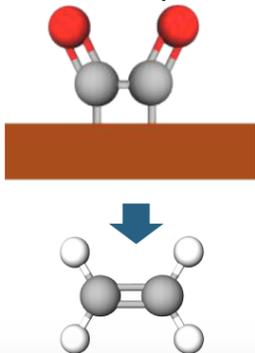


Plasmonic gas diffusion reactor for CO₂ conversion to high-value chemicals

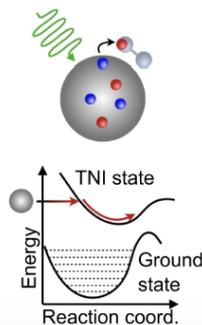
Industry, government, and private investment in CO₂ capture is growing to address climate change. Without carbon utilization, however, high costs impede large scale capture efforts. Alexander Al Zubeidi, a Stanford post doc in the D-Lab, has developed an inexpensive, scalable gas flow cell based system to convert atmospheric CO₂ to other hydrocarbon based chemicals (like ethylene) using light and excess renewable electricity.

Technology: Cu nanoparticles on a gas diffusion electrode illuminated by LEDs:

Cu(100) can make multicarbon products:



Plasmon excitation increases conversion:



Gas diffusion membrane allows gas flow:

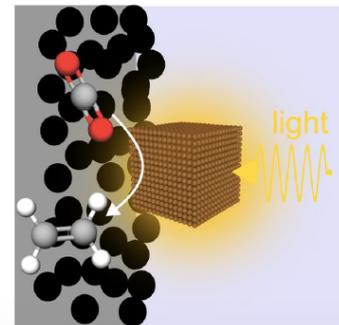


Figure 1 - Prototype Cell Process

(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 CO₂ to ethylene. These electrolyzers can produce hydrocarbon based chemicals and syngas, a mixture of H₂ and O₂. 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 CO₂ emissions to high-value products. This inexpensive, scalable plasmonic gas flow reactor system provides cost effective carbon capture CO₂ gas separation and storage while producing valuable feedstocks for the chemical industry or zero-carbon fuels.

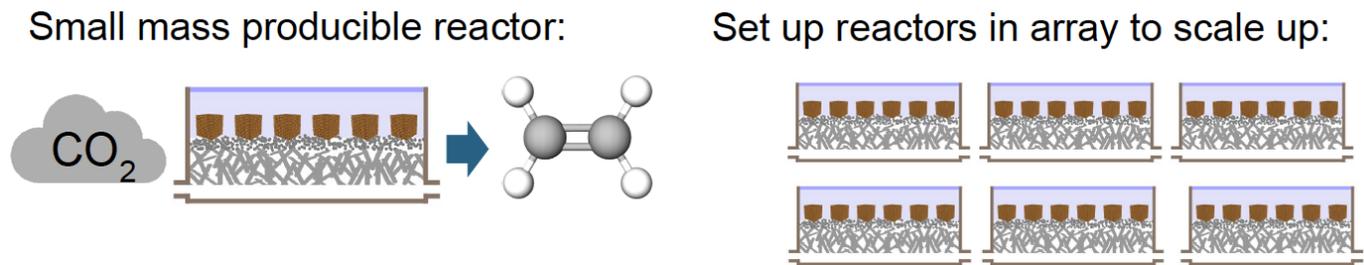


Figure 2 - Scaled Up Reactor Array
(Image courtesy the D-Lab)

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 cm² reactor operating at 80% selectivity for ethylene at 0.5 A/ cm² 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 electrolyzers in parallel to keep production and supply chain uncomplicated.

- **No purification of reactants:** The gas diffusion electrode operates with captured CO₂ and gas mixtures containing CO₂, 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 CH₃

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](#)

Patents

- Published Application: [WO2026011140](#)

Innovators

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