Controlled Porosity and Surface Coatings for Advanced Gas Diffusion Layers (DOE Phase I SBIR)

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Overview

Timeline

- Project Start (Phase I): April 9, 2018
- Project End: January 8, 2019
- Percent Complete: Kickoff

Budget

- FY18 = $150K (DOE)

Barriers Addressed

- The problems of current generation gas diffusion layers will be addressed by engineering controlled porosity that improves water management in polymer exchange membrane fuel cells and by coating the gas diffusion layers with a novel corrosion resistant layer to achieve greater resistance to chemical attack at operating conditions.

Project Partners

- University of Tennessee (UT, Dr. Mench)

Relevance and Project Objectives

Overall Project Objective: Develop novel gas diffusion layers (GDLs) with controlled, low tortuosity pores and improved durability

- PSI's approach will provide a scalable, low cost manufacturing method that will increase PEMFC cell potential by 10% at current densities up to 1.6A/cm^2.
- PSI will also improve durability by reducing chemical corrosion of the GDL.

Technical Objectives:

  - Demonstrate the targeted porosity, average pore size and tortuosity.
  - Demonstrate the targeted thickness for the corrosion resistant layer.
  - Demonstrate the transport properties equivalent to state of the art GDLs.
  - Demonstrate resistance to electrochemical corrosion.
  - Develop a manufacturing plan that will result in a final production cost within 10% of the current generation of GDLs.

Program Approach/Strategy

This Phase I program will develop scalable and cost effective processing solutions to produce gas diffusion layers for polymer exchange membrane fuel cells. Two highly scalable processing methods will be employed:

- Controlled, low tortuosity pores will be engineered into the gas diffusion layer structure by a combined tape casting and ice-templating approach. These pores will be tailored to limit water flooding in the cell, while minimizing the dehydration of the membrane.
- The gas diffusion layers will be coated with a protective layer via the pre-ceramic polymer method to improve chemical durability.

- Both of these processing methods are highly scalable and can be introduced into existing manufacturing lines.

Partners/Collaborators

- Professor Matthew Mench, University of Tennessee Knoxville
  - Role: Characterization of the thermal, mass, and electrical transport of the GDLs developed under this effort.
  - Description: UT will focus on characterizing the transport properties and chemical durability of GDLs produced by PSI. To determine the transport properties of the GDLs, electrochemical performance tests will be carried out using UT's specialized test equipment.

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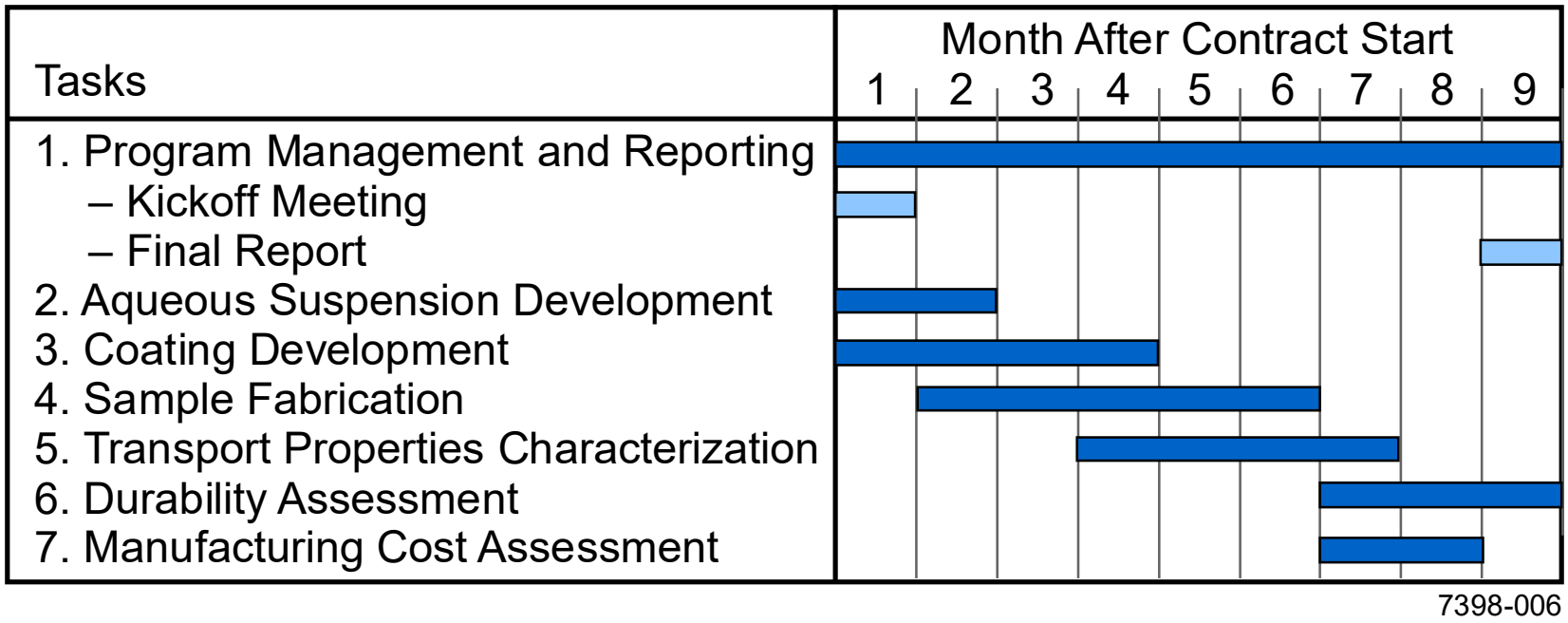
Proposed Work

During the Phase I, PSI and UT will:

- Develop the processing methods to produce carbon based GDLs that combine tailorable, low tortuosity pores and a corrosion resistant coating.
- Fully characterize the physical properties (including thermal conductivity, electrical conductivity, water transport, and ex-situ chemical durability) of the GDLs to prove that the GDLs are superior to current generation materials.
- Develop a manufacturing cost model for this novel processing approach.



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

Summary

The objective of this Phase I SBIR is to develop novel gas diffusion layers (GDLs) with controlled, low tortuosity pores and improved durability using a cost effective manufacturing approach.

- The controlled porosity will improve water management in polymer exchange membrane fuel cells.
- Application of a novel corrosion resistant layer will increase resistance to chemical attack at operating conditions.
- PSI, together with UT, will develop the processing methods, fully characterize the physical properties of the GDLs, and develop a manufacturing cost model for this novel processing approach.

If successful, this Phase I will demonstrate that GDLs with enhanced water transport and improved durability can be cost effectively produced. This will provide improved performance and durability to PEMFCs aiding their application to light duty automobiles.