ADVANCED DIRECT METHANOL FUEL CELLS

Co-Operative Agreement DE-FC02-98EE50536

Giner, Inc.

Presented at
DOE/ONR Fuel Cell Workshop

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DRAWBACKS OF PRESENT-DAY DMFC MEMBRANES

- Crossover - Loss of fuel from anode (methanol oxidation) to cathode (O_2 reduction) side of fuel cell

  Impact: Reduced fuel efficiency (parasitic fuel loss) Reduced cathode voltage resulting in reduced fuel cell power

- Cost - State-of-the-Art Nafion cost is $70/ft^2 ($340/kW based on LANL data) (0.37 V @ 600 mA/cm^2; 100°C, 30 psig; National Lab Review Meeting, June 1999)

  Impact: High cost of DMFC stack

BENEFITS EXPECTED FROM ADVANCED MEMBRANE DEVELOPMENT

- Improved DMFC Performance
- Improved DMFC Efficiency
- Lower Membrane and Membrane-Electrode Assembly (MEA) Cost, Relative to Nafion®

APPROACH TO MEMBRANE DEVELOPMENT

- Using pre-cross-linked fluorinated base polymers, graft select monomers with additional cross-linking if necessary, to the base film. Finally, sulfonate and hydrolyze to provide proton conductivity.

- Subsequent to membrane preparation, evaluate select chemical/physical membrane properties. Evaluate the most promising membranes in a complete LFDMFC.

Comparison of Membrane Properties

Property	Nafion 117[1]	s588-07-02[2]
Ion-Exchange Capacity (meq/g)	0.91	1.30
Water Content (%)	34.6	10.4
H^+ Resistivity (Ω-cm^2)	0.229	0.282
Thickness (dry) (mils)	7.4	5
N_2 Permeability $\left(\frac{cm^3\text{-}mil}{ft^2\text{-}hr\text{-}atm}\right)$	148.3	82.5
Crease/Crack	Pass	Pass

[1]Baseline Membrane
[2]Advanced Membrane

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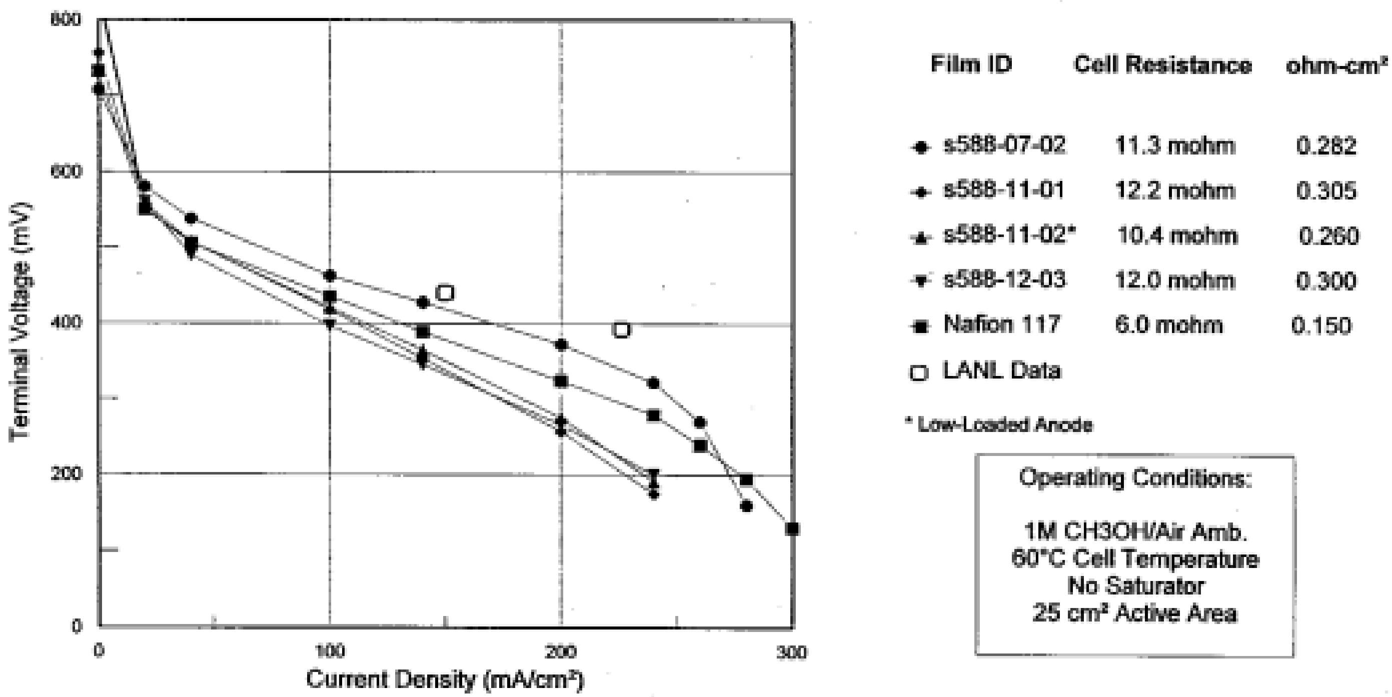

DMFC Performance of Advanced Membranes

Methanol Permeability and Fuel Cell Performance

Membrane Sample ID	MEA#	CH_3OH Permeability Equivalent Current Density (mA/cm^2) @100mA/cm^2, 60^oC, 1M CH_3OH	Cell Potential @ 100 mA, cm^2, CH_3OH/Air (mV)
s588-07-02	588-09-01	33	463
s588-11-01	588-14-01	32	417
s588-11-02[1]	588-14-02	42	421
s588-12-03	588-15-01	30	397
Nafion 117 (Baseline)	554-68-00	62	436

[1] low-loaded anode

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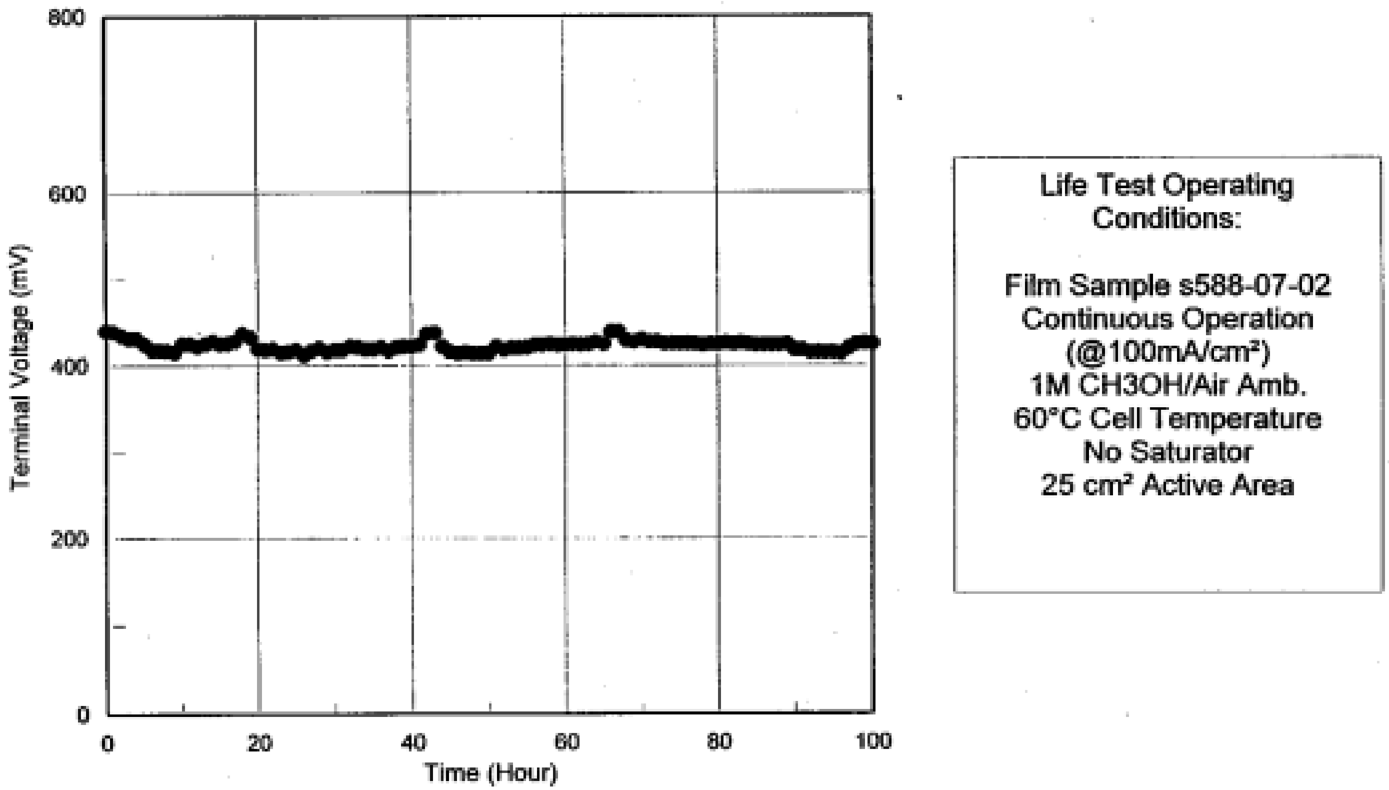

Short-Term Life Stability, Advanced Membrane

Economic Analysis

Item	Cost ($ per square feet)
Base Films	0.64 to 0.90
Radiation	0.04 to 0.12
Sulfonation	0.20
Monomers	0.50 to 5.00 per pound
Estimated Manufacturing Cost	1 to 2
Estimated Cost*, $/kW	4 to 9

* Based on 0.4 V @ 600 mA/cm^2; 90°C, 20 psig air, 1M CH_3OH