Breakout Group 2: Membrane Electrode Assemblies

PARTICIPANTS

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GAPS/BARRIERS

- There is a lack of a direct relationship between the properties of the membrane electrode assembly (MEA) that is made and the ultimate performance
- Lack of fundamental understanding of all MEA components
  - Water transport
  - Gas transport
  - Electrical transport and properties
- Lack of measurement techniques
  - In-situ measurements
  - Interfacial properties
- Degradation mechanisms
- Electrolyte/Catalyst interactions and high temperature low relative humidity (RH) catalyst ionomer and catalyst interaction
- Water transport
- Better materials

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RD&D NEEDS

MODEL & MEASURE (fundamental data)	DEGRADATION MECHANISMS (especially for new materials)	ELECTROLYTE/ CATALYST INTERACTION AND HIGH TEMPERATURE/LOW RELATIVE HUMIDITY CATALYST IONOMER & CATALYST INTERACTION
• Need fundamental data on and understanding of all MEA components - Develop methods to quantify internal surface chemistry of porous materials (porosity, structure, etc.) - Measurements of mass transfer and electron transfer in each layer of MEA and through interfaces, as well as physical properties of MEA (or layers), as a function of temperature, RH and time, to validate models - Model electron, proton, and mass transfer (as function of temperature, RH and time) in each MEA layer and through interfaces: ▪ Electrode ▪ Membrane-electrode ▪ GDL-electrode ▪ GDL-bipolar plate ▪ Catalyst-support ▪ Catalyst-membrane ▪ Other multiple phase interfaces (other interfaces between phases in catalyst layer, GDL or membrane) - Macroscopic and nanoscopic (molecular level) interface characterization (property and composition distribution) - Models that determine MEA performance based on MEA components and structures	• Understanding of fundamental degradation mechanisms for known and new materials • Effects of impurities on degradation (especially air impurities) • How do chemical/mechanical structural changes affect performance? • How does high current density affect degradation?	• Modeling/study of ionomer/catalyst/support triple phase interface ▪ Electron transport ▪ Proton transport ▪ Gas transport ▪ Water mobility ▪ Interfacial adhesion • Modeling of electrochemistry and transport without water or proton solvent • Studies of ionomer/catalyst interactions - characterization and modeling of interactions • Modified electrode structures for non-traditional catalysts - can't expect non-PGM catalysts to behave like platinum • Modeling/study of the ionomer/catalyst/support triple phase interface

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RD&D NEEDS

MANUFACTURING/ PROCESSING (Lab scale to roll-to-roll processing and structure-manufacturing-performance relationships)	IMPROVED MATERIALS	TRANSPORT ISSUES	OPERATION AT INCREASED CURRENT DENSITY/ POWER DENSITY
• Develop structure-manufacturing-performance relationships • Develop on-line composition and characterization techniques, performance measurements • Develop simpler, more easily processed MEA structures (eliminating components, interfaces)	• Improved catalysts with higher activity and higher efficiency • Catalysts and catalyst layer ionomers that operate at high temperature and low RH • Improved membranes that operate hot and dry and cold and wet - Correlate morphology to properties such as conductivity, gas permeability, mechanical properties, etc. • More durable membranes, catalysts, supports, and gas diffusion layers	• Fundamental understanding of the role of the GDL • Develop measurement methods for - Porosity - Pore structure - Pore surface chemistry (hydrophobicity/ hydrophilicity, etc.) - Capillary pressure - Permeability - In-situ liquid water • In-situ measurements of electron and mass transfer in components and at interfaces, including - Water transport - Gas transport - Proton transport - Electronic transport	• Current density levels need to increase • New catalysts that provide higher current density/power densities • Develop methods to render 3-dimensional catalyst microstructures of nanoporous materials • Develop structure-composition-performance relationships for electrodes