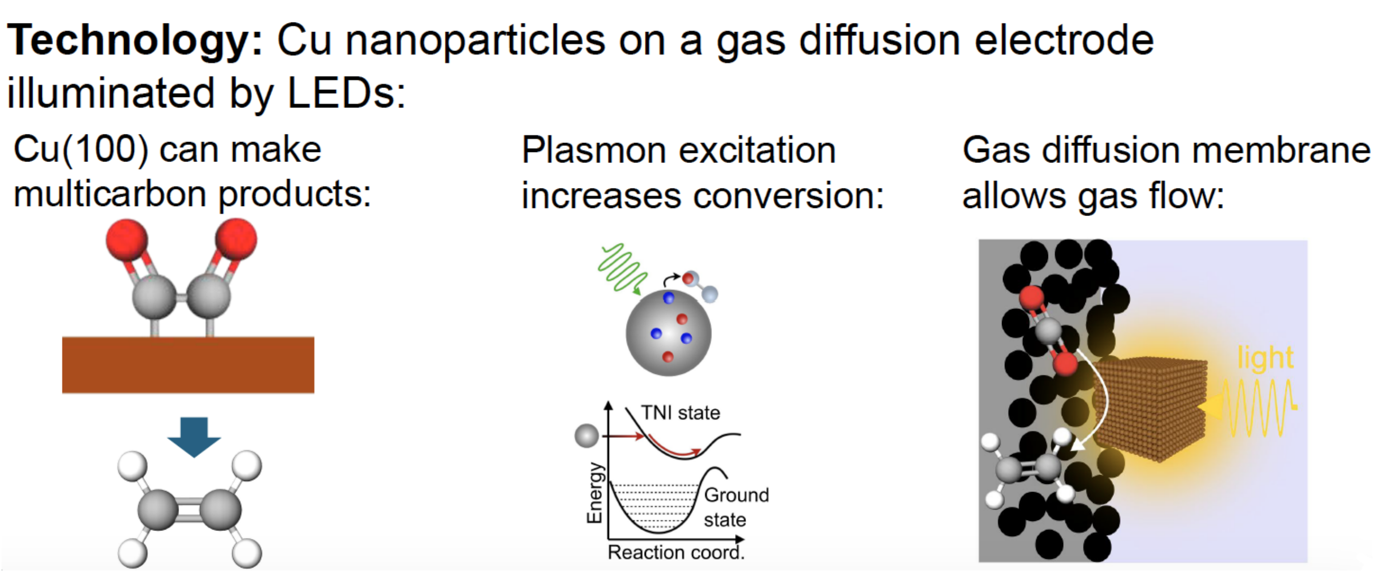

Figure 1 – Prototype Cell Process
(Image courtesy the D-Lab)

In the prototype system, gas enters the reactor cell via a gas flow channel, flows over the gas diffusion electrode covered in copper nanoparticles and electrolyte solution at ambient temperature. Visible light (450-800 nm) enters through the cell window, exciting copper nanoparticle electrons that reduce CO_2 to ethylene. These electrolyzers can produce hydrocarbon based chemicals and syngas, a mixture of H_2 and O_2. Unlike competing electrolyzers that are built to operate on large scales, with long payback periods that typically require high capacity factors, the D-Lab system (Figure 2) can operate when renewable energy is in excess, generating net-zero emissions and converting point-source CO_2 emissions to high-value products. This inexpensive, scalable plasmonic gas flow reactor system provides cost effective carbon capture CO_2 gas separation and storage while producing valuable feedstocks for the chemical industry or zero-carbon fuels.

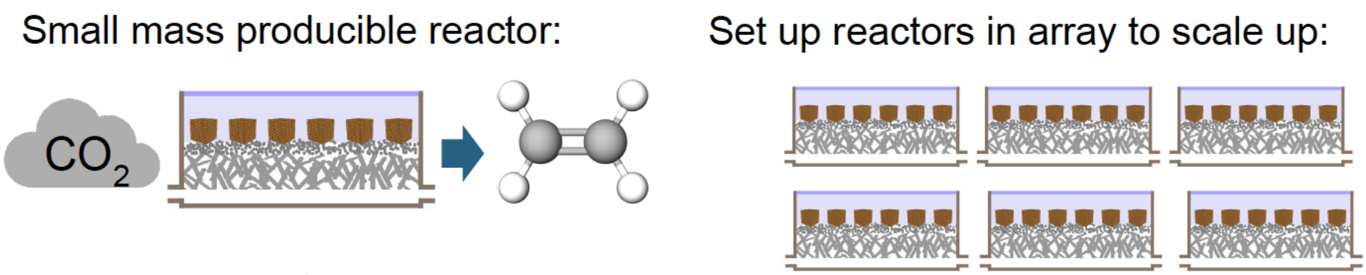

Figure 2 – Scaled Up Reactor Array
(Image courtesy the D-Lab)

Stage of Development – Proof of Concept Prototype

Applications

- Industrial chemical production, especially ethylene
- Green fuel / hydrocarbon based fuel production
- Syngas production

Advantages

- **Low cost** ethylene production with **high cap-ex return**: A 20 x 20 cm^2 reactor operating at 80% selectivity for ethylene at 0.5 A/ cm^2 operated 6 h a day can produce enough ethylene in 1 month to pay for itself.
- **Compact, scalable and mass producible**: Easy to ship and scale up using eletrolyzers in parallel to keep production and supply chain uncomplicated.

- **No purification of reactants**: The gas diffusion electrode operates with captured CO_2 and gas mixtures containing CO_2, which reduces upfront costs and energy consumption.
- **Operates at ambient temperature**: The electrolyzer can be started and shut down rapidly, allowing it to only operate when electricity costs are low.
- Does not require CH_3

Publications

- **Stanford Report: Sustainability Accelerator** - The first cohort of the accelerator's new postdoc fellowship program for innovators will focus on the challenges of removing billions of tons of greenhouse gases from Earth's atmosphere by 2050

Innovators

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