THE UNIVERSITY OF IOWA

Selective And Efficient Electrochemical Production Of Neat Formic Acid From CO_2 Using Novel Platinum Group Metals-free Catalysts

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Project ID: DE-FE0031704

Overview

Timeline:

- Project start: 01/29/2019
- Project end: 01/28/2022

Budget:

- Total Project Funding: $931,662
- Total DOE Share: $732,109
- Total Cost Share: $199,553 (21.42%)

Project Lead:

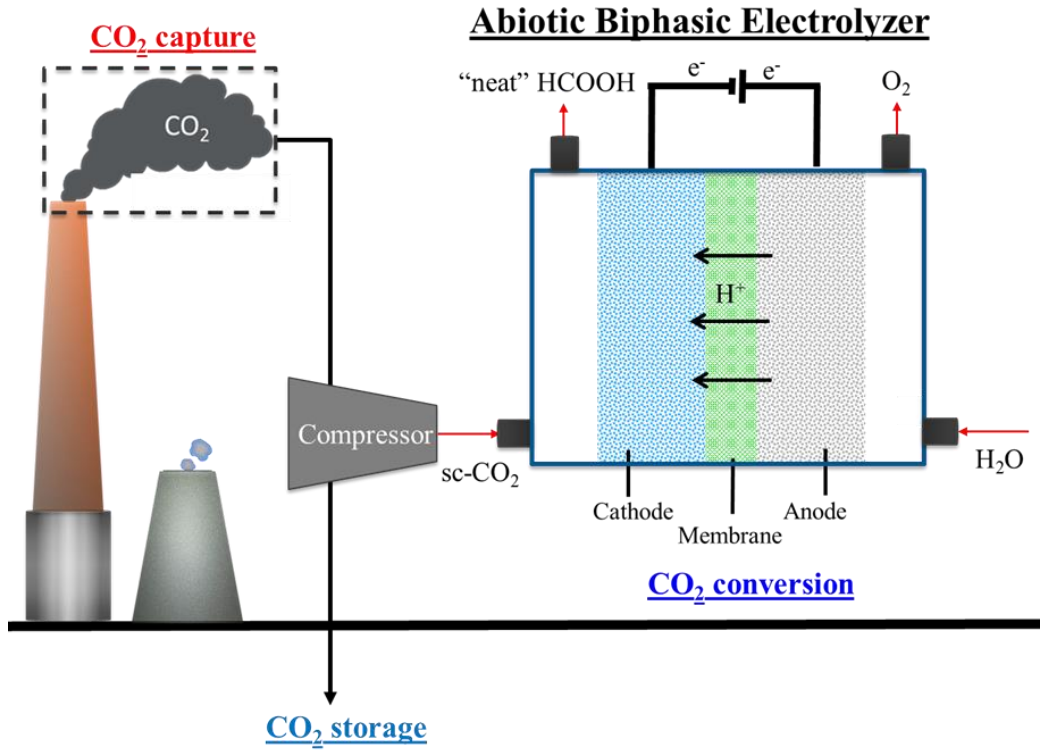
- University of Iowa, Iowa City

Project Partners:

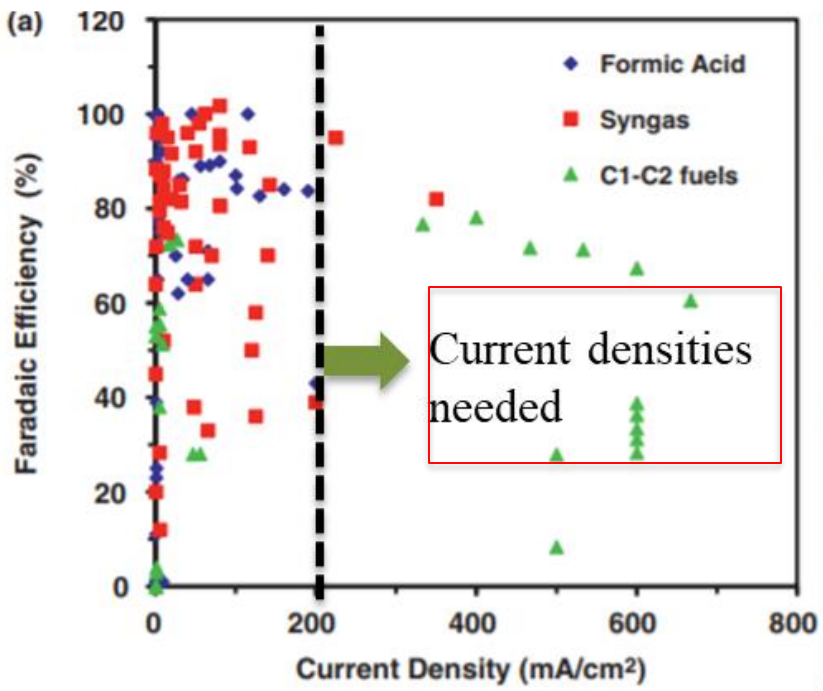
- University of Michigan, Ann Arbor
- University of California, Santa Barbara

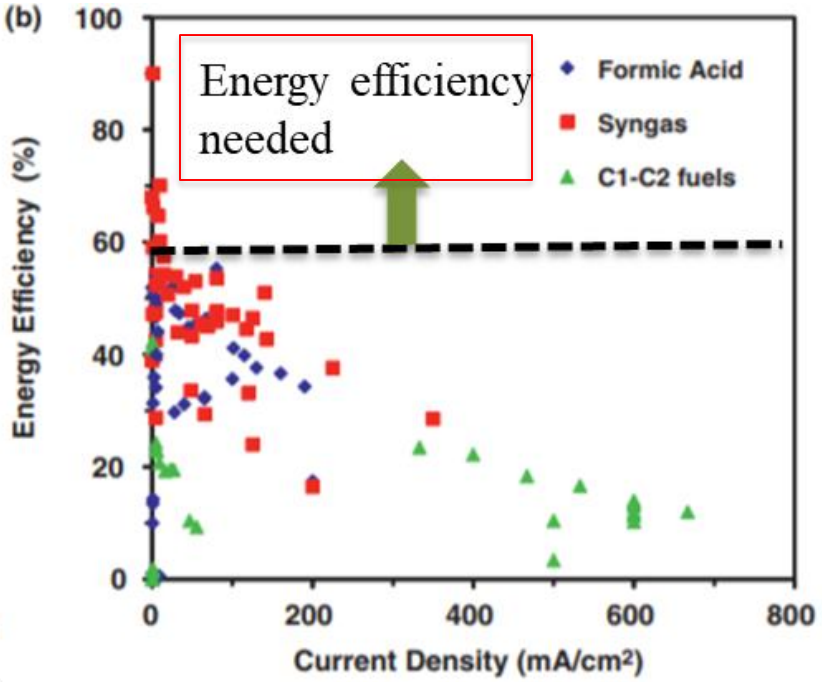
Project Objective:

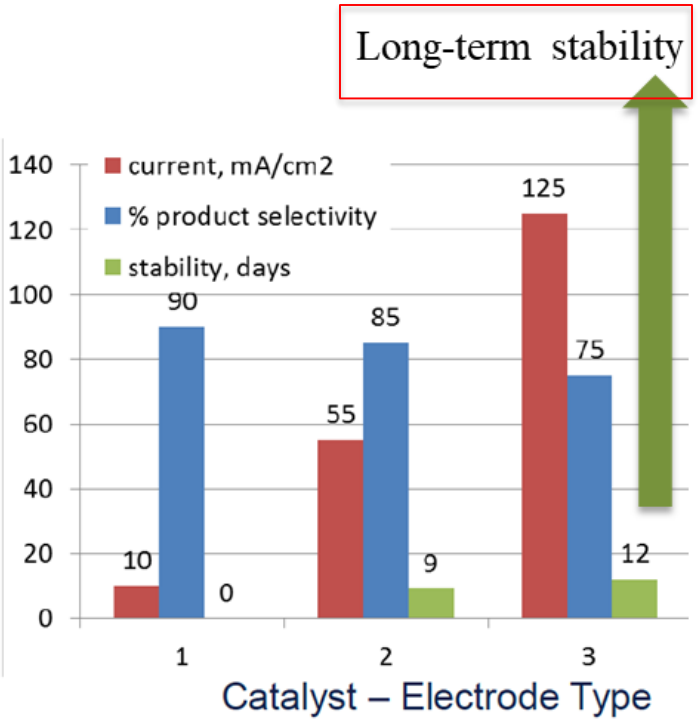
Establish the technical and economic feasibility of a novel **biphasic-electrolyzer**-based CO_2 conversion process that uses **Platinum group metal (PGM)-free catalysts** for sustainable production of **"neat" formic acid**.



Technical Barriers To be Addressed





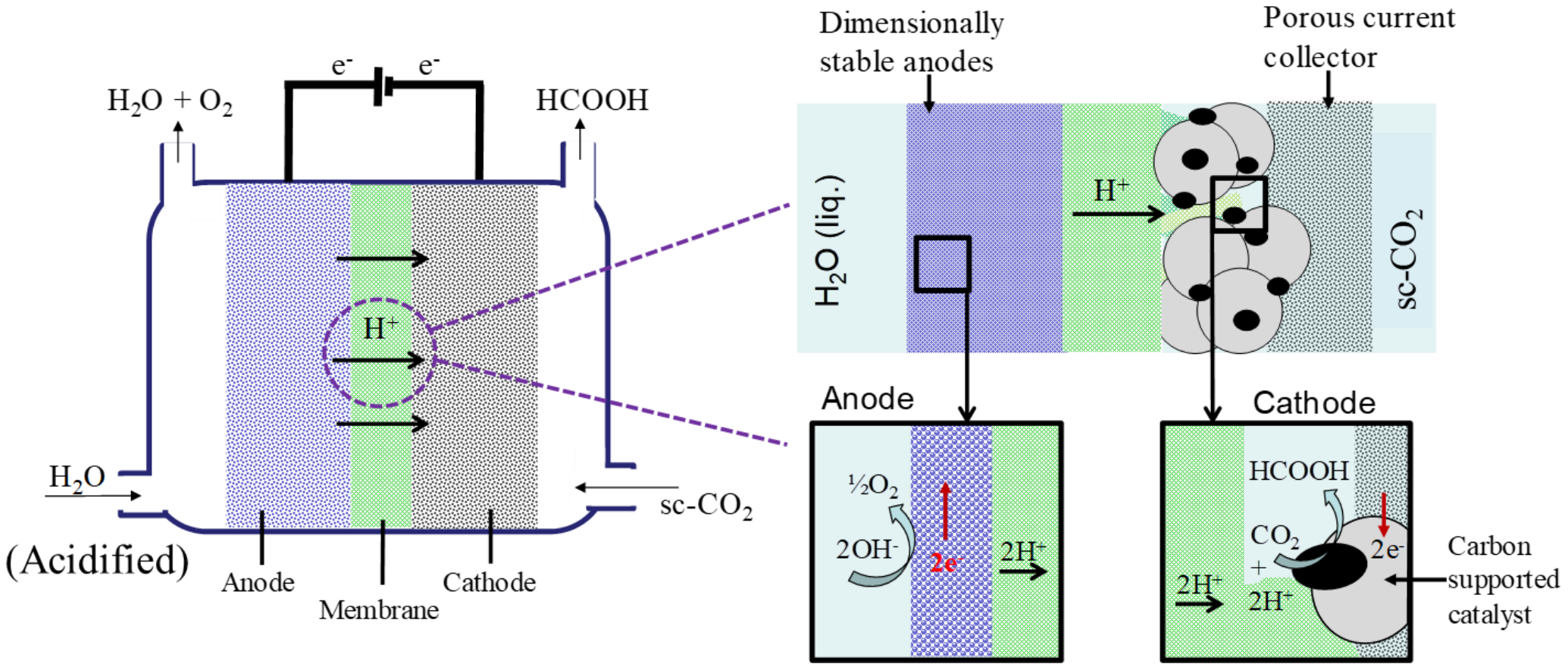


Current Opinion in Chemical Engineering 2013, 2:191–199

ChemSusChem 2011, 4, 1301 – 1310

- Low energy efficiency and Low product generation rates
- Poor selectivity and durability of catalysts for CO_2 conversion
- Low product purity

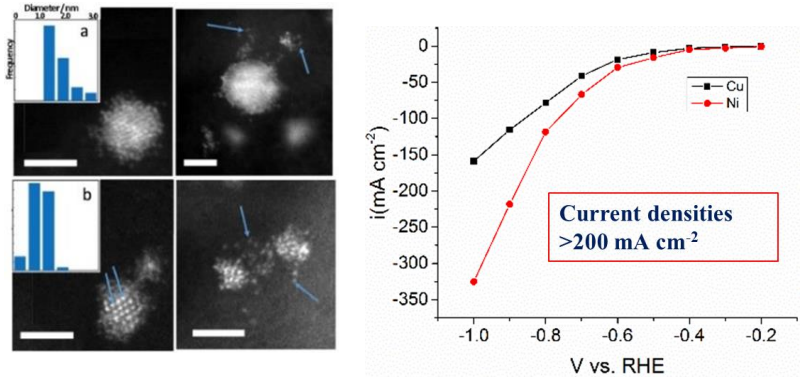
Formic Acid from CO_2 – Proposed Technology



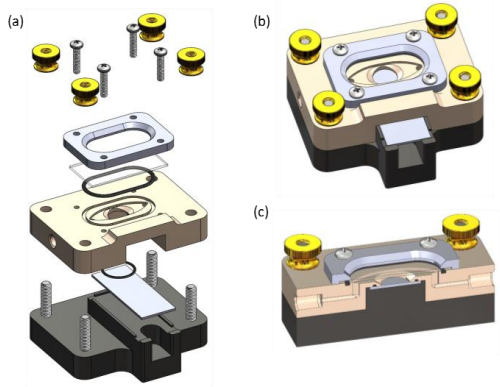
- Use of **supercritical CO_2 as feedstock** for CO_2 reduction → enhances product selectivity
- The **biphasic electrolyzer** design allows generation of neat formic acid

Project Tasks and Approach

1. Novel, low cost, PGM-free metal-alloy catalysts that are selective for formic acid production

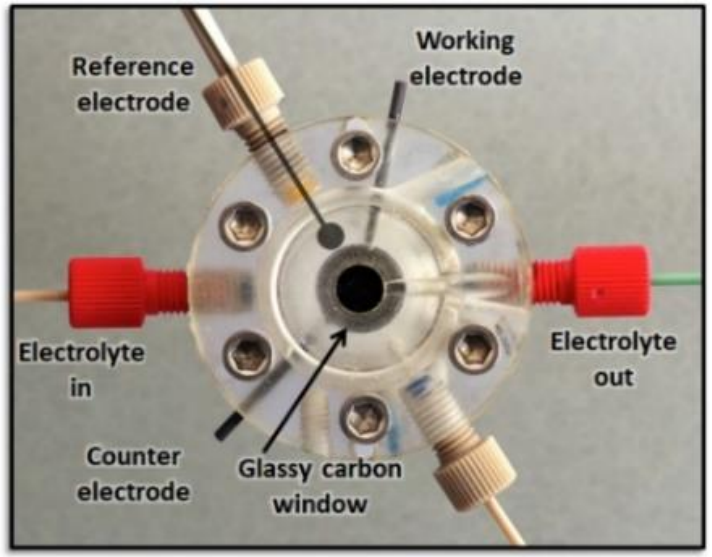


2. In-operando characterization of catalyst-electrolyte interfaces to discern corrosion mechanism



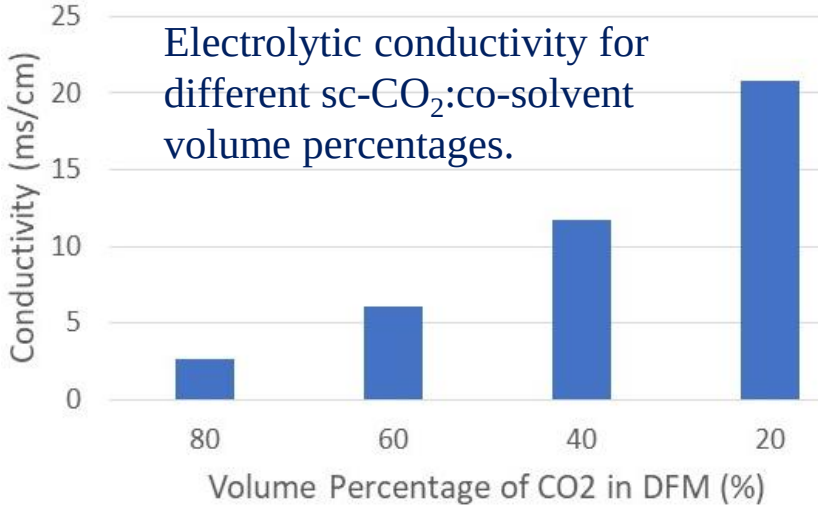
Raman electrochemical cell. (a) Exploded view; (b) assembled view; and (c) section view.

4. Lab scale (5 cm^2) demonstration of CO_2 to HCOOH conversion and LCA/TEA analysis.



A preliminary 1cm^2 device design.

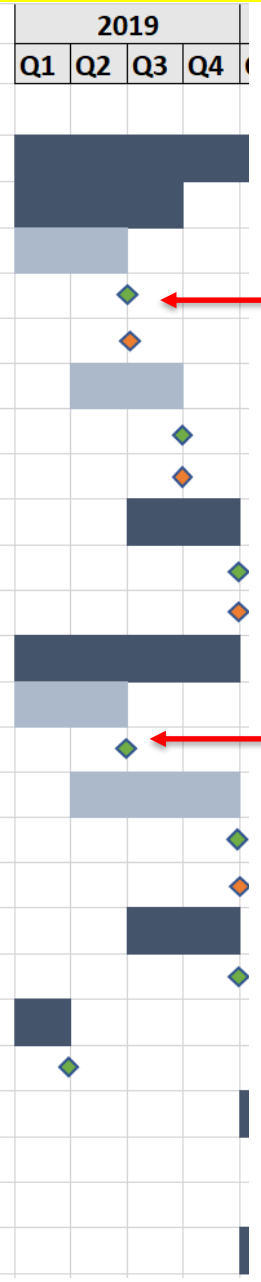
3. Optimize electrolyte formulations to improve overall energy efficiency.



Electrolytic conductivity for different sc-CO_2:co-solvent volume percentages.

Project Schedule

Task Name	Start	Finish	Team
Task 1.0 - Project Management and Planning	**01/01/19**	**12/30/21**	**UI**
Task 2.0 - PGM-free Catalysts and Electroactive Supports	**01/01/19**	**09/30/19**	**UI/UM**
Subtask 2.1 - Characterization of electroactive support	01/01/19	03/30/19	UI
Milestone 1	03/31/19	03/31/19	UI
Success Criteria 1	03/31/19	03/31/19	UI
Subtask 2.2 - Catalyst deposition on electroactive supports	04/01/19	09/27/19	UI/UM
Milestone 2	09/30/19	09/30/19	UI/UM
Success Criteria 2	09/30/19	09/30/19	UI/UM
Task 3.0 - Half-cell Testing in 1 atm CO2	**06/30/19**	**12/31/19**	**UI**
Milestone 3	12/31/19	12/31/19	UI
Success Criteria 3	12/31/19	12/31/19	UI
Task 4.0 - In-situ Operando Raman at 1 atm CO2	**01/01/19**	**12/31/19**	**UCSB**
Subtask 4.1 - Catalysts synthesis on SERS-active substrates	01/01/19	06/28/19	UCSB
Milestone 4	06/30/19	06/30/19	UCSB
Subtask 4.2 - Operando SERS in 1 atm CO2	04/01/19	12/30/19	UCSB
Milestone 5	12/31/19	12/31/19	UCSB
Success Criteria 4	12/31/19	12/31/19	UCSB
Task 5.0 - Design and Build Gen I (1 cm2) Biphasic Electrolyze	**07/01/19**	**12/31/19**	**UM**
Milestone 6	12/31/19	12/31/19	UM
Task 6.0 - Preliminary TEA and LCA Analysis	**01/01/19**	**03/31/19**	**UM**
Milestone 7	03/31/19	03/31/19	UM
Task 7.0 - Electrolyte Formulation	**01/01/20**	**06/30/20**	**UI**
Milestone 8	06/30/20	06/30/20	UI
Success Criteria 5	06/30/20	06/30/20	UI
Task 8.0 - Characterization of Commercial Membranes	**01/01/20**	**06/30/20**	**UM**



Milestones completed

Milestones completed

Acknowledgement

- DOE/NETL Project Officer(s) – **Dr. Sai Gollakota (Current) and Dr. Bruce W. Lani (Past)**

- DOE/NETL Contract Specialist/Award Administrator – **Mr. Nicholas Anderson**

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Thank You !