Electrocatalytic conversion of CO_2 to ethylene

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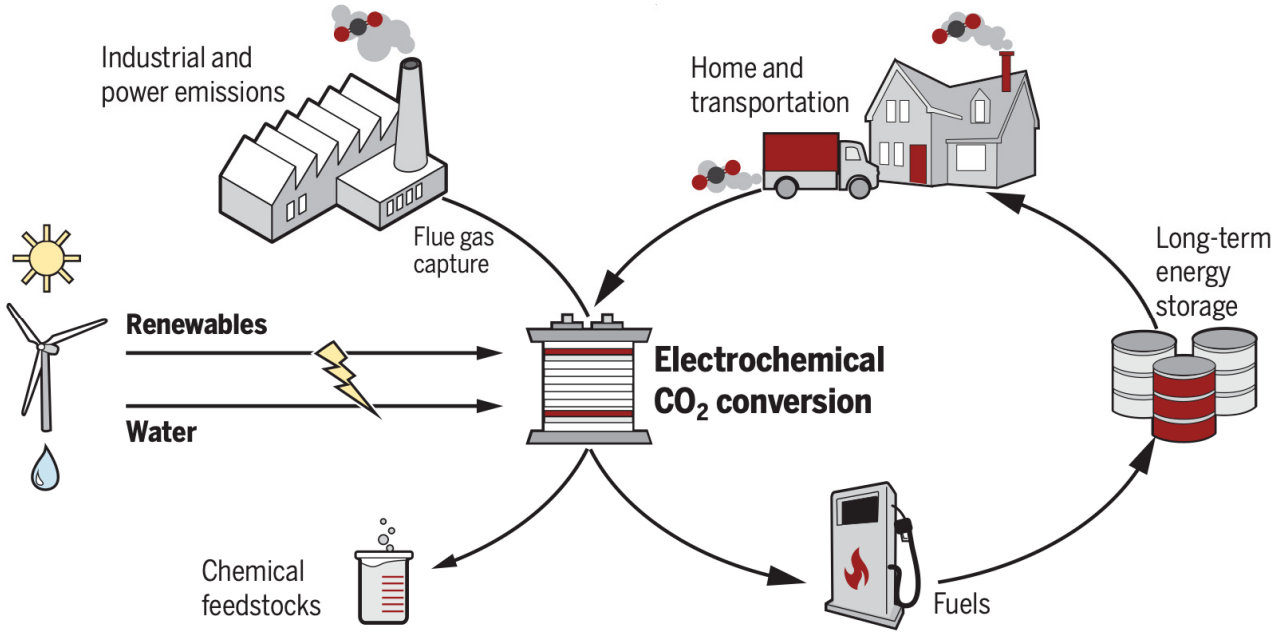
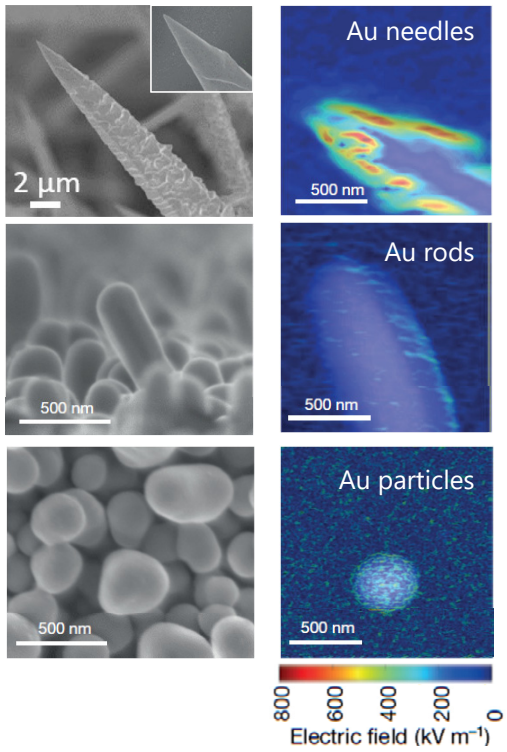
Chemicals from renewable electrons + CO_2



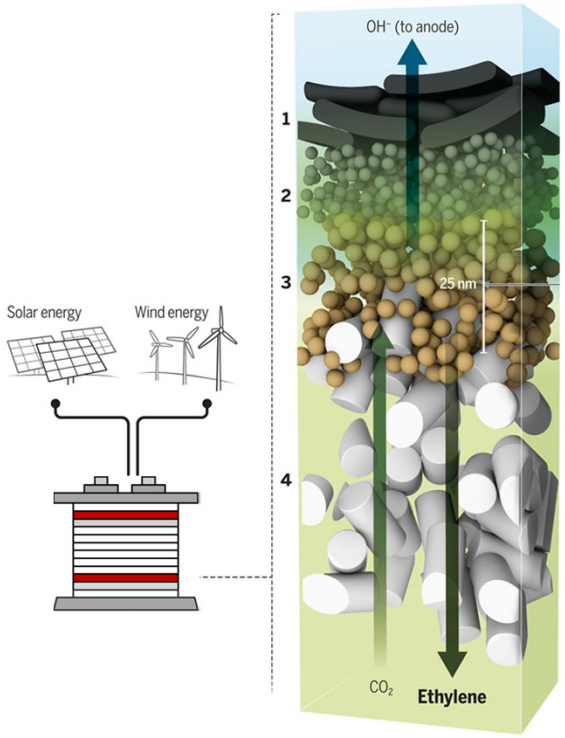
[P. De Luna et al. (2019) *Science*]

CO_2 Electrocatalytic Reduction

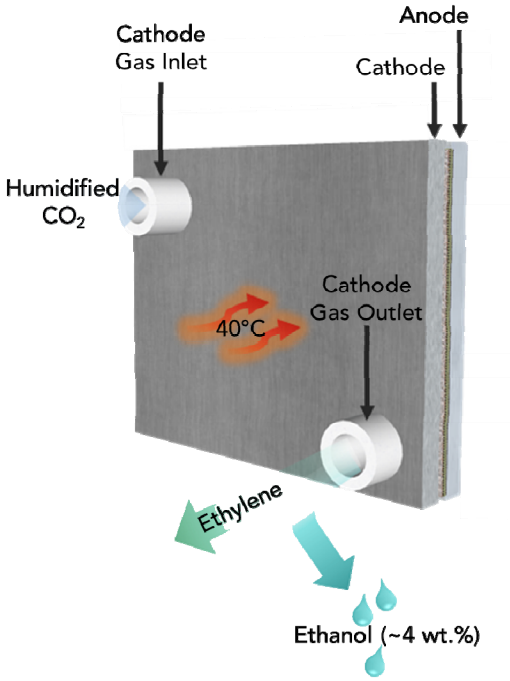
Nanostructured Catalysts ➡ Microstructured Electrodes ➡ Macroscale Systems



[Liu et al. (2016) *Nature*]



[Dinh, Burdyny et al. (2018) *Science*]



[Gabardo et al. (2019) *Joule*]

Input

Cheap CO_2

Low purity

Ubiquitous

Cell

Productive

Efficient

Stable

Output

Valuable product

High purity

Large market

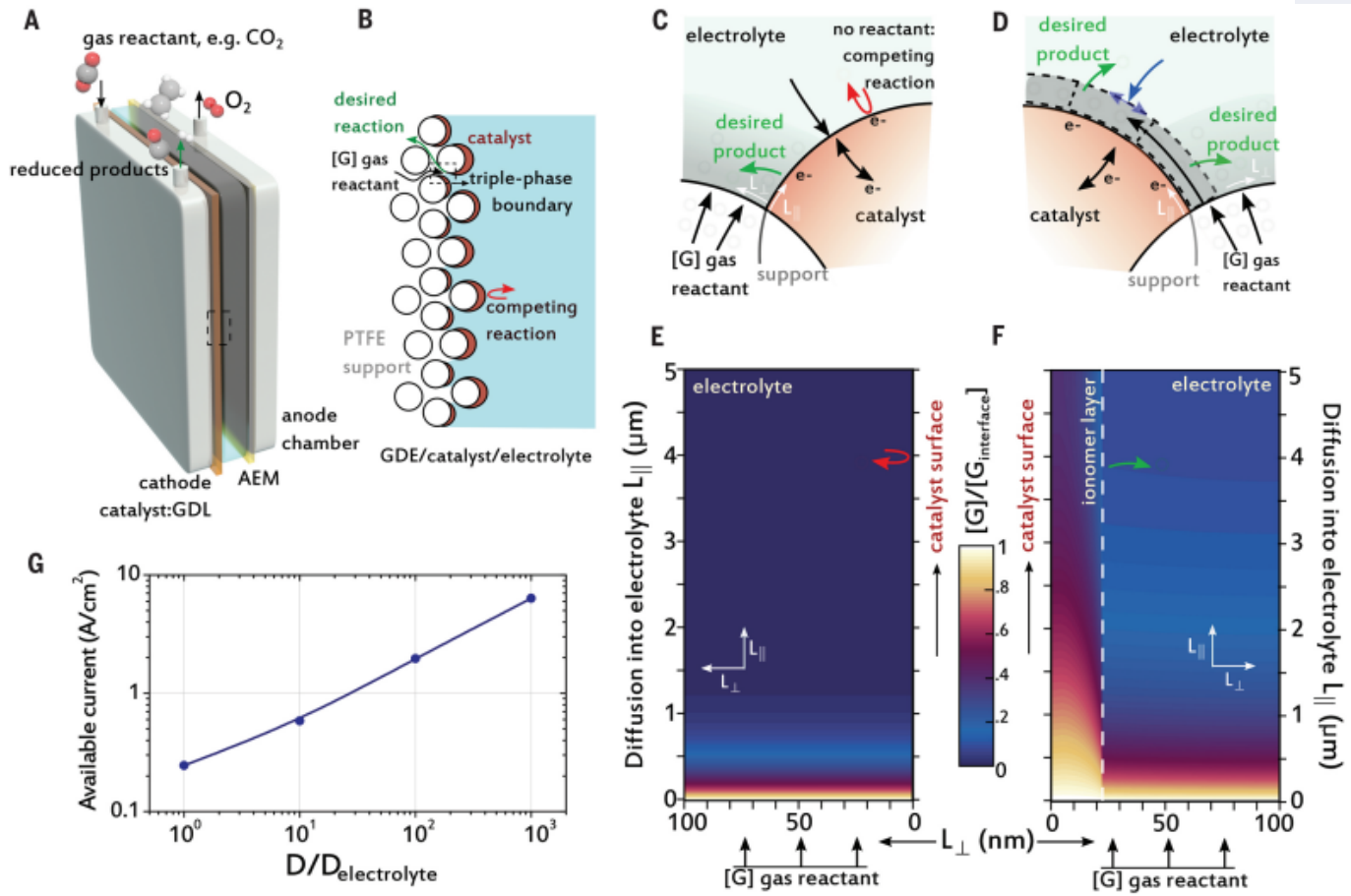
Productivity: Extending the active area

How to extend the reactive area?

A metal:ionomer hybrid catalyst decouples gas, ion, and electron transport, extending the reactive interface.

> 1 A/cm^2

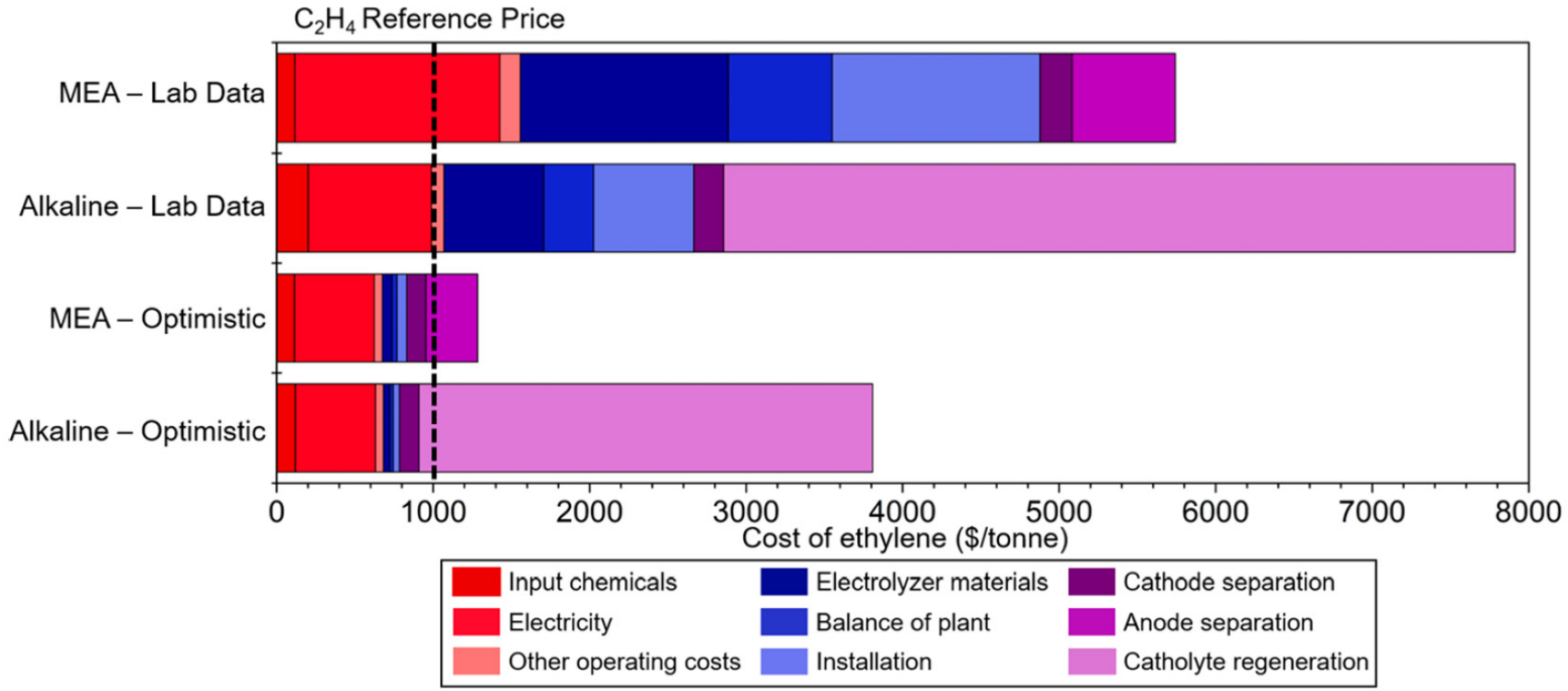
for C2 products



[de Arquer, FPG et al. (2020) Science]

Efficiency and Stability

CO_2 loss to carbonates is costly: electrolyte loss (flow cells) or downstream separation (MEAs)



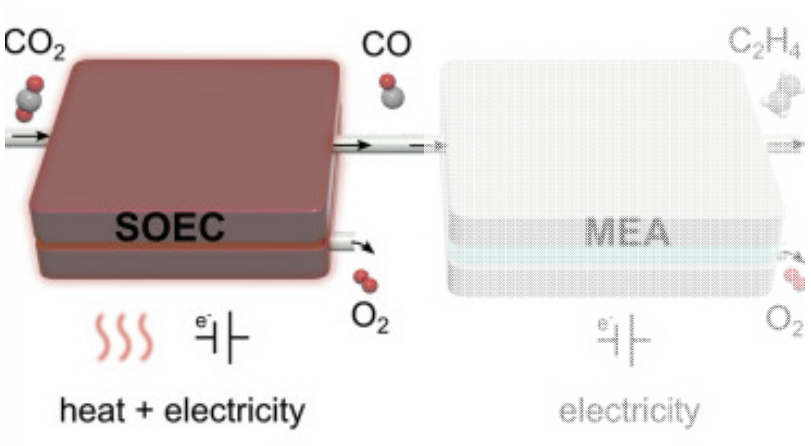
[Sisler et al (2021) Joule]

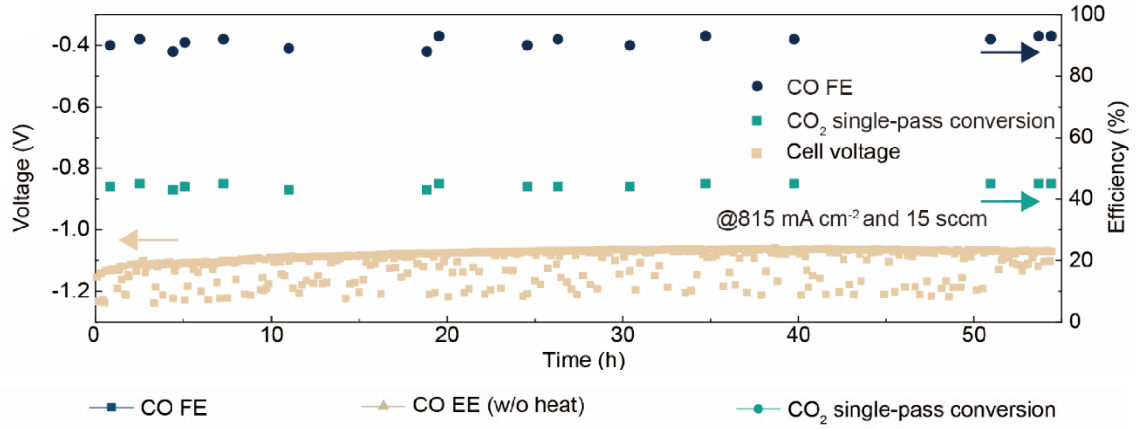
Efficiency and Stability

Carbonate formation reduces process efficiency, and salt formation limits stability

A cascade approach:

Step 1 CO2-to-CO in SOEC





[Ozden et al (2021) Joule]

Efficiency and Stability

Carbonate formation reduces process efficiency, and salt formation limits stability

A cascade approach:

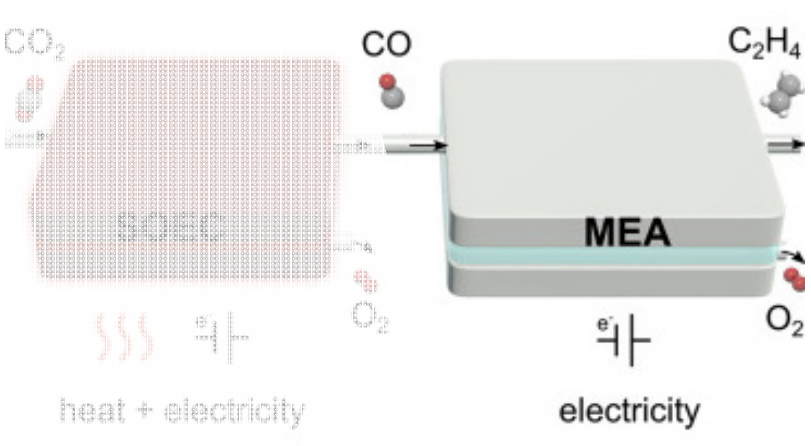
Step 1 CO2-to-CO in SOEC

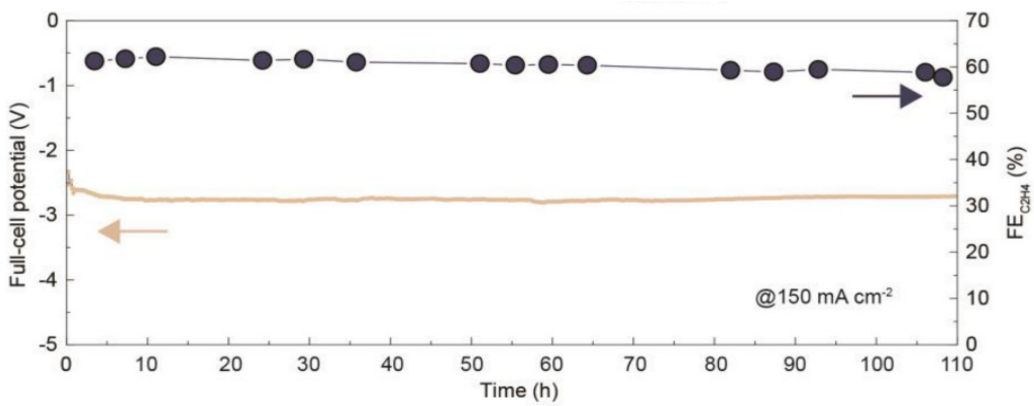
Step 2 CO-to-C2H4 in MEA

Overall process:

140 GJ/tonne_ethylene

(50% of direct route)

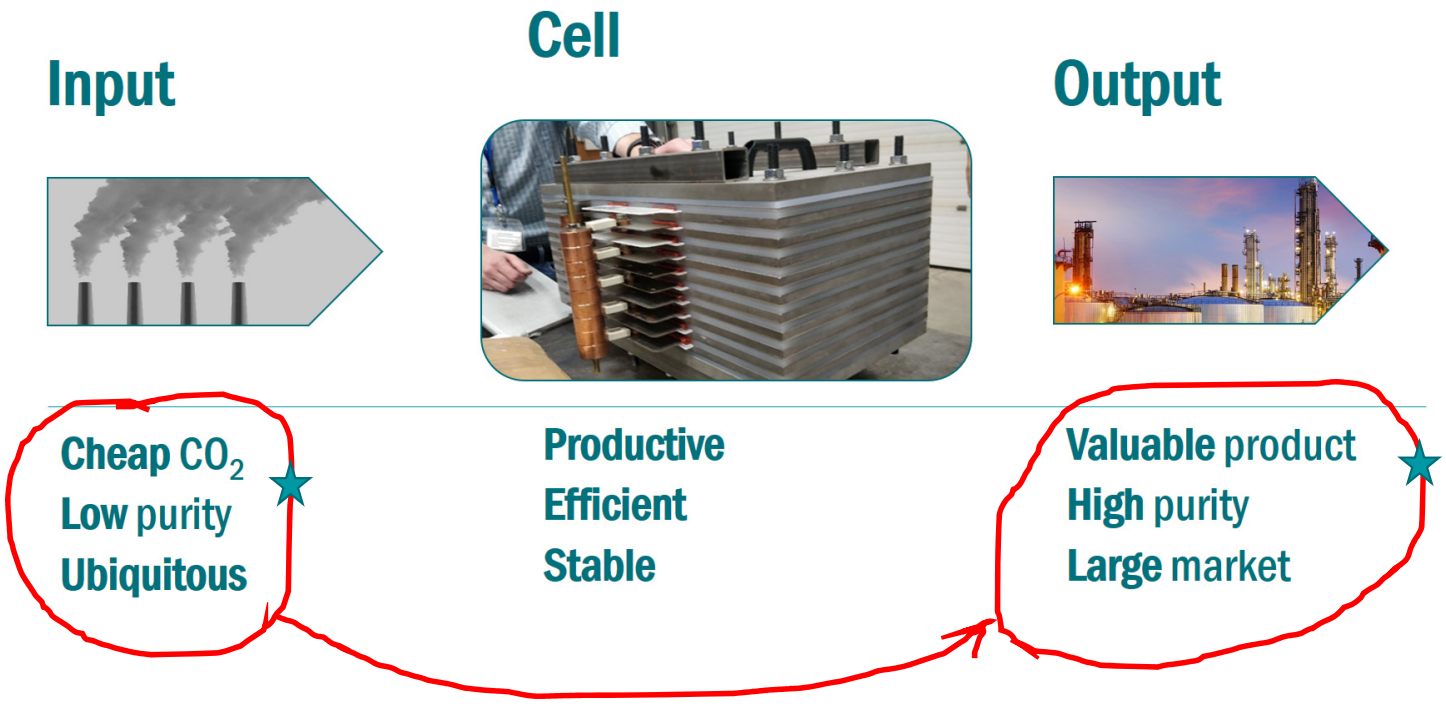




[Ozden et al (2021) Joule]


cert
40,000 cm^2 running 24hrs a day for months
I) MEA is the reactor form compatible with scale
II) No substitute for testing at scale
III) Innovations needed upstream, in the stack, and downstream

Discussion: How to have it all?



Thank you!

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