INNOVATE NEW MEXICO® TECHNOLOGY SHOWCASE

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NEW MEXICO ECONOMIC DEVELOPMENT DEPARTMENT

new mexico MEP manufacturing extension partnership

Enabling the Disruption of the Next Generation Energy Economy via Advanced Membrane Technologies

Jeffrey S. Nelson
Sandia National Laboratories
jsnelso@sandia.gov

Sandia National Laboratories · STC.UNM · THE UNIVERSITY of NEW MEXICO · AFRL AIR FORCE RESEARCH LABORATORY NEW MEXICO · Los Alamos NATIONAL LABORATORY EST. 1943 · NEW MEXICO TECH SCIENCE • ENGINEERING • RESEARCH UNIVERSITY · NM STATE UNIVERSITY

RESEARCHERS AND FUNDING

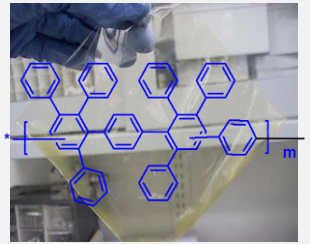
- **Cy Fujimoto**
  - Principal Member of Technical Staff
  - Organic Materials Science Department - 1853
  - Sandia National Laboratories
  - Polymer Membranes for Energy Technologies

- **Michael Hibbs**
  - Principal Member of Technical Staff
  - Microsystem Pkg & Polymer Processing Department - 1833
  - Sandia National Laboratories
  - Polymer Membranes for Energy Technologies

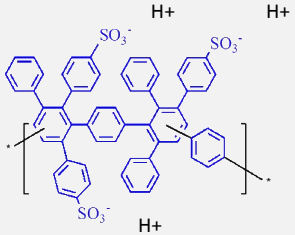
- **Funding**
  - Laboratory Directed Research and Development Program
  - DOE, Energy Efficiency and Renewable Energy – Fuel Cell Technologies Office
  - DOE, Office of Electricity – Energy Storage Program
  - DOE, ARPA-E
  - WFOs, CRADAs

THE INNOVATION

Sandia has developed disruptive polymer membranes for emerging energy markets



- Base structure of materials being developed at SNL – Poly(phenylene)
- Chemically most stable backbone without containing C-F bonds
- Versatile chemical functionalization



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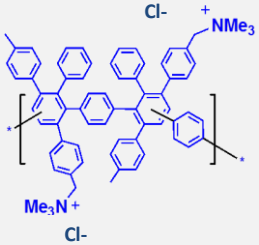

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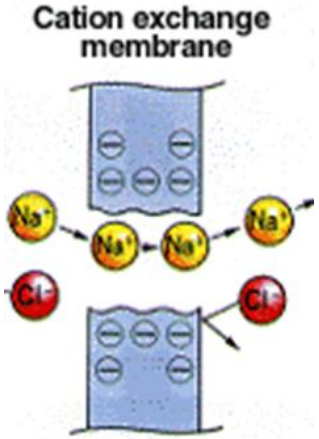
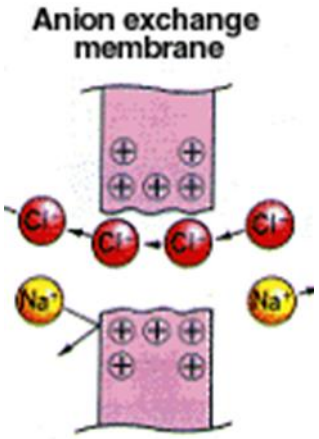


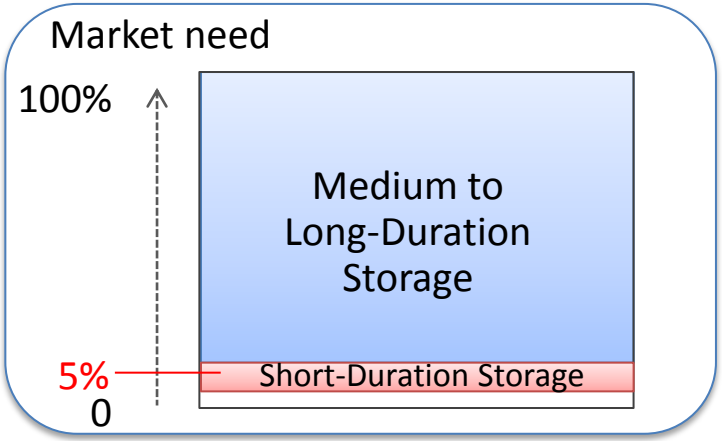


Background: Crucial Industry Need

Energy storage technologies—a key enabler of the next generation energy economy—have not kept pace with global industry needs

- ✓ Only 5% of Next Gen energy market will require short-duration storage (e.g. Li-Ion batteries)
- ✓ 95% of Next Gen energy economy will require medium to long- duration storage
- ✓ Current storage systems (e.g., Li-Ion) are unable to address medium to long-duration storage demands

Next Gen Energy Storage Requirements



Application: Burgeoning Market Sectors

Sandia membranes offer a unique, disruptive storage solution relevant across several key market sectors, and more

- **Flow Batteries**
  - Grid Support
  - Stationary Energy Storage
  - Energy Integration

- **Fuel Cells**

  - Stationary Energy Storage
  - Commercial and Residential Energy Systems

- **Alkaline Electrolysis**
  - Hydrogen Production
  - Stationary Energy Storage

- **Chemical Manufacturing**

  - Chlorine production
  - Other chemicals

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Next Gen Energy Market Is Huge. . . and Growing Fast

- **Key Target Markets**
  - Hydrogen Production
    $115B (2016) to $150B+ (2021)
  - Stationary Energy Storage
    $947M (2016) to $14B (2023)

- **Additional Opportunities**
  - Chloro-Alkali Production
    $85B (2016) to $100B+ (2021)
  - Fuel Cells
    $2B (2016)… growing to (by 2025-2035)
    - Transportation ~$18B- $97B
    - Stationary ~ $14B
    - Portable ~ $11B

Membrane
Total Addressable
Market
at
$2.5B+
by 2025-2030

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Data and Results:
Customers Confirm Our Advantage

WattJoule

	Power (mW/cm²)
Sandia	1159
Nafion	946

Usage: Flow Batteries

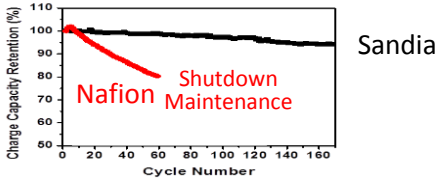
AUTOMOTIVE FUEL CELL COOPERATION

RH @ 85°C	Nafion (S/cm)	Sandia (S/cm)
30%	0.008	0.004
50%	0.019	0.022
95%	0.19	0.20

Usage: Fuel Cells

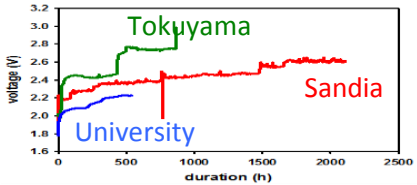
- ✓ Outperforms Nafion by ~ 25%
- ✓ Requires lower maintenance
- ✓ Allows for wider operating conditions
- ✓ Is significantly less costly

Pacific Northwest NATIONAL LABORATORY



Usage: Flow Batteries

PROTON
THE LEADER IN ON SITE GAS GENERATION.



Usage: Alkaline Electrolysis

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CURRENT STATUS

- ✓ Establish company & strengthen commercialization strategy
- ✓ Raise SEED round
- ✓ Look for light-lab space for membrane manufacturing, sampling & detailed characterization
- ✓ Secure and augment IP portfolio from SNL, LANL & others

For more information, contact:

Tom Brennan

ARCH Venture Partners