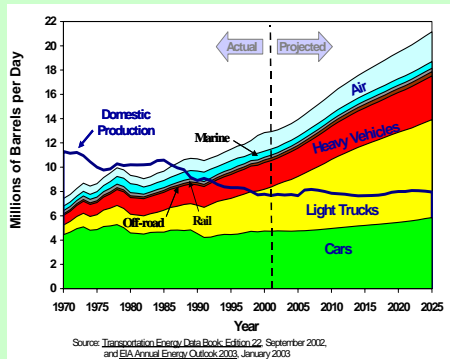


# Testing and Evaluation of Metallic Bipolar Plates for PEM Fuel Cells

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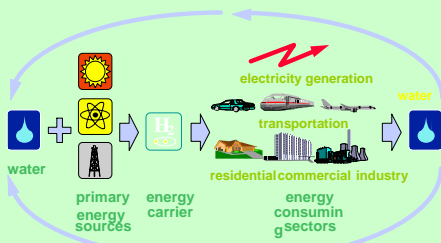
## MOTIVATION

- High oil cost threatens our national economy
- Hydrogen fuel cells promised clean and efficient alternative energy
- Bipolar plates that represent the backbone of the PEM fuel Cell are currently made of graphite or graphite composites that are brittle, permeable to gases, and have poor manufacturability and conductivity relative to most metals
- Metallic bipolar plates hold excellent potential for durability and cost effectiveness



- Transportation accounts for 2/3 of the 20 million barrels of oil our nation uses each day.
- The U.S. imports 55% of its oil, expected to grow to 68% by 2025 under the status quo.
- Nearly all of our cars and trucks currently run on either gasoline or diesel fuel.

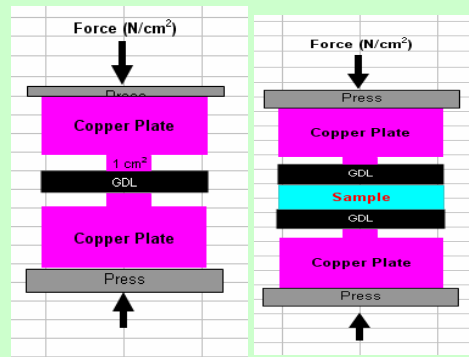
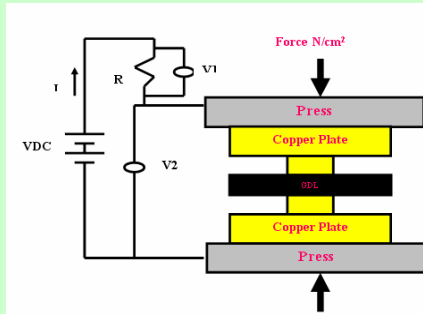
## Hydrogen Economy or Hydrogen Energy System



## Types of Fuel Cells

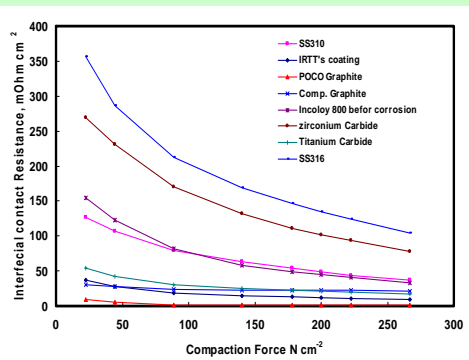
Fuel Cell Type	Electrolyte	Anode Gas	Cathode Gas	Temp.	Efficiency
Proton Exchange Membrane (PEM)	Solid Polymer Membrane	Hydrogen	Pure or Atmospheric Oxygen	75 C 180 F	35-60%
Alkaline (AFC)	Potassium Hydroxide	Hydrogen	Pure Oxygen	Below 80 C	50-70%
Direct Methanol (DMFC)	Solid polymer membrane	Methanol solution in water	Atmospheric oxygen	75 C 180 F	35-40%
Phosphoric Acid (PAFC)	Phosphorous	Hydrogen	Atmospheric oxygen	210 C 400 F	35-50%
Molten Carbonate (MCFC)	Alkali-Carbonates	Hydrogen, methane	Atmospheric oxygen	650C 1200 F	40-55%
Solid Oxide (SOFC)	Ceramic Oxide	Hydrogen, methane	Atmospheric Oxygen	800-1000 C 1500-1800 F	45-60%

## Contact Resistance Experimental Setup

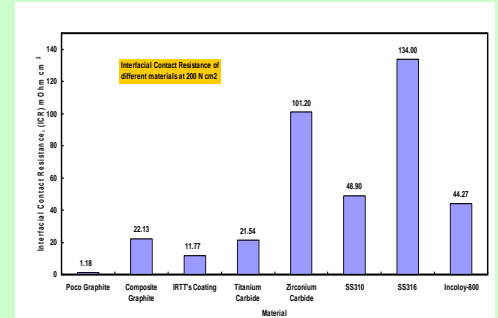


### Contact Resistance Measurements calculation

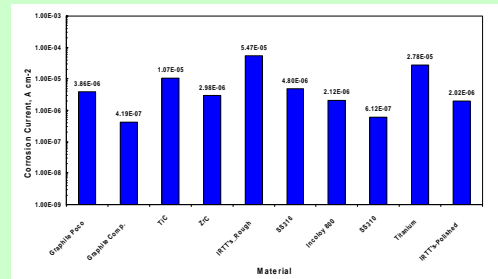
- X1 = Contact resistance between copper and gas diffusion layer (GDL)
- X2 = Contact resistance between bipolar plate and gas diffusion layer (GDL)
- $R1 = X1 + X1 = 2(X1)$
- $R2 = X1 + X2 + X2 + X1 = 2(X1) + 2(X2)$
- $X2 = [R2 - 2(X1)] / 2 = (R2 - R1) / 2$



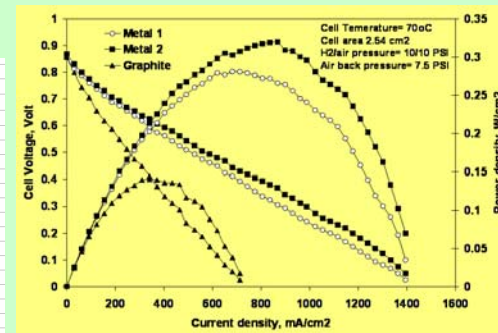
Interfacial Contact Resistance Milli-Ohm.cm2



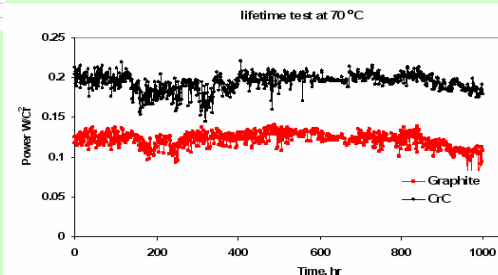
Interfacial Contact Resistance Milli-Ohm.cm2 at 200 N/cm²



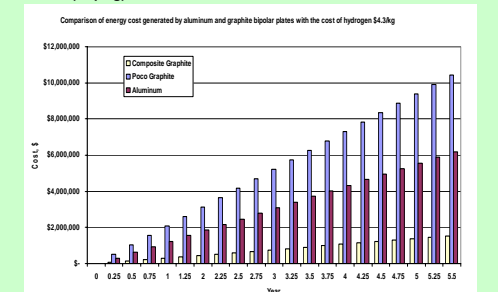
Corrosion Current for Various Materials Amp/cm²



Polarization and Power Curves for Metallic and Graphite Bipolar Plates



Lifetime testing of Metallic and Graphite Composite Bipolar Plates for 1000 hrs Under Identical Operating Conditions (70 Degree C, ) airflow rate of 470 SCCM (8 SCFH) with back pressure of 0.52 Bars (7.5 psig), hydrogen pressure of 0.69 Bars (10 psig)



Cost Analysis and Comparison between Metallic and Graphite Bipolar Plates