High Temperature, Low Relative Humidity PEM Fuel Cell Membranes

Bindu R. Nair

Foster Miller Inc

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Objectives

To develop a high temperature capable (150°C) PEM fuel cell membranes that can operate at variable relative humidity

To develop PBO/acid membranes that might compare to PBI/acid membranes, the only viable high temperature membrane currently available

To use polymeric acids instead of small molecule acids to improve the stability of the PEM to thermal/humidity cycling

Budget

- Funding for April ’03 to Dec ’03 -- $150K
- Funding for May ’04 to May ’05 -- $150K

- Subcontractors include:
  - Jesse Wainright, CWRU -- $60K
  - Ron Eby, UAkron -- $5K

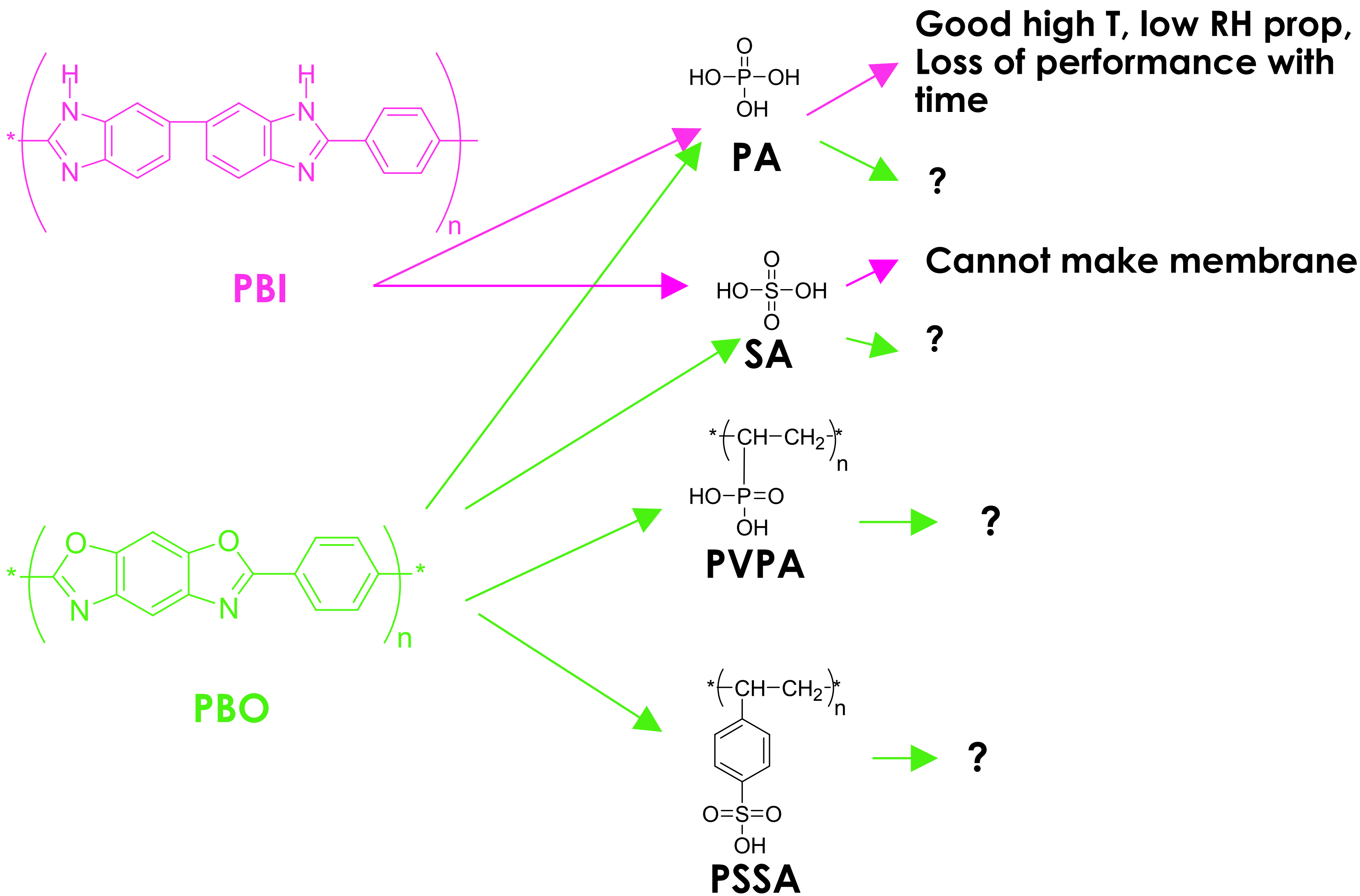
Technical Barriers and Targets

- DOE Technical Barriers for Fuel Cell Components
  - O. Stack Material and Manufacturing Cost
  - R. Thermal and Water Management
- DOE Technical Target for Fuel Cell Stack System for 2010
  - Cost $35/kW
  - Durability 5000 hours

Approach

- Current high temperature fuel cell membranes that can operate at 150°C with no pressurization have load cycling and temperature cycling limitations.
- Some of the current membranes are composites of PBI/PA
- This program considers a different substrate (PBO) that enables the use of stronger acids (leads to higher conductivity)
- This program also considers polymeric acids to increase the cycling stability of the membrane

Approach (cont'd)



Project Safety

- Attempting to design for low pressure systems (membranes that can perform at low relative humidity)
- Aqueous processing of ion conducting polymer (MOC)

Project Timeline

- Year 1
  - Make PEM samples with PBO/phosphoric acid, PBO/sulfuric acid and PBO/polymeric acid
  - Evaluate conductivity and leaching of samples
  - Milestone: moderate conductivity, non-leaching samples achieved
- Year 2
  - Make most promising samples into MEAs
  - Test single performance at variable RH and T
  - Milestone: single cell performance of non-leaching high T, low RH PEM

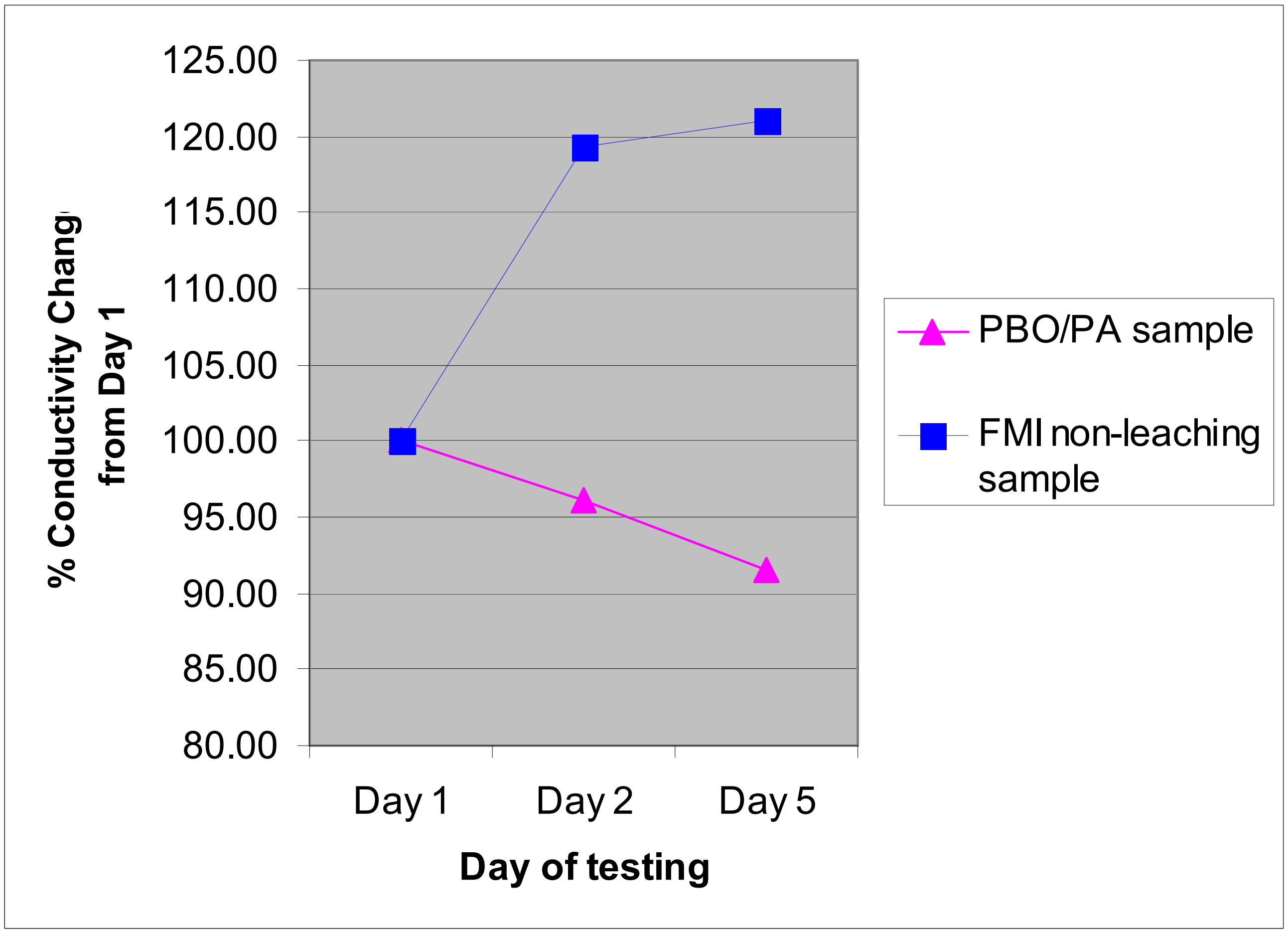
Technical Accomplishments/ Progress

- Demonstrated that PBO imbibed with PA conducts at high T, low RH
- Demonstrated that PBO imbibed with SA conducts at high T, low RH
- Demonstrated that PBO imbibed with polymeric acids do not conduct well at high T, low RH.
- Demonstrated that it is possible to create non-leaching membranes with respectable conductivity at high T, low RH.

Conductivity PBO PEMs at 150°C, low RH

Sample	Conductivity (S/cm)
PBO/PA	6.02×10^{-2}
PBO/SA	8.45×10^{-2}
PBO/PVPA	3.97×10^{-5}
PBO/PSSA	3.33×10^{-5}
Non-leaching sample	1.30×10^{-3}

Change in 150°C-conductivity as a function of time at ambient humidity



Interactions and Collaborations

- Prof. Jesse Wainright, CWRU – testing and evaluation of PBO samples at high T low RH.
- Dr. Joe Fellner, WPAFB/PR – Foster Miller is currently a recipient of Air Force funding to develop composite proton exchange membranes for 120°C operation. Dr. Fellner is actively interested in FMI's fuel cell membrane development programs.
- Prof. Ron Eby, UAkron – performs microscopy on FMI composite membranes.
- Prof. Sanjeev Mukerjee – performs polarization curves and studies on FMI composite membranees.

Future Work

- Improve conductivity of FMI non-leaching samples
- Convert FMI non-leaching samples into MEAs and test fuel cell performance
- Work closely with UAkron to understand the morphology of FMI non-leaching samples