



Transport in PEMFC Stacks

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Dimensionally Stable Membranes for High-Temperature Applications

Timeline

- Begin 10/5/2009
- Review 10/4/2012

Budget

- Total Project Funding
 - \$3.36M DOE Funding
 - \$1.12M Fiscal Year 1
 - \$1.12M Fiscal Year 2
 - \$1.12M Fiscal Year 3
 - \$676K Recipient
 - 20% Cost Share

Barriers Addressed

- Performance
- Water Transport with Stack
- System Thermal and Water Management
- Start-Up and Shut Down

Technical Targets

- *Cold Start-up Times*
- *Specific Power Density*
- *Stack Power Density*
- *Stack Efficiency*

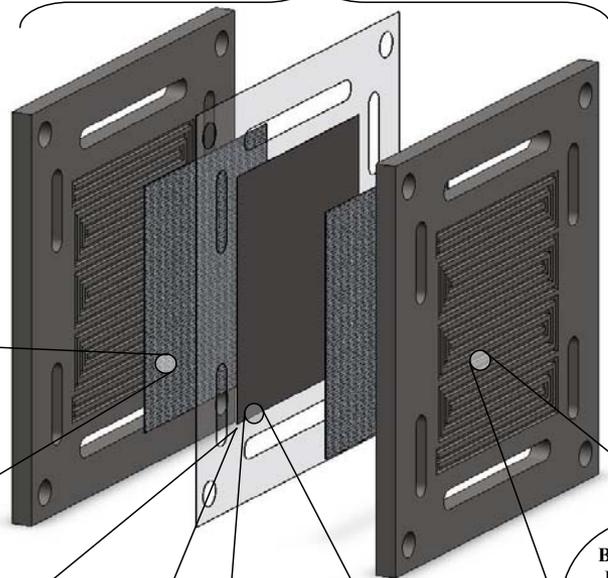
Partners

- University of S. Carolina
- Virginia Tech
- Tech Etch
- Engineered Fiber Technologies

Overview: Team and Tasks



Fuel Cell Testing and Modeling
University of South Carolina



Diffusion Media Fabrication and Properties
EFT



Synthesis and nano-scale PEM characterization
Virginia Tech

MEA Fabrication and Properties
GES



Bipolar Plate Fabrication and Properties
Tech-Etch



Tech Etch,
Virginia Tech and
EFT Providing Materials

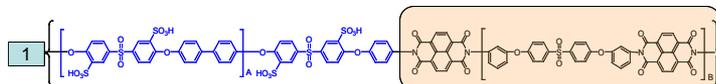
GES, VT and EFT
Providing component
characterization

GES and USC doing fuel cell
testing

USC Modeling

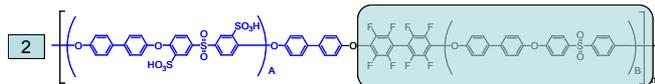
*Focus on transport and role
of water*

Tasks: Synthesis

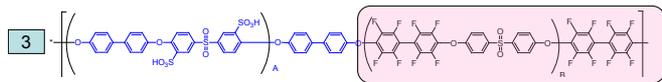


BPSH-PI (A:B)

A~ Hydrophilic block length in kg/mole, B~ Hydrophobic block lengths in kg/mole



BPSH-BPS (A:B)



BPSH-BisSF (A: B)

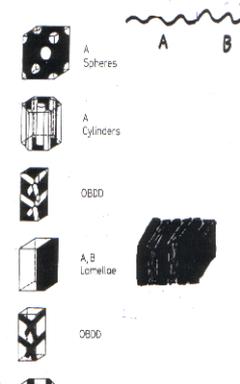
4

BPSH-xx random



How do block chain length and composition effect structure

Jogy, A. E. Woodward, Harzer Publishers, 1989.

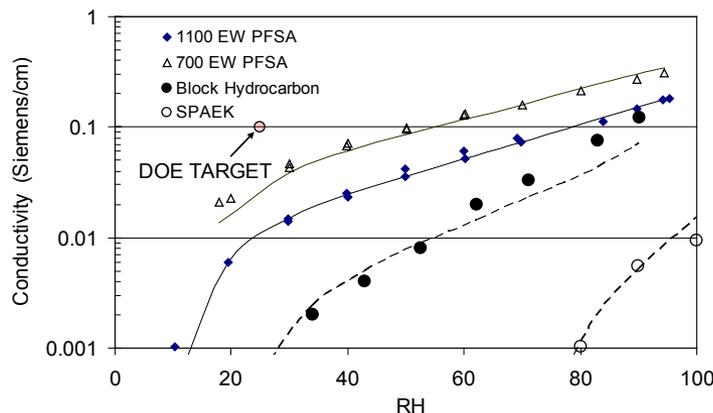
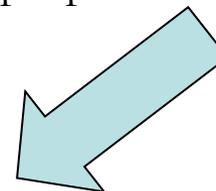


Our system

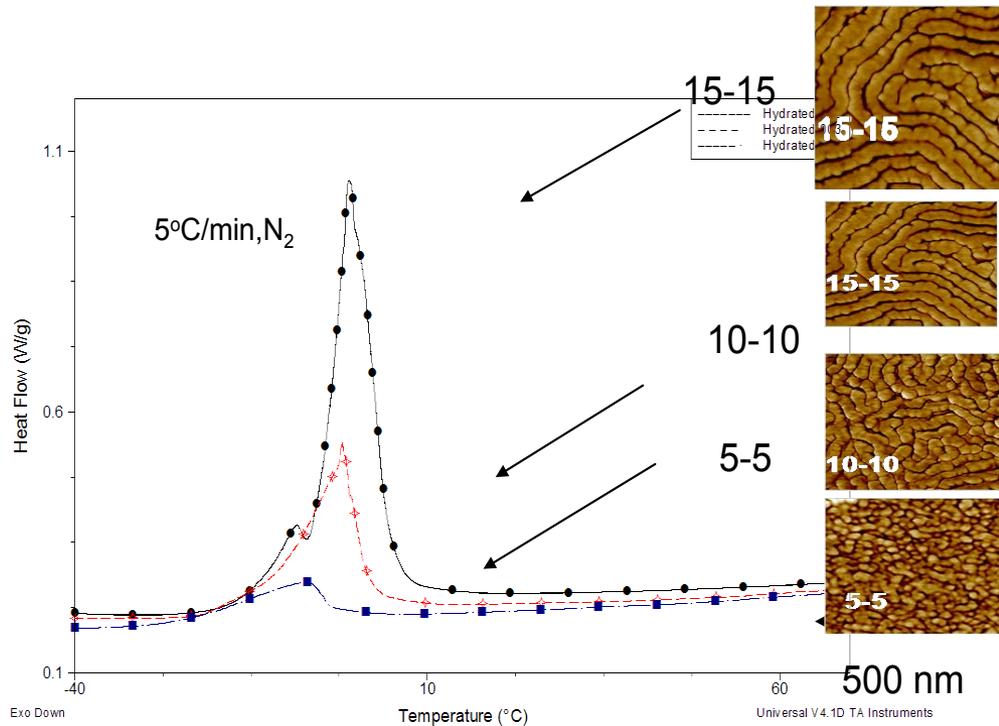
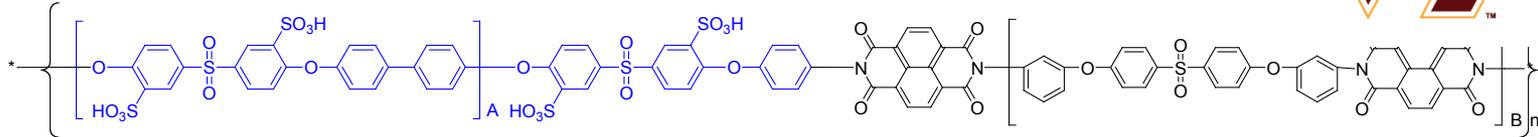
- Presence of ionic groups
- Multiblock and not triblock
- Volume fraction of hydrophobic phase > volume fraction of hydrophilic phase



How does structure effect physical properties



Nature of Water as a Function of Block Copolymer Morphology for Similar IEC



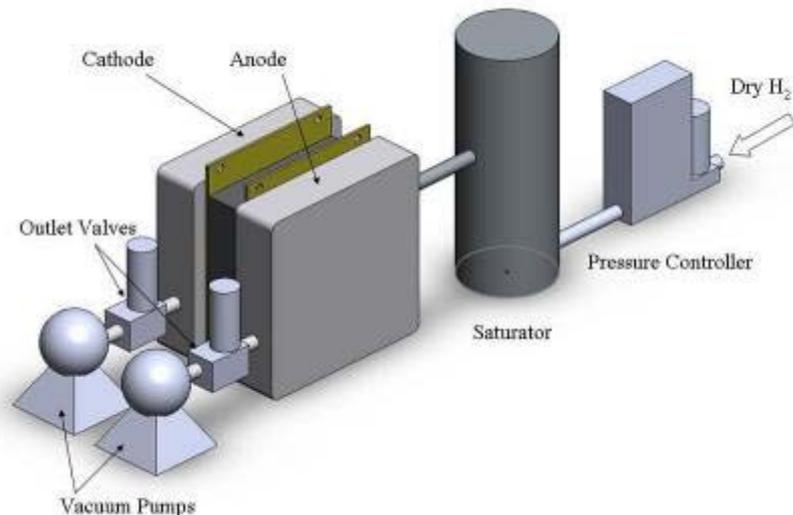
ΔH_{fus} (kJ/g)	L_b (λ)	Free (λ)
172	11	6
71	8	1
33	4	0

The copolymers were of similar IECs of 1.6 meq/g

Tasks: Bulk Properties



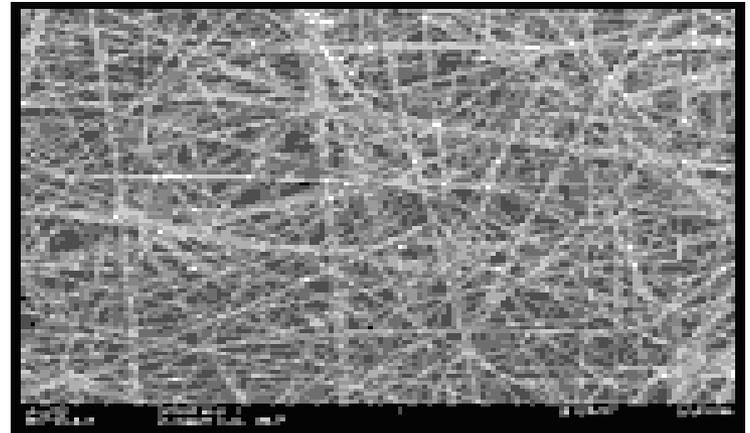
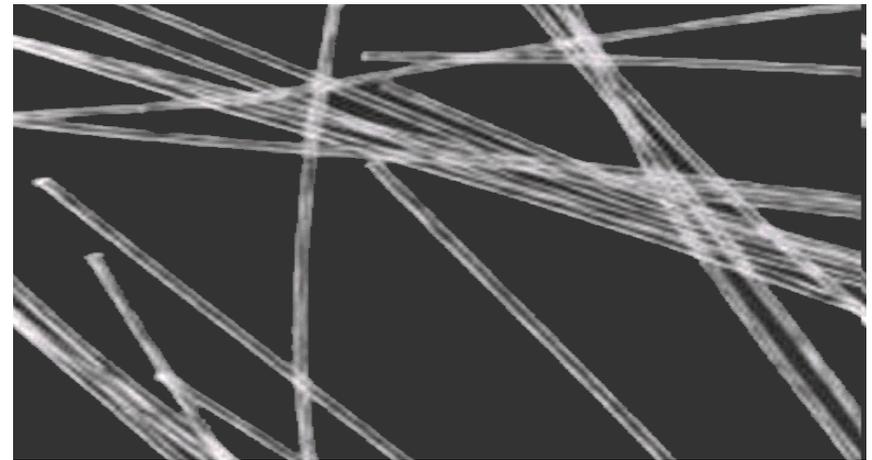
- Want to know how PEM composition and morphology effect
 - Gas permeability
 - Water diffusivity
 - Electroosmotic drag
 - Conductivity
- Model needs these numbers for water balances/performance prediction



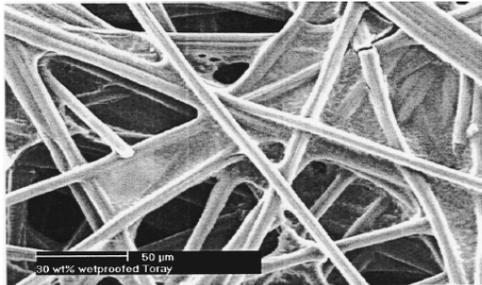
Tasks: Diffusion Media



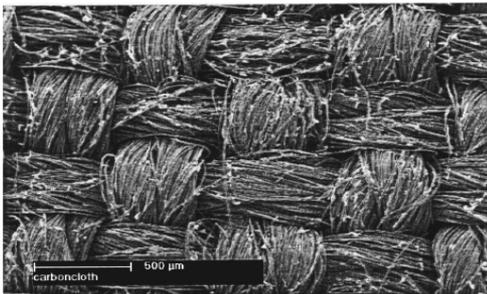
- Need to generate materials of known
 - Porosity
 - Hydrophobicity
 - Bubble point
- Determine
 - Permeability
 - Conductivity
- Confirm in testing and models



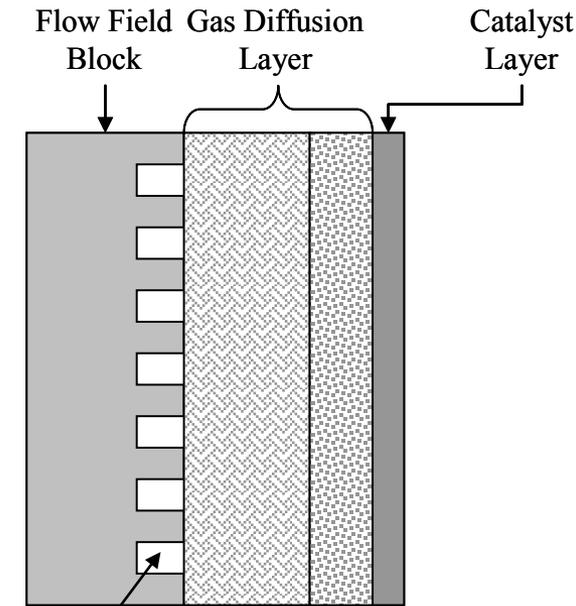
Dual-Layer, Carbon-Based GDL (Microporous Layer)



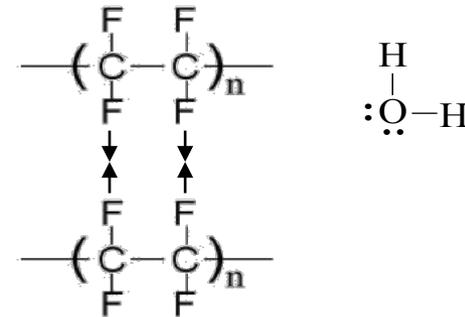
(a) SEM of Toray Paper GDL



(b) SEM of Carbon Cloth GDL
Pasaogullari and Wang



Teflon™
Polytetrafluoroethylene (PTFE)



Flow Channel Macroporous Layer Microporous Layer

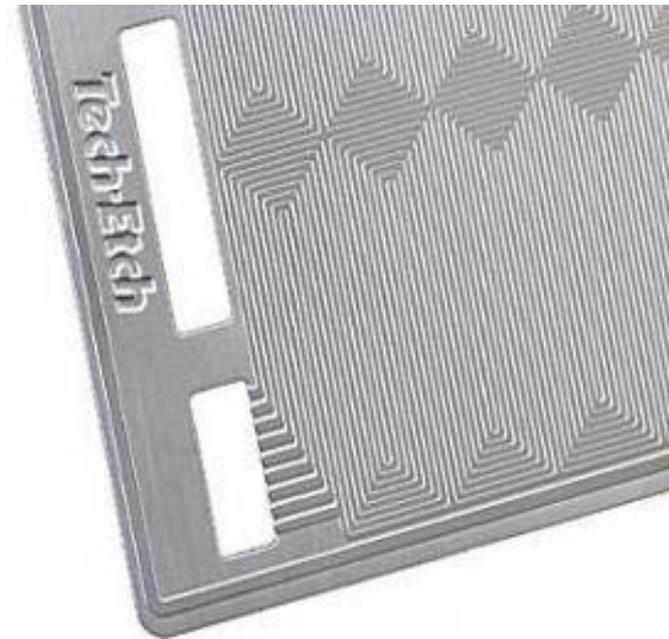
Carbon Cloth
or
Carbon Paper

Carbon Powder
and
Hydrophobic Agent

Tasks: Flowfields

Tech-Etch

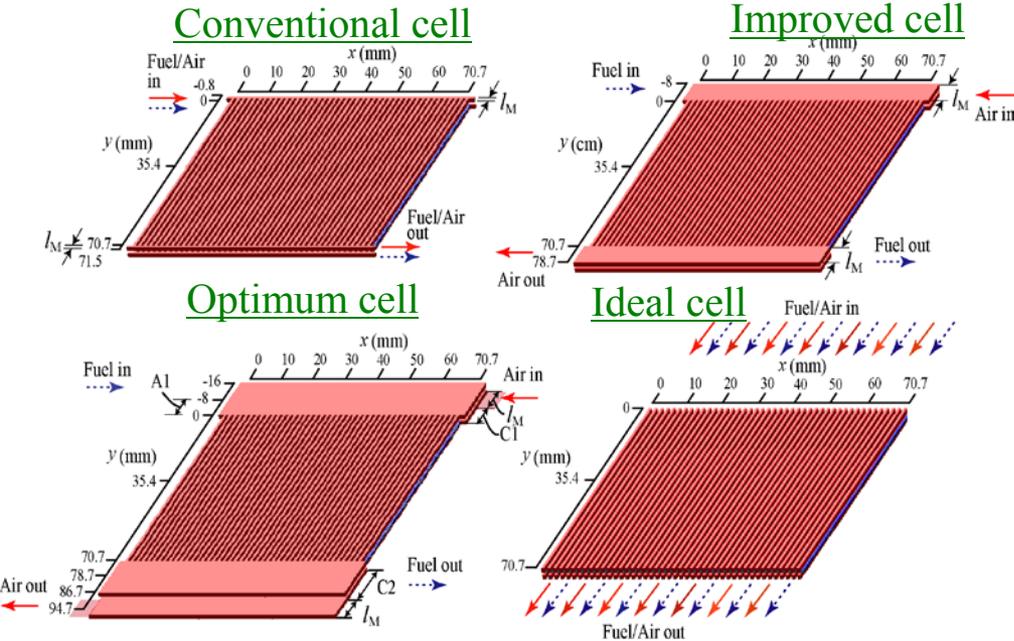
- Need a number of various flow patterns constructed for confirming model
- Needs to mimic commercial product as closely as possible without enormous costs
 - Commercial product looks to be stamped plates with inner cooling plate
 - Stamped molds are expensive
 - Here small number can be made relatively inexpensively



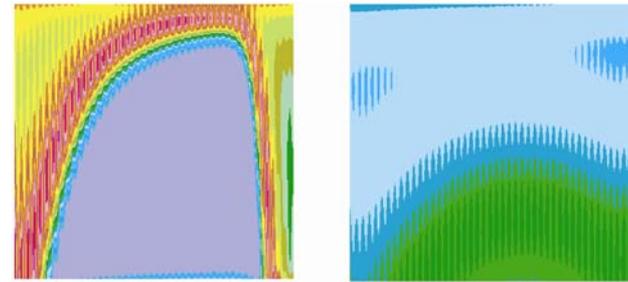
Tasks: Modeling

Putting it all together through modeling and testing

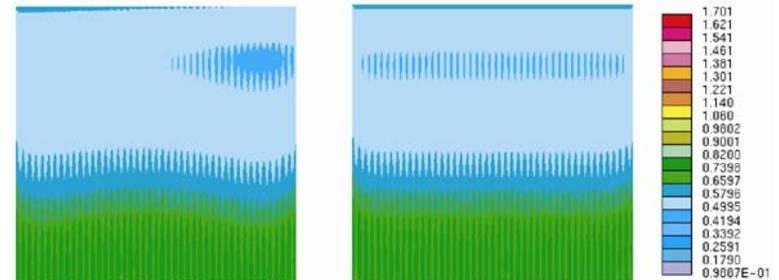
Current density distributions (0.6 A/cm^2)



Conventional cell Improved cell

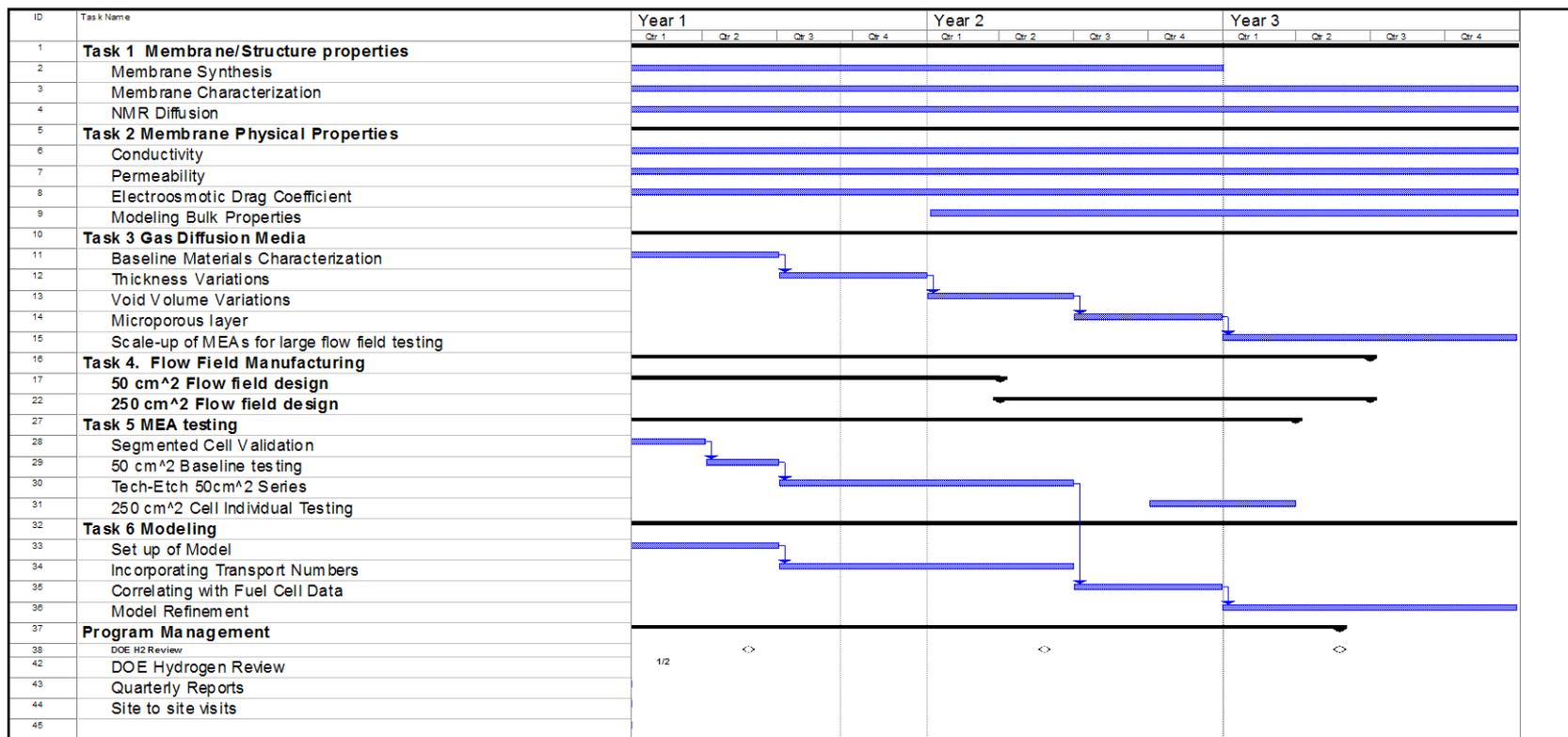


Optimum cell Ideal cell



Work Plan

Milestones to be worked out with Program Monitor



Work Plan

