Integrated Manufacturing for Advanced MEAs
Kickoff Meeting at Forrestal Bldg
30 Oct 2001

DE NORA NORTH AMERICA INC.

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E-TEK *division*

Solicitation Topics and Division of Efforts

- Improved Cathodes (1A1): DNNA E-TEK Div (*Contractor*); Northeastern U. (*Subcontractor*)
- High Temperature Membranes (1A2): DuPont (*Subcontractor*)
- Advanced MEA Fabrication (1A3): DNNA E-TEK Div
- Verification of new technology at “stack element scale”: Nuvera FC (*Subcontractor*)
- Deliverable: Nuvera FC

Overall Program

- *Deliverable*: two short stacks whereby one operates with improved cathodes and the other operating at high temperature. Both are to be assembled with components fabricated via advanced MEA technologies
- Effort is four years
- Total effort is ~$20MM

Topic 1A1 Advanced Cathodes

- GOAL: *E-TEK is responsible for developing* <u>*new cathode alloys*</u> *and* <u>*ELAT® structures*</u> *that facilitate an overall cell performance of greater or equal to 0.4A/cm^2 at 0.8V or 0.1A/cm^2 at 0.85V operating on air with precious metal loadings of 0.05mg/cm^2 or less and scales to mass manufacturing technology.*

- Approach: for Catalyst identify methods of formation that best manipulate the relative abundance of crystal facets, using best method create alloys with enhanced populations of active crystallites; for gas diffusion and active layer create highly controlled gradients of porosity and hydrophobicity

1A1 Improved Cathode
Go / No Go

1. By Dec 2002 (FY03): Identify a catalyst preparation approach that provides a pathway for highly active catalyst or alloy catalyst for oxygen reduction with high metal loading on carbon support and/or demonstrate proof of principle of the fine gradient ELAT® ("fg-ELAT") leading to higher catalyst utilization.
2. By July 2003 (FY03): Identify a new catalyst and fg-ELAT system that shows significant improvement over current state-of-the- art. (1A3 Funding trip-point)
3. By March 2004 (FY04) Scale best system to 225cm^2 with performance validation at NFC

Topic 1A2 High Temperature Membranes DuPont

(Mark Roelofs: mark.g.roelofs@usa.dupont.com)

- GOAL: *DuPont is responsible for either a membrane capable of operating for at least 5,000 hours between 120 and 150°C, with cost target of $10/kW in high volume production and/or a membrane capable of operating for at least 20,000 hours between 120 and 150°C, with cost target consistent with projected a cost of $1,500/kW for the residential fuel cell system.*

- Approach: for 120°C, extend Nafion® chemistry with additives and/or ionomer modifiers; for 150° C, develop a new class of materials consistent with the Grotthus mechanism for proton transport.

1A2 High Temperature Membranes Go / No Go

1. By Dec 2002 (FY03): Operation of single element fuel cell at 120°C or greater.
2. By July 2003 (FY03): Either single cell operation at 120°C for over 1000 hrs, or proof of Grotthus Mechanism of conduction for assemblies operating at over 150°C. (1A3 Funding Trip point)
3. By March 2004 (FY04) Scale best to 225cm^2 with performance validation at NFC

Topic 1A3: Advanced MEA Fabrication

- Goal: *E-TEK will develop a MEA fabrication technology compatible with targets outlined for high temperature membrane (1.A.2) and improved cathodes (1.A.1) with a total precious metal loading of no more than 0.2g/peak kW.*

- Approach: Develop two application technologies, ultra-low level ink and ion beam deposition, and determine most suitable application methodology based on performance and total manufacturing cost; use stack level results to guide selection

1A3: Advanced MEA Fabrication Go / No Go

(Initiated upon satisfying either 1A1 or 1A2 trip points, begins FY04, Oct 2003)

1. By May 2004 (FY04): Demonstration that changes in membrane microstructure lead to highly active anode catalysts deposited directly on membrane though ion beam assisted deposition or demonstration that ultra-low loaded (<0.05mg/cm^2) membrane electrode assemblies are achievable using ink based coatings on the gas diffusion layer.
2. By Jan 2005 (FY05): Demonstration that the optimized cathode of 1A1 can be integrated into the best MEA fabrication methodology and complete MEA approaches DOE Program performance targets at 60 cm^2 scale.
3. By Sept 2005 (FY05) Deliverable: two short stacks, one operating at high temperature, other at normal temperature

Opportunity for Collaborations

New cathode alloys

Anticipate working with scientists at LBNL and BNL as well as others

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