Materials and Modules for Low Cost, High Performance Fuel Cell Humidifiers

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Project ID FC067

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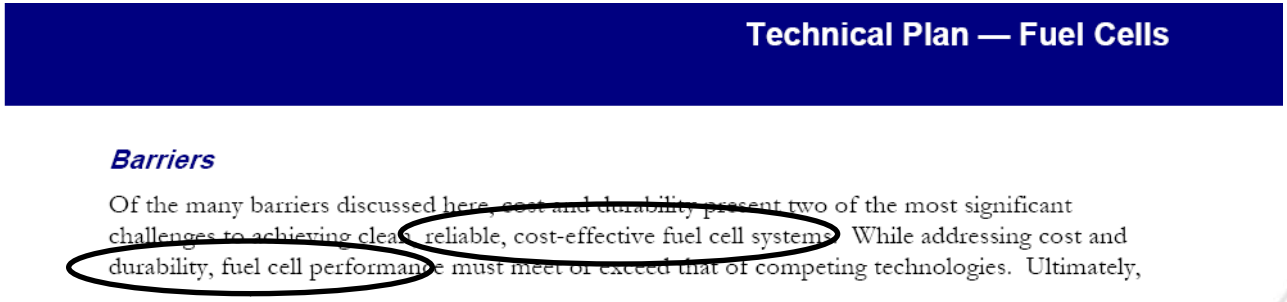
Overview

***OBJECTIVE**: Demonstrate a durable, high performance water transport membrane; and a compact, low-cost, membrane-based module utilizing that membrane for use in an automotive, stationary and/or portable fuel cell water transport exchangers.*

***TIMING**: Two year program, start date TBD.*

***BUDGET**: Expected budget, $1.865MM.*

***DOE PLAN BARRIERS ADDRESSED**: System cost, fuel cell performance and durability (no specific targets in DOE technical plan for water transport membranes)*



Technical Plan — Fuel Cells

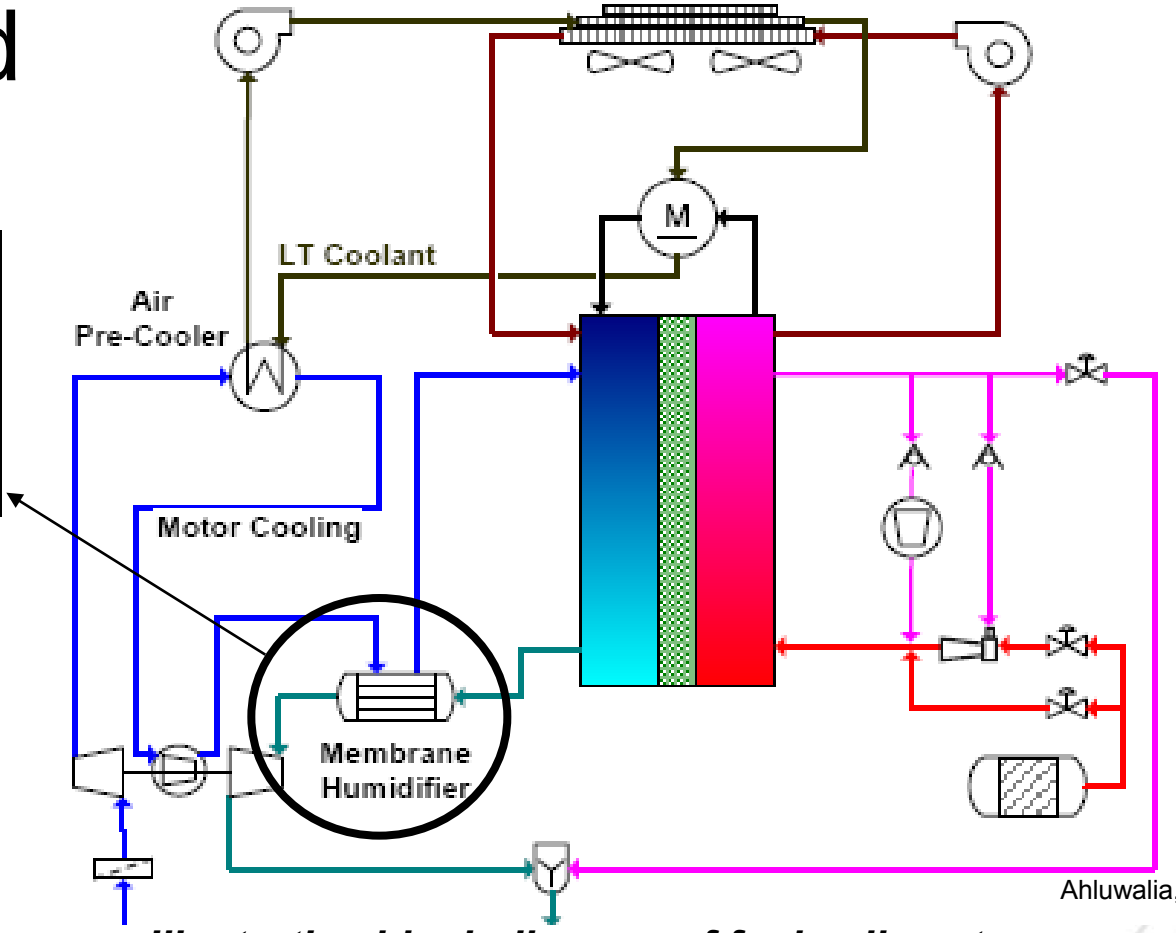
Barriers

Of the many barriers discussed here, cost and durability present two of the most significant challenges to achieving clean, reliable, cost-effective fuel cell systems. While addressing cost and durability, fuel cell performance must meet or exceed that of competing technologies. Ultimately,

***TEAM**: Prime - W. L. Gore & Associates, Inc.*
Subcontractor - dPoint Technologies

Background

dPoint module



Ahluwalia, et. al, ibid.

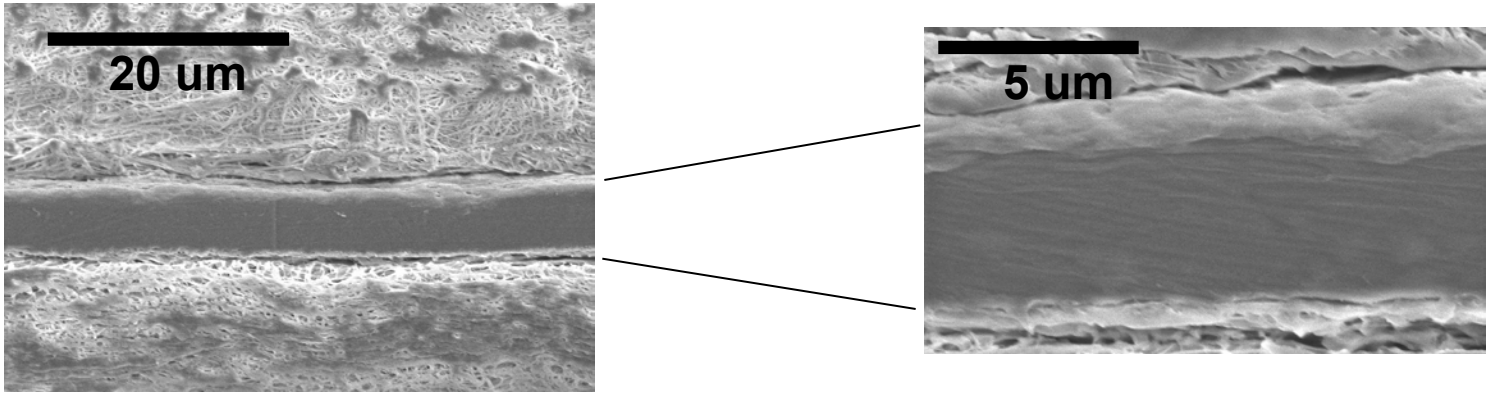
Illustrative block diagram of fuel cell system

More efficient, low-cost humidifiers can increase fuel cell inlet humidity:

- **Reduce system cost and size of balance of plant;**
- **Improve fuel cell performance;**
- **Improve fuel cell durability.**

Approach

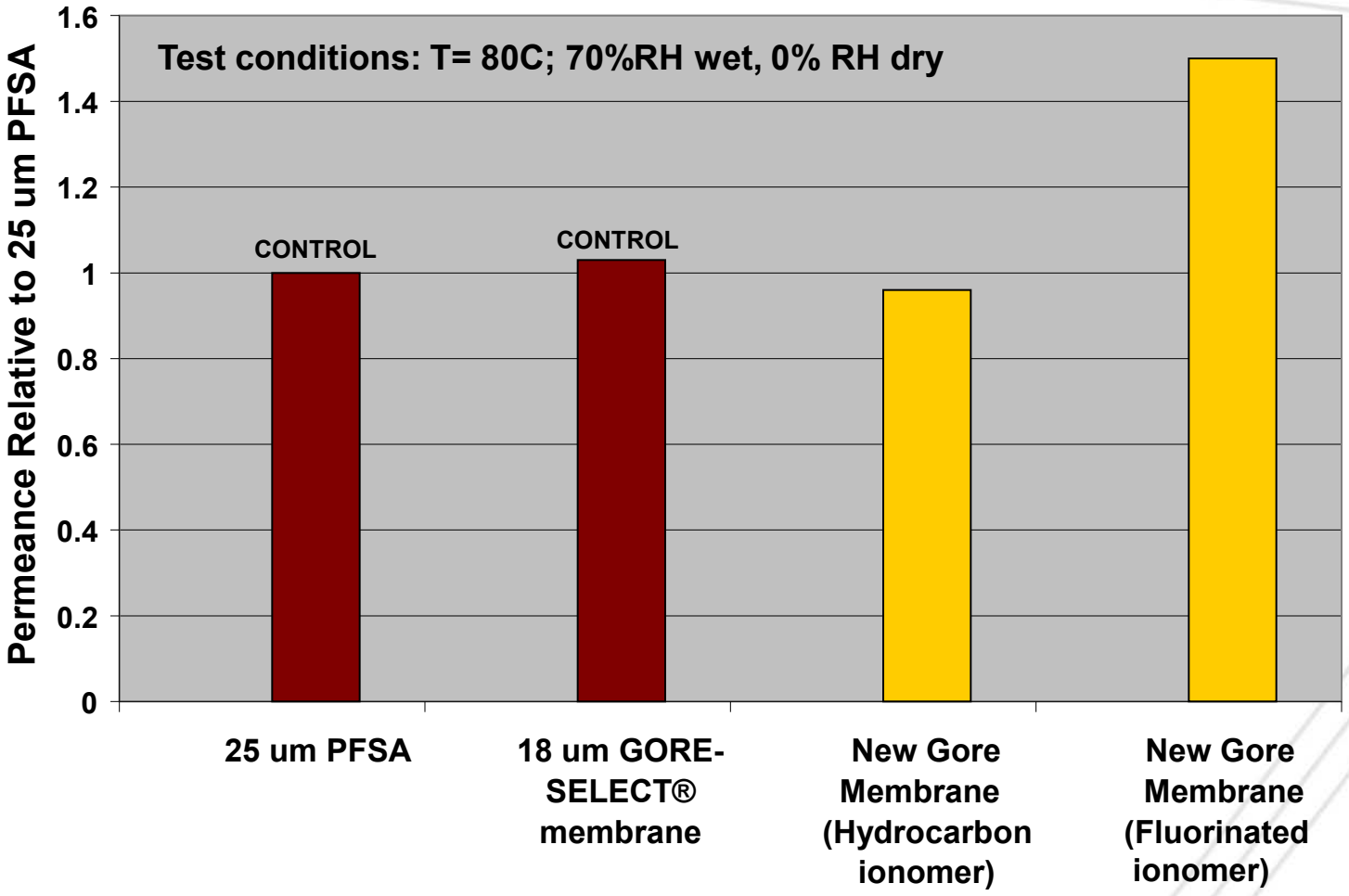
- Utilize unique, high performance GORE™ Humidification Membrane



- Optimize ionomer and microporous layer types using unique Gore materials to maximize permeance and durability, and minimize cost.
  - ✓Will explore range of fluoro- and hydrocarbon ionomers

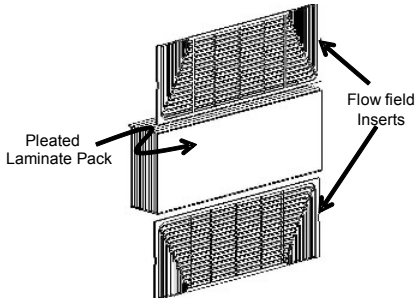
- Design and build dPoint humidification module to take advantage of very high permeance of these membranes.

Approach: High Performance Membranes



Approach: Low-Cost Modules

dpoint technologies



Optimize flow field, pleat geometry and module design to take advantage of very high transport rate materials, while maintaining low-cost assembly process.

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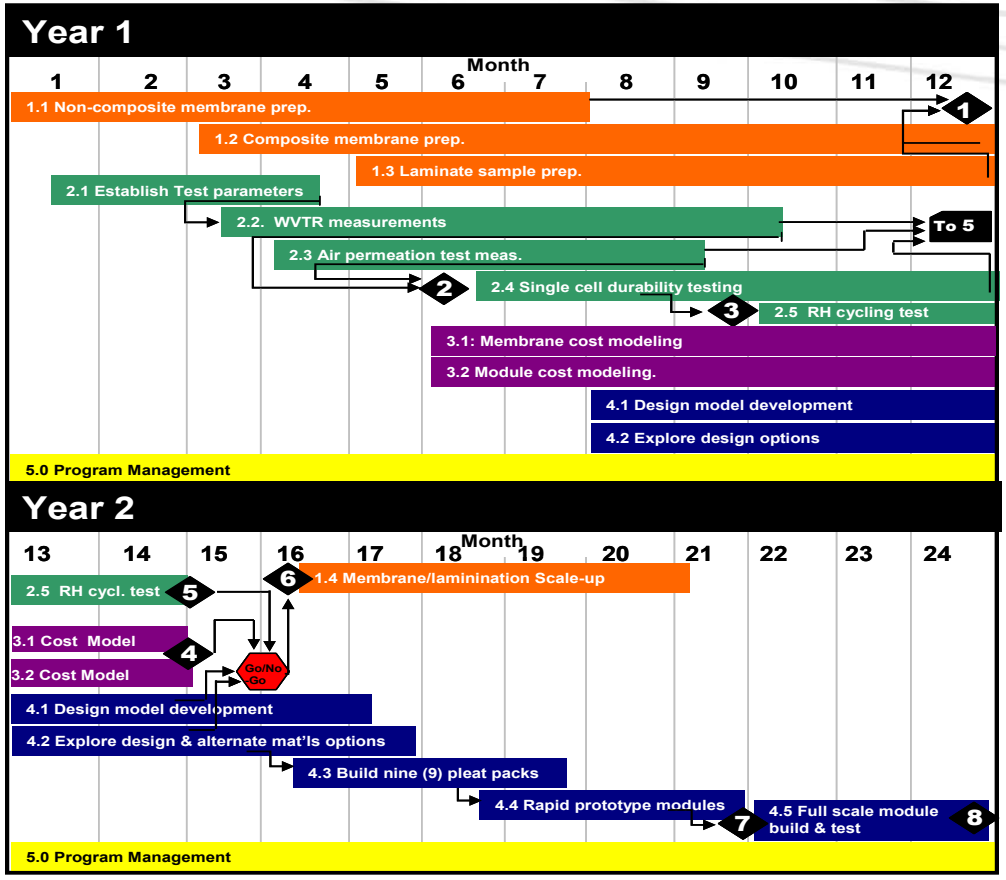
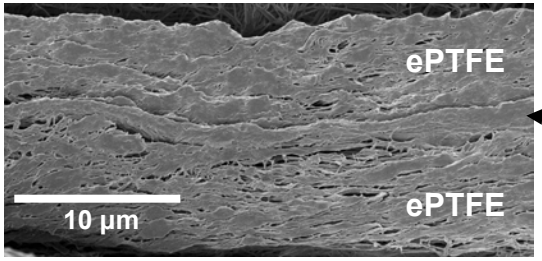
Timeline and Milestones



- Program contract has not been signed as of presentation submission date, so official start date is to be determined.
- Gore has begun limited program work using internal funding in anticipation of at least partial DOE reimbursement.

Initial Results*

- Contacts with automotive and stationary OEMs have been initiated, and some preliminary feedback on conditions has been obtained.
  - Stationary: 60 C temp operating
  - Automotive: 80-90 C operating, with transients as high as 105 – 110 C under heavy loads
- Initial investigation of a number of membranes and processes have been explored.



~ 1 µm ionomer layer!

  - Thinner ionomer layer will yield higher performance and lower cost.

* Performed pre-contract signing using Gore (at-risk) funding in anticipation of at least partial reimbursement

Initial Results*

- Permeance system redesigned, and initial testing commenced between 60 and 95 C, 70% RH for several Gore humidification membranes.
- Alternate room temperature water vapor transport test protocol developed for rapid screening.
  - Based upon a modified version of ISO Standard 15496, “Measurement of Water Vapor Permeability of Textiles for Purpose of Quality Control”.
  - Initial testing indicates reasonable correlation with higher temperature permeance test results.

* Performed pre-contract signing using Gore (at-risk) funding in anticipation of at least partial reimbursement

Collaborations

- Subcontractor
  - dPoint Technologies
    - Design and build low-cost module using new membrane
- Partners providing Input at no cost
  - Automotive OEMs to provide data on conditions
    - GM, Ford, Daimler, Volkswagen, etc.
    - Depending on project success, some may test in their own designs
  - Argonne National Laboratory to utilize data in modeling effort as-required.

Summary

- Water transport rates through GORE™ humidification membranes can be VERY high, especially for the fluorinated ionomer-based materials.
- Transport measurements of these high-rate materials are a challenge.
- Initial testing has begun, even though program has not yet officially started (awaiting contract…)
- Output of this program may also lead to non-fuel cell energy saving applications for these and related materials.