Dioxide Materials™
The $CO_2$ Recycling Company™

# $CO_2$ and Renewable Electricity into Chemicals: Formic Acid Production From Coal Flue Gas DE-FE0031706

Hongzhou Yang

Dioxide Materials Inc.
Boca Raton FL 33431

# Project Overview

- Project Overview
  - Funding: $800,000 DOE, $200,000 OCO
  - Overall Project Performance Dates
    - 02/01/2019 to 01/31/2021
  - Project Participants:
    - Dioxide Materials: responsible for electrolyzer development
    - OCO: responsible for economic evaluation, testing at Talen Energy coal fired power plant
    - Talen Energy: Providing space/$CO_2$ for real tests
  - Overall Project Objectives
    - Understand how to run the electrolyzer for the conversion of $CO_2$ into formic acid using flue gas from a power plant as a source of $CO_2$.
    - Key questions
      - Can we run directly on the $CO_2$ produced by the power plant, or is separation needed?
      - What cleanup is needed?

# Brief Technology Background

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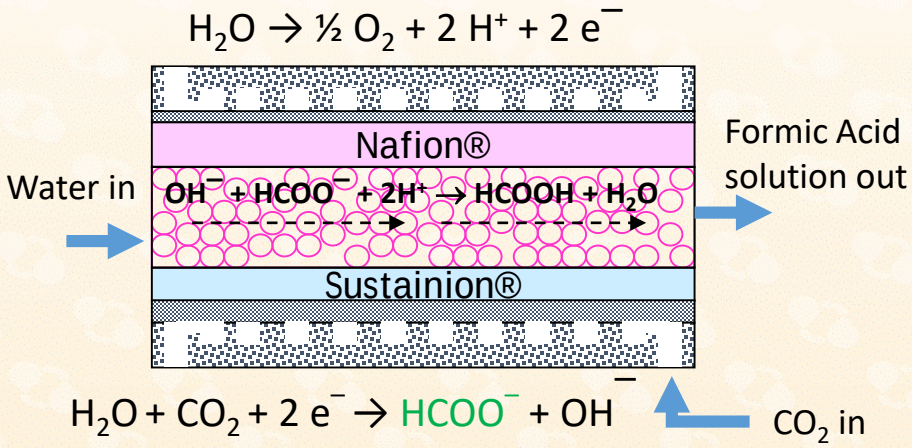
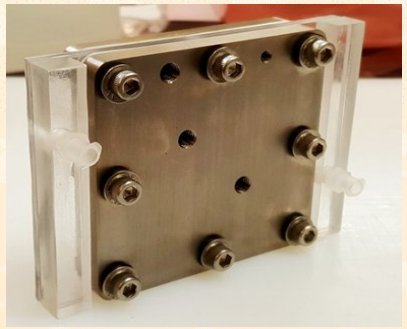
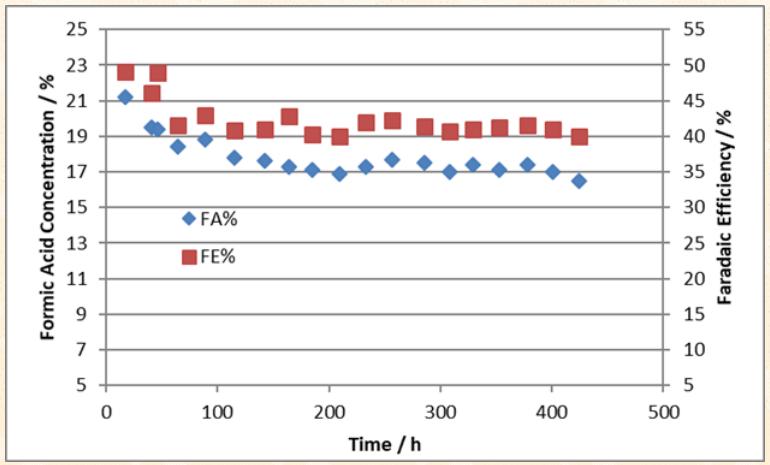
  - Data that supports premise of the project



Lab scale formic acid electrolzyer

FA concentration and Faradaic efficiency of formic acid electrolyzer operating at 600 mA constant current for over 400 hours



# Technical Approach/Project Scope

- Experimental design and work plan
  - 3-electrode cell ("H" type cell) and Dioxide materials 5 $cm^2$ formic acid electrolyzer
  - Commercially available catalysts or synthesized catalysts
  - Gas products analyzed by gas chromatograph (GC), formic acid by titration
  - Short and long term run at constant current with different gas conditions using 5 $cm^2$ formic acid electrolyzer
- Project schedule
  - Obtain 100 mA/$cm^2$ of current feeding a mixture containing 50% $CO_2$ (Oct 1, 2019)
  - Demonstrate 200 mA/$cm^2$ for 1000 hours feeding a mixture containing 50% $CO_2$ (Sept 1, 2020)
  - Obtain 200 mA/$cm^2$ of formic acid current feeding a mixture containing 50% $CO_2$, 5% $O_2$ (Sept 1, 2020)
  - Demonstrate 200 mA/$cm^2$ current for 100 hours feeding a mixture containing 50% $CO_2$. 10% $O_2$ 35 ppb $SO_2$ (Feb 15, 2021)
  - Test on coal gas (Feb 15, 2021)
- Key project success criteria
  - Demonstrate a formic acid electrolyzer running on 14% $CO_2$ with total faradaic efficiency (FE-HCOOH+FE-CO+FE-$H_2$) greater than 50%. (Mar 1, 2020)
  - Demonstrate a formic acid electrolyzer running for 1000 hours on 50% $CO_2$, with a cell voltage that never exceeds 4 V. (Nov 1, 2020)
  - Demonstrate a formic acid electrolyzer running on 50% $CO_2$ , 2% $O_2$ with total faradaic efficiency (FE-HCOOH+FE-CO+FE-$H_2$) greater than 50%. (July 1, 2020)
  - Production of a formic acid stream with at least 5% formic acid from $CO_2$ produced by a coal fired power plant. (Feb 14, 2021)