



Clean. Lightweight. Power.

University Research & Entrepreneurship Symposium

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Dr. Avni Argun ([argun@mit.edu](mailto:argun@mit.edu))

Nathan Ashcraft ([jnathan@mit.edu](mailto:jnathan@mit.edu))

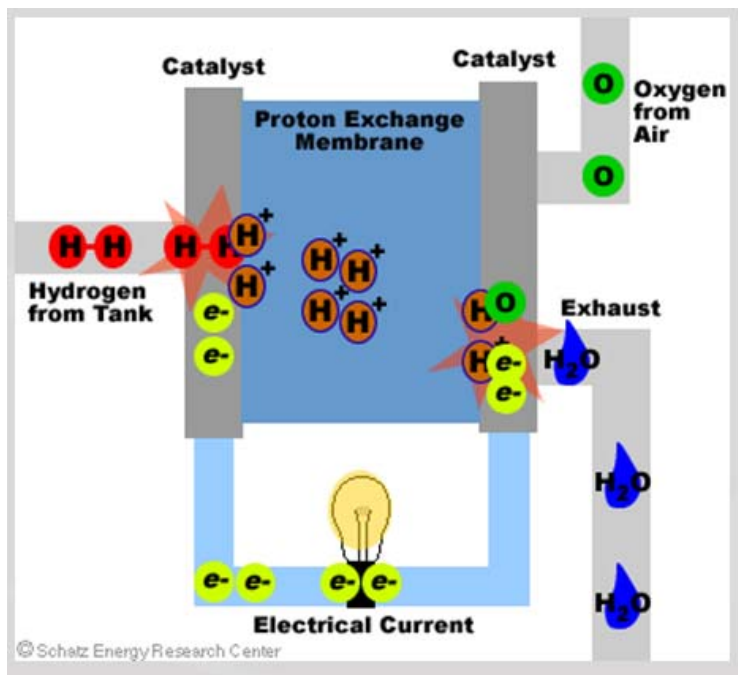
Ted Carstensen ([carstensen@sloan.mit.edu](mailto:carstensen@sloan.mit.edu))

Juliet Duffy ([jduffy@mit.edu](mailto:jduffy@mit.edu))

Amy Fazen ([amcknigh@mit.edu](mailto:amcknigh@mit.edu))

Dr. Meredith Fisher ([mcfisher@mit.edu](mailto:mcfisher@mit.edu))

# Fuel Cells Overview



## Fuel Cell Technology

- Clean, quiet, continuous energy
- Need for low temperature operation + low cost components
- Applications in both stationary and portable energy

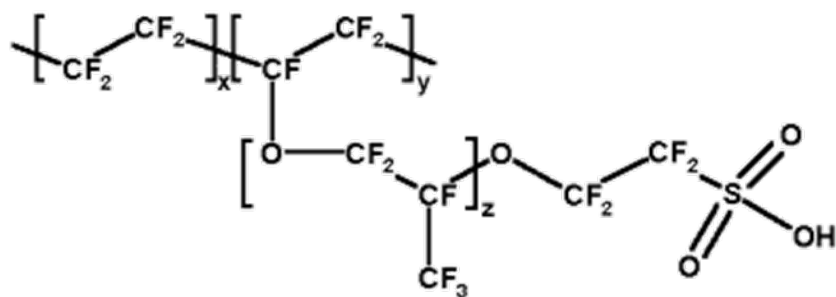
Fuel Cell	Fuel	Catalyst	Temp(°C)	Electrolyte	Power
Solid Oxide	Hydrocarbons	Nonprecious metal	600-1000	Ceramic	kW - MW
Phosphoric Acid	Hydrogen	Platinum	200	Liquid	kW
Proton Exchange Membrane	Hydrogen	Platinum	25-120	Polymer membrane	1-250 kW
Direct Methanol	Methanol	Platinum	25-60	Polymer membrane	100mW - kW

# Direct Methanol Fuel Cells / Membranes

## Critical Membrane Properties

High proton transport  
 Low fuel crossover  
 Cost Effective

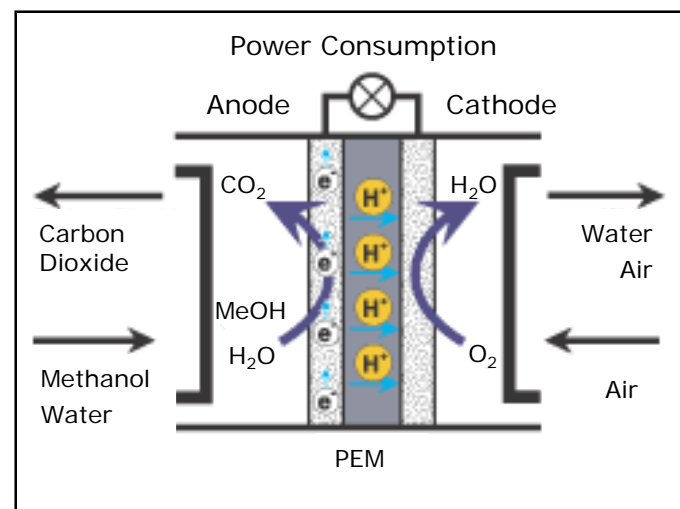
DuPont – Nafion®



High proton transport

**High fuel crossover**

**Expensive**



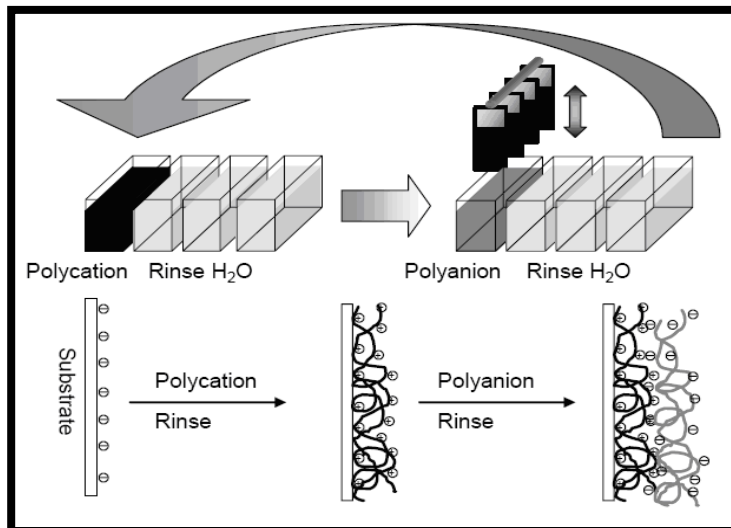
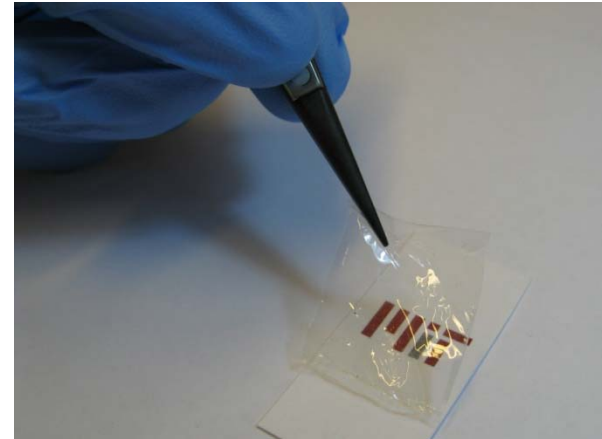
“Methanol crossover is the key issue for DMFC's”

-- Director of Advanced Technologies / Innovation Scouting, Merck

# DyPol is a solution anchored by proprietary membrane technology and robust manufacturing

## IP Positioning

US Patent Application & PCT  
filed through MIT TLO



## Layer-by-layer Assembly

- Versatile, cost-effective polymer membrane manufacturing technology
- Environmentally benign, water-based
- High-throughput processing using non-fluorinated, cheap polymers

“Researchers are trying to come up with more efficient membranes—and one group, led by Paula Hammond of the MIT, appears to have done so.”

-- The Economist (6/08)

# DyPol leads the DMFC membrane market in performance and price

## Low Cost

- Low raw materials cost
- Simple, water-based membrane processing at room temperature
- Less catalyst required

## High Efficiency

- 53% more power
- Best solution for 100 – 500 Watt-hr portable applications

## The DyPol Advantage

## Light Weight

- Higher fuel density allows for smaller, lighter devices

## Expertise

- US Patent / PCT filed through MIT Technology Licensing Office
- Inventors members of team

# Our first target market will be DMFC manufacturers of military portable electronics

## Target Markets for Military Applications

- Portable Radios
- Blue Force Tracker (GPS & 2 Way Radio)
- Unmanned Aerial Vehicles
- Land Warrior

## Target Customers (DMFC Manufacturers)

- MTI
- Polyfuel
- Smart Fuel Cell (SFC)
- Ultracell

## Military CAGRs 2007-2014

Total Portable : 25%

DMFC: 81%

“5 -10 years ago, a soldier on average would consume 3-4 watts of power on a typical mission. Today ... we’re seeing power numbers of around 20 watts.”

- Steve Slane, Chief of battery branch at CERDEC

## Department of Defense Wearable Power Competition

- Challenge: develop a long-endurance, lightweight power pack
- \$1M prize
- **DMFC technology** wins 1<sup>st</sup> place

On average, a soldier carries 20 lbs of battery weight – which outweighs his rifle ammunition and takes up more space

# DyPol's technology stacks up well against the competition

## DuPont – Nafion® Membranes

- Industry Standard
- 70% of fuel cell membrane market
- Expensive
- Performance issues in DMFCs

## PolyFuel Membranes

- Startup, spun out of SRI in 1999
- 2007 revenues of \$1.4M

Batteries are not the enemy

- Battery-DMFC hybrids
- DMFCs as battery chargers

“The problem with Dupont’s Nafion is that it’s so expensive. If you could produce a membrane with equivalent performance at a lower cost, it would be very attractive.”

-- Gary Colello, CEO Premium Power

### DyPol Advantages:

**Cost:** Use less catalyst

**Cost:** Cheaper membrane

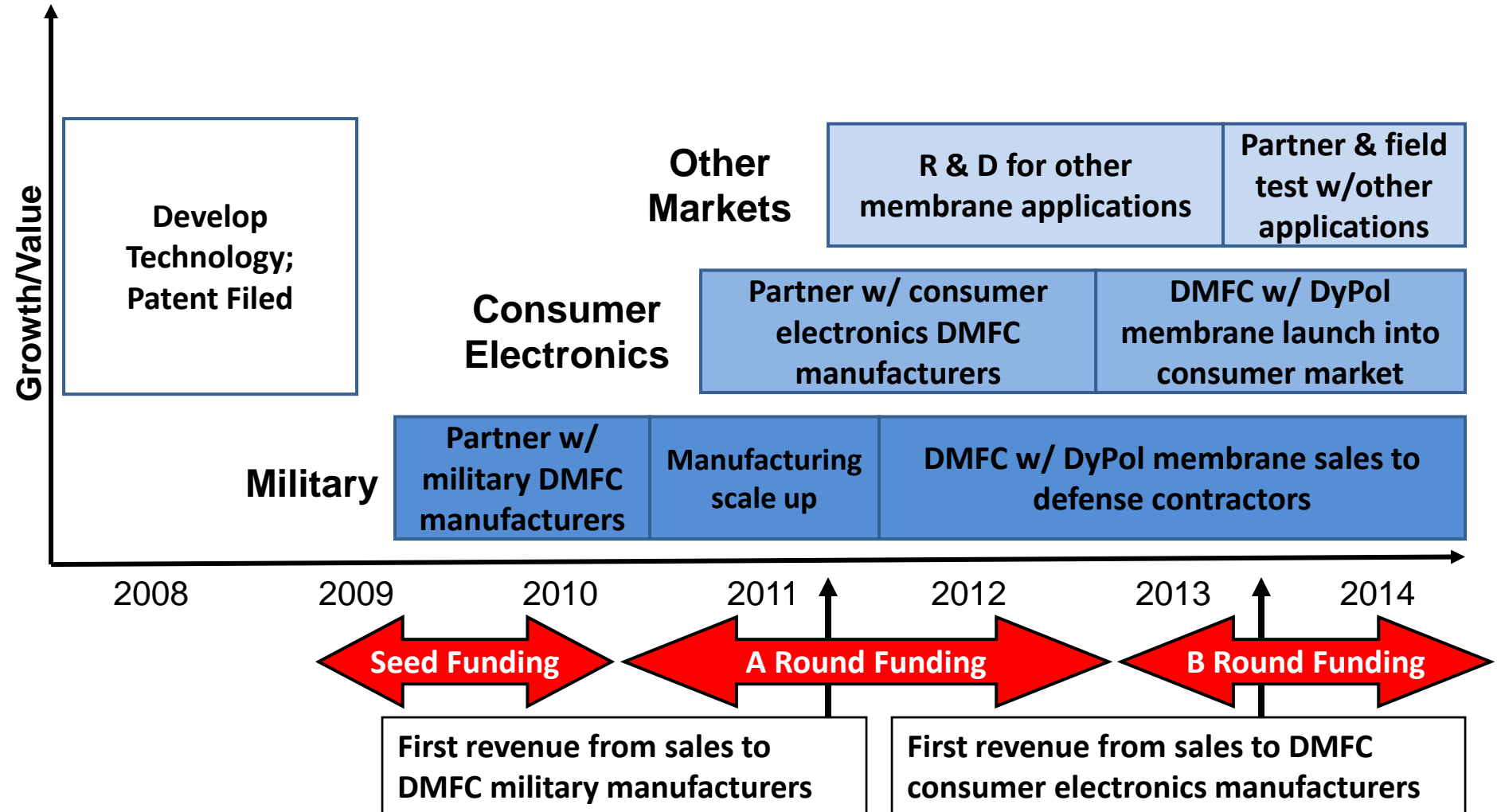
**Performance:** 53% more power output

**Manufacturing:** Flexible layer-by-layer assembly

**Environmentally Friendly:** Water-based membrane assembly vs. harsh solvents

DyPol based DMFCs will lead in performance and price

# DyPol Development



DyPol will develop high-performance DMFC membranes for military and consumer use while continuing to develop membrane technology for other applications



# Our team blends industry experience with MIT science

## Current Team

### Avni Argun, PhD

- PhD, Chemistry, Florida; Postdoc, Chemical Engineering, MIT

### J. Nathan Ashcraft

- PhD Candidate, Chemical Engineering, MIT

### Ted Carstensen

- MBA Candidate, MIT Sloan

### Juliet Duffy

- MBA Candidate, MIT Sloan; MS Candidate, Chemical Engineering, MIT

### Amy Fazen

- MBA Candidate, MIT Sloan

### Meredith Fisher, PhD

- PhD, Biology, Harvard; MBA Candidate, MIT Sloan;

## Current Company Relationships

### Fuel Cell Companies/Customers

- Nuvera
- General Motors
- Giner
- TIAX

### Military

- Natick Soldier Systems
- Army personnel
- Navy personnel
- Marine personnel

### Membrane Manufacturers

- Koch Membranes
- Sigma-Aldrich
- Porogen
- Merk

### Consumer Electronics

- Apple

## Future Team

- |                          |                     |
|--------------------------|---------------------|
| • CEO                    | • R&D               |
| • Membrane Manufacturing | • Sales & Marketing |

### Science Advisor Paula Hammond, PhD



- Bayer Chair Professor, Chemical Engineering, MIT
- PhD, Chemical Engineering, MIT

We are positioned to move quickly and successfully with 15+ years of business experience and proven MIT technology