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High Performance Gas Diffusion Layer

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Company Background

- Founded in 2010, located in Columbus, OH
- Mission: to develop and commercialize material-based products for alternative energy applications.
- Expertise in:
  - Catalyst synthesis, development, and scale-up
  - Fuel Cell and electrochemical device development
- Commercialization experience with catalysts, advanced materials, and electrochemical devices

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Overview

Timeline and Budget

- Project Start Date: 04-09-2018
- Project End Date: 01-08-2019
- Total Project Budget: $ 155,000
- SBIR Phase I project

Partners

- Gas Diffusion Layer (GDL) Manufacturer

Barriers Addressed

- Cost:
  - Demonstrate a low-cost surface treatment for GDLs and the Micro-Porous Layer (MPL) that creates higher-performing GDLs.
- Performance:
  - Develop GDLs with improved mass transfer that translates to enhanced activity in an MEA testing.

Relevance

Project Objectives

- Develop and demonstrate a novel GDL and MPL for PEM fuel cells that is designed to have optimal hydrophobicity for improved water transport
- Demonstrate improved properties compared to commercial GDLs
  - Hydrophobicity
  - Gas transport
  - Electrical Conductivity
  - Thermal Conductivity
  - Corrosion
- Perform initial sub-scale MEA testing to demonstrate better performance than standard PTFE-coated GDLs in a PEM fuel cell environment

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Project Background

- The GDLs serve several functions and should be porous, electrically conductive, and good thermal conductors.
- In a PEM fuel cell, the GDLs must not corrode in the acidic environment.
- GDLs consist mostly of thin carbon fiber paper or cloth.
- To address the issue of cathode flooding from the water product in a PEM fuel cell, GDLs are often coated with a hydrophobic polymer to increase hydrophobicity at the expense of porosity and electrical conductivity
- High-loadings of carbon-based microporous coating containing hydrophobic polymer binder also decreases electrical conductivity and gas porosity.
- **In this project, pH Matter will develop a GDL that is free of the hydrophobic insulating polymers that clog the GDL porosity and increase contact resistance.**

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Approach

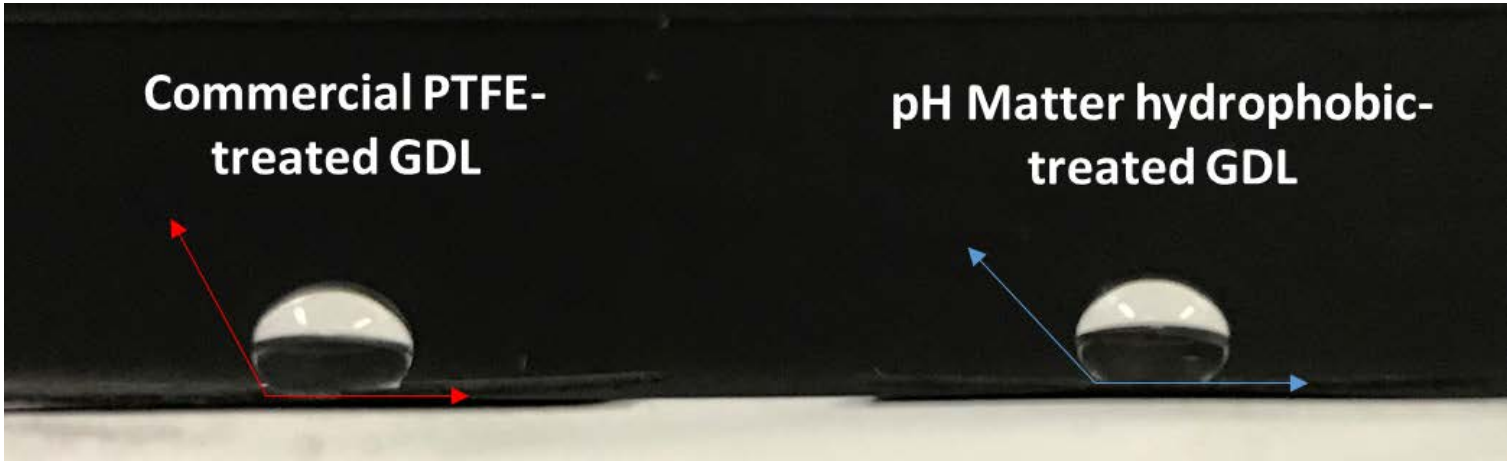
Task / *Milestone*	Month after project initiation								
	1	2	3	4	5	6	7	8	9
Task 1. Sample Preparation	——	——	——	——	——				
Initial samples ready for corrosion testing		●							
Sample matrix complete					●				
Task 2. Corrosion Testing			——	——	——	——			
Down-select pre-treatment approach				●					
Samples pass corrosion testing requirements						●			
Task 3. Physical Property Measurements				——	——	——	——	——	——
Improvement in hydrophobicity, mass transfer, and electrical conductivity demonstrated								●	
Initial MEA tests reported									●
Task 4. Economic Projections						——	——	——	——
Cost Projections Reported									●

Approach

- Prepare a matrix of GDL samples to examine the effects of synthesis parameters on important properties
- Test for corrosion resistance, hydrophobicity, mass transfer of gas, electrical conductivity, and thermal conductivity
- Down-select at least one GDL for MEA testing to demonstrate better performance than standard PTFE-coated GDLs in the real environment
- Perform initial manufacturing design of the process to fabricate the GDL at introductory and commercial scale quantities

Accomplishments

Preliminary Work

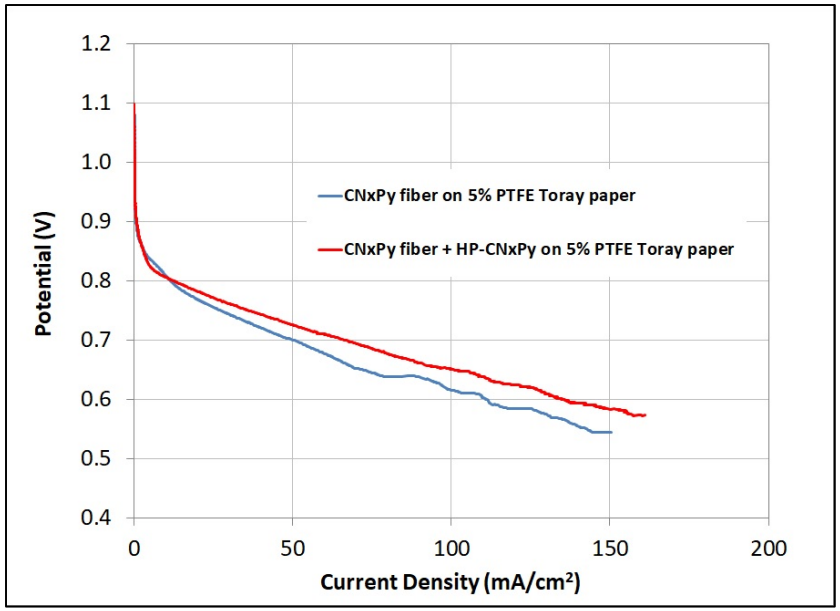


- The commercial GDL showed typical contact angles for PTFE-treated carbon paper, while the sample treated with pH Matter's hydrophobic surface treatment process showed even larger contact angle with better porosity.
- Verifies that the treatment process is capable of making a more hydrophobic GDL without the need for hydrophobic polymer addition

Related Work

Demonstrated improved performance with tuned hydrophobicity GDEs on a reversible alkaline fuel cell project

Contact angle measurements



Improved performance with the addition of 5-wt% surface-treated hydrophobic additive in the catalyst layer for alkaline fuel cell testing

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Responses To Previous Year Reviewers' Comments

This project was not reviewed last year

Collaboration

Gas Diffusion Layer (GDL) Manufacturer

- Provide untreated and treated GDLs
- Perform independent testing to verify improvement in performance

Remaining Challenges

- Preparation of GDL samples made with varying pre-treatment conditions
- Demonstrate GDLs meet application requirements using half-cell corrosion testing and physical property measurements
- Demonstrate overall improved GDL performance in MEA testing

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Proposed Future Work

- Optimization of properties and scalability based on initial results
- Development of optimal microporous layer using surface-treated pH Matter material
- Transfer of technology from pilot-scale to commercial-scale production equipment

Any proposed future work is subject to change based on funding levels

Summary

- Patent-pending hydrophobic surface treatment process developed by pH Matter is capable of making a more hydrophobic GDL without the need for hydrophobic polymer addition that blocks porosity

- The technology being developed in this project aims to increase hydrophobicity and improved mass transport of GDL and MPL without the expense of porosity and electrical conductivity

- If successful, the project will improve the power density of PEM fuel cells.