PolyFuel™

DMFC Power Supply for All-Day True-Wireless Mobile Computing

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Project ID# FC33

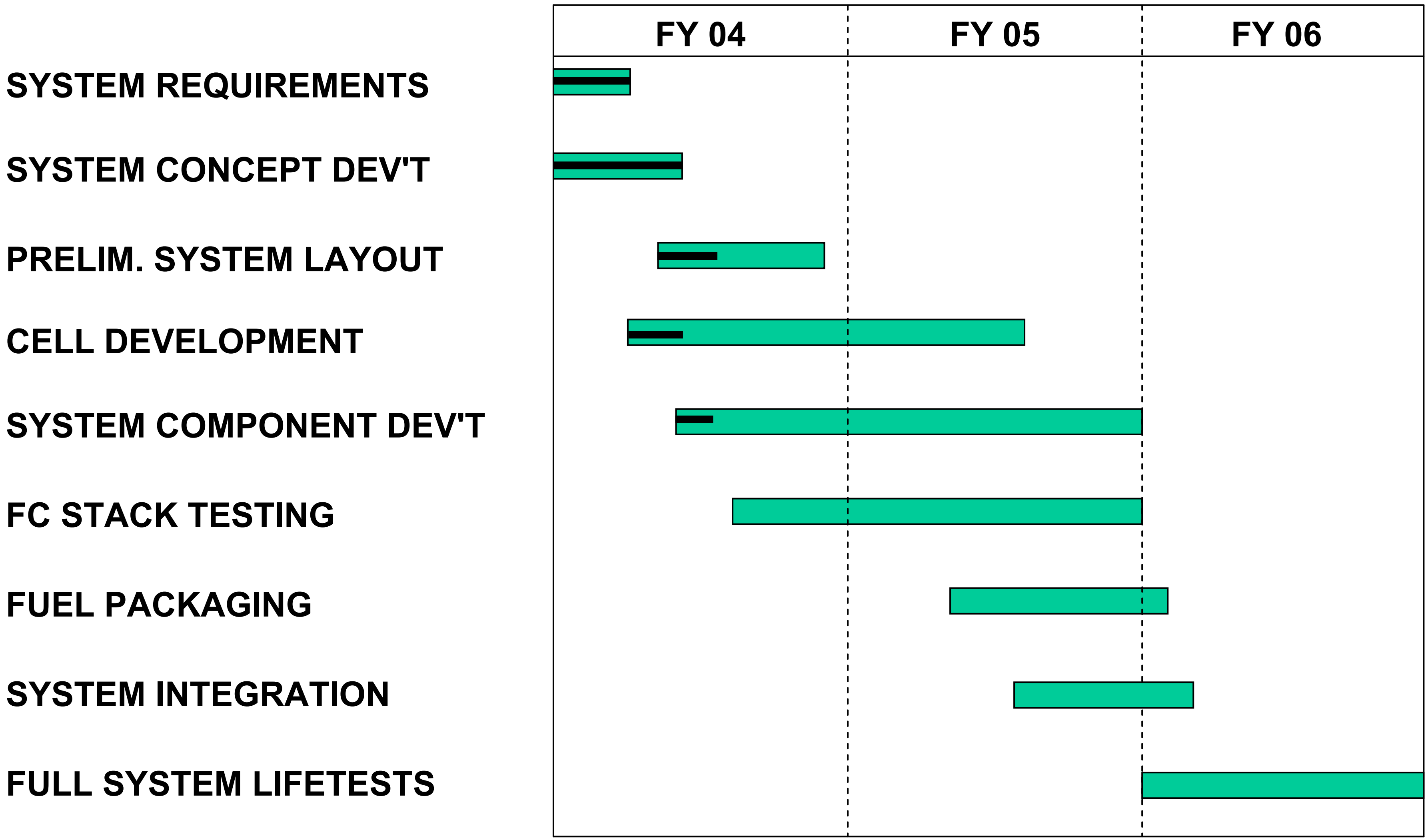
PolyFuel™

Project Budget & Technical Targets

Year	PolyFuel Share	DOE Share	Budget Amount
Sept. '04 – Sept. '05	$1,048,000	$941,668	$1,990,000
Sept. '05 – Sept. '06	$1,265,000	$1,135,000	$2,400,000
Sept. '06 – Sept. '07	$1,028,000	$922,000	$1,950,000
Total	$3,340,000	$3,000,000	$6,340,000

- **Volumetric Power Density: > 30 W/l**
- **Gravimetric Power Density: > 30 W/kg**
- **Energy Density: > 500 W·h/l**
- **Cost: < $5/Watt**
- **Lifetime: > 1000 hours**

Project Timeline

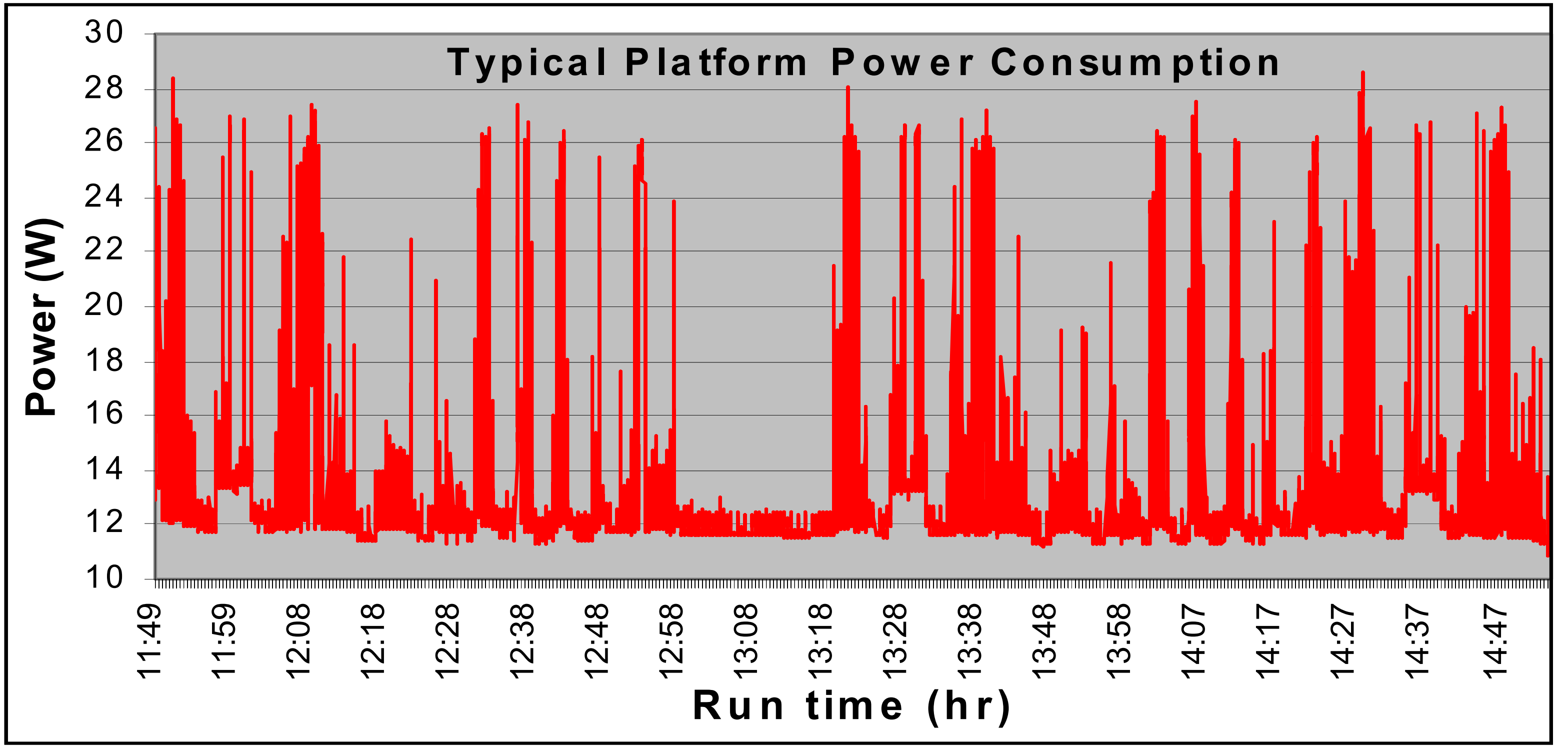


Objectives

- To build a DMFC laptop power supply with a significant advantage over Li-ion batteries
- To fully integrate this power supply into a laptop computer
- A radical departure from conventional active systems is required to realize competitive power density

Requirements Definition

- Average Power Level: 15 Watts
- Peak Power Level: 40 Watts
- Voltage: 8.0 - 12.6 Volts, with 10.8 Volt nominal
- Requires Fuel Cell – Battery hybrid design



Requirements Definition

- Operating Life: 1000 hours or 125 refueling cycles
- Cost: Less than $100 per unit at 100,000 per year
- Ambient Temperature: +5 °C to +40 °C
- Orientation Independent
  - Must run while tilted or inverted
- Fuel cell system volume: 250 cc
- Methanol cartridge volume: 120 cc
- Fuel: pure or nearly pure methanol
- Maximum noise level: 40 dbA at 0.5 meter

Project Approach

The best system will involve co-optimization of membrane properties and system strategy

PolyFuel is approaching the problem from both sides

System/Cell

"What membrane properties are required by the cell/system?"

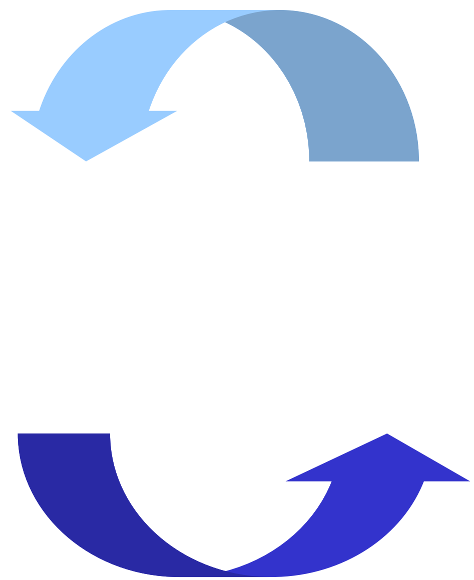
Operating Strategy

Electrical Architecture

Water management

Thermal Management

Packaging



Membrane

"What conditions are required by the membrane?"

Conductivity

MeOH crossover

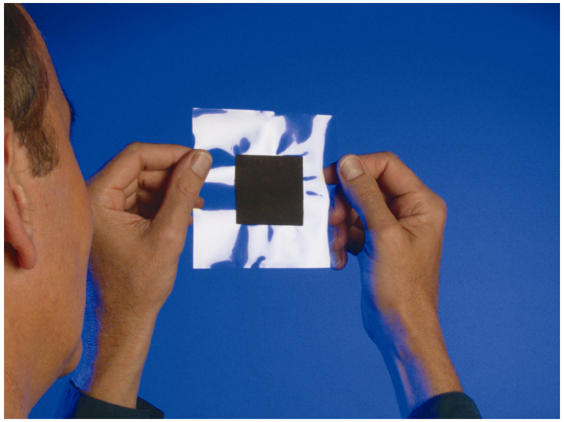
Diffusivity

Mechanical Strength

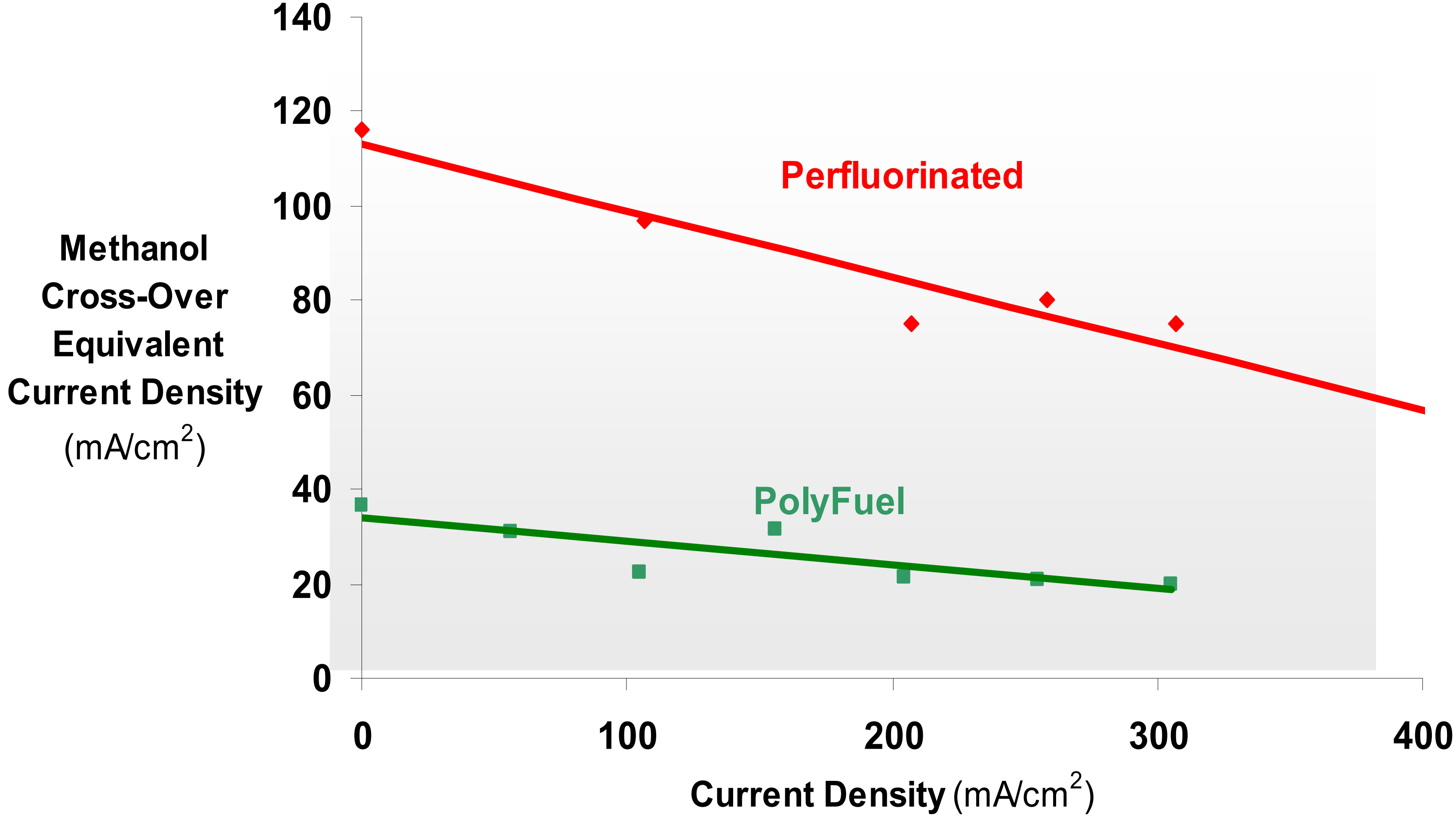
Bonding

Membrane Development

- **25 prototype polymers have been made and cast into membrane**
- **These materials are being screened for desired properties in a variety of in-situ and ex-situ tests**
- **Ex-situ screening tests include:**
  - Conductivity
  - Diffusivity (methanol, water)
  - Tensile strength
  - Chemical stability
- **In-situ screening tests include:**
  - Performance on PolyFuel standard cell design at 1M methanol
  - Methanol crossover
  - Electro-osmotic drag (EOD)

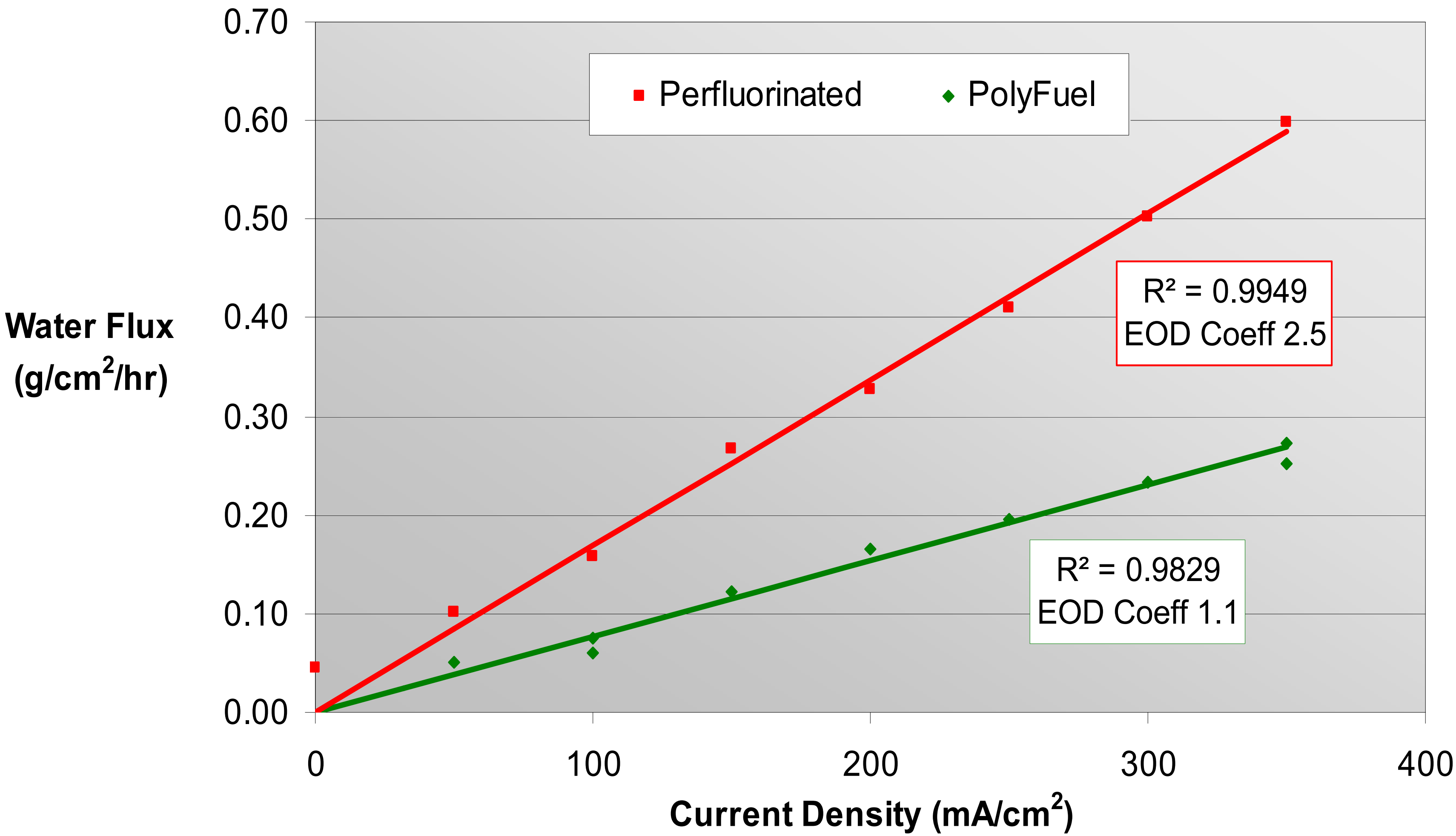


PolyFuel Methanol Cross Over Comparison



Note: *Standard PolyFuel Active Test Cell Conditions used*

Water Flux

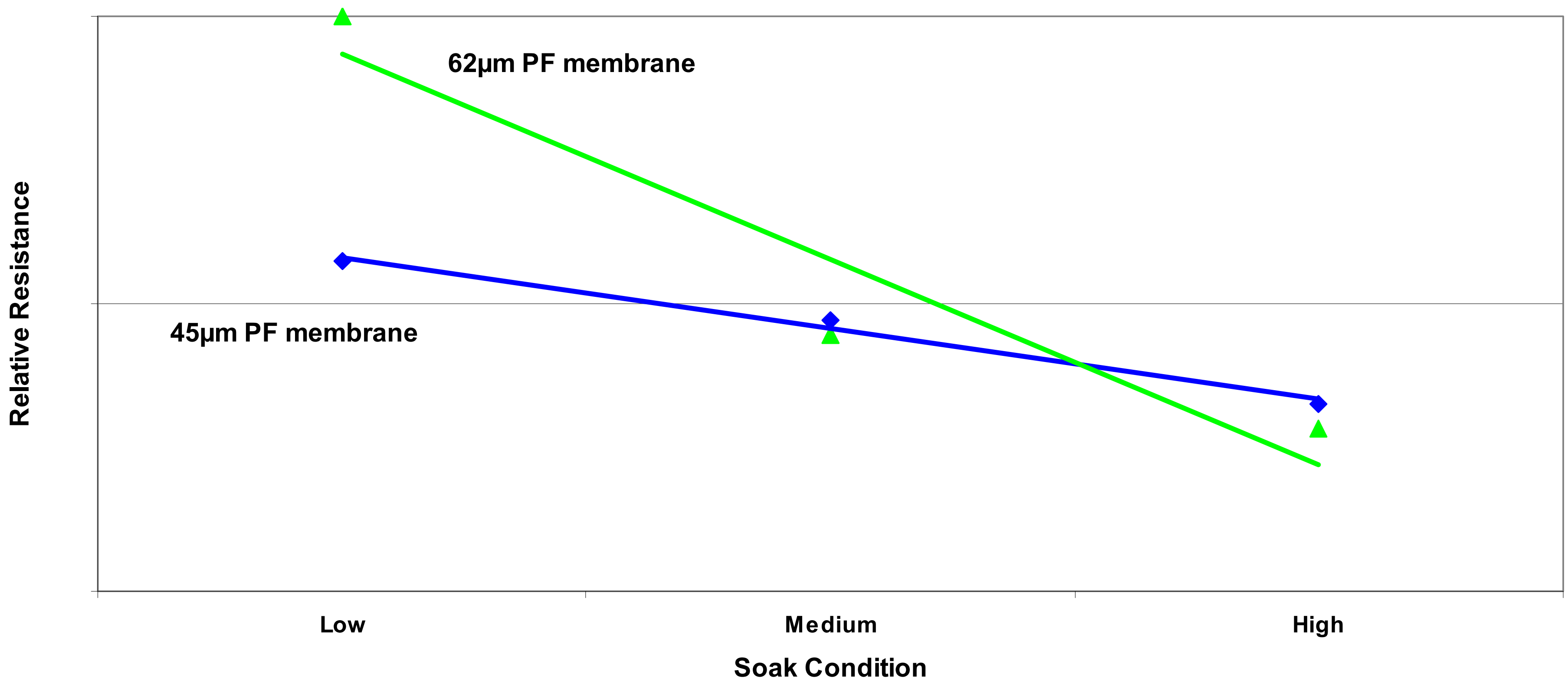


Note: *Standard PolyFuel Active Test Cell Conditions used*

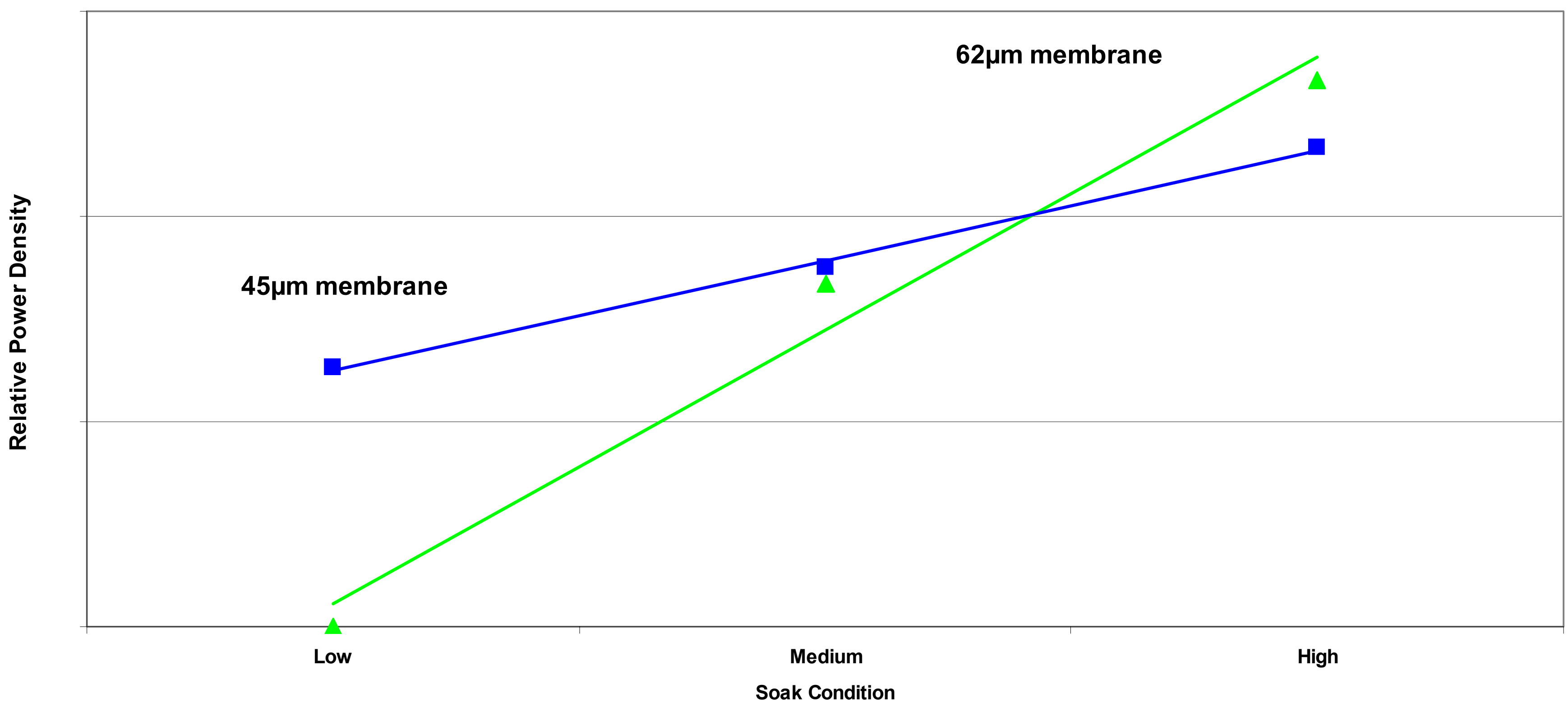
PolyFuel Hot Bonded Membrane

- Hot bonded membrane allows for simpler cell assembly with lower cell compression
- PolyFuel has developed a hot bondable membrane with good properties for passive type DMFC applications
- The pretreatment conditions need to be matched with the hot press bonding conditions

Effect of Presoak conditions on cell resistance



Relative performance of cells depends on Hot Press Conditions



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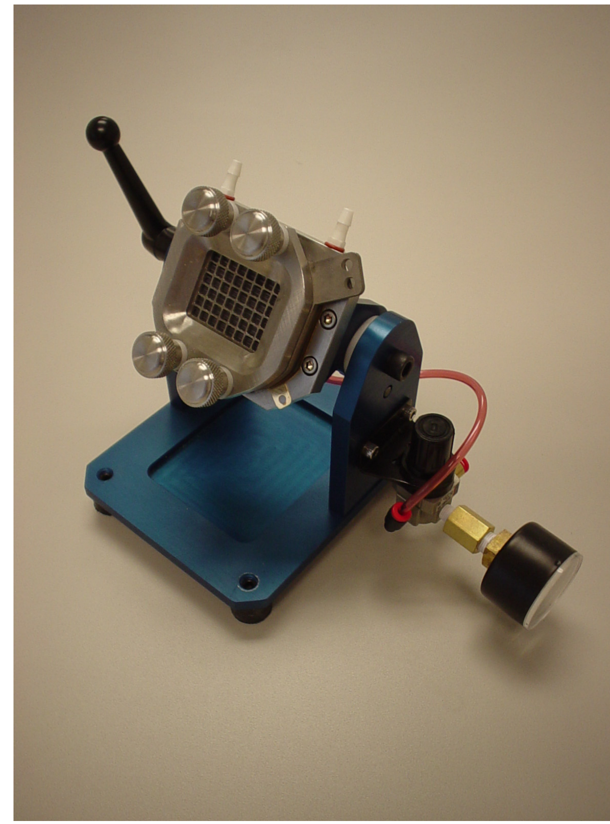
System/Cell Development

- **System (thermal and fluid) performance model complete**
- **Variety of system and cell architectures have been evaluated**
- **A preferred architecture has been downselected based on multiple criteria:**
  - Packaging (into a laptop)
  - Thermal management
  - Water management
  - Power density
- **Key membrane properties have been identified**

Air Breathing Reference Hardware

Designed, built and installed 12 test stations for air breathing cell testing



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Future Work

- Develop cell performance model, including multi-species transport and 2 phase flow effects
- Build system-intent cell array and conduct performance and durability testing
- Develop fuel delivery, oxidant delivery, cooling subsystems
- Develop power conditioning and power integration with laptop battery and laptop electronics

Hydrogen Safety

Major concern is large hydrogen leak into lab

- Excess flow valve at bottle
- Restrictor orifice limits total H_2 flow into lab manifold to ~20 SLPM
- Small onsite hydrogen inventory such that leaking the entire contents will not exceed 50% LEL
- Large fan in lab area aids in convective mixing of H_2 to dilute any leak
- Hydrogen detector in lab