Fuel Cell Cadet Capstone Research

PRESENTED BY

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OUTLINE

- Background
- Construction
- Results
- Conclusion

BACKGROUND

- **Fuel Cell are gradually becoming the alternative energy solution for the future. As of today some of the practical applications of fuel cells are: automobiles, buses, home power generation, and portable power such as laptops and cell phones.**

- **The goal of this capstone project was to develop and construct a fuel cell stack system that will run on both hydrogen and methanol and produce 12 volts and 12 watts. This power requirement was set by an electrical engineering capstone which was developing a remote security system.**

BACKGROUND

- Preliminary research on existing fuel cells, developed by MAJ Plummer and ARL research scientist Dr. Chu and Dr. Jiang, assisted in establishing a design and configuration for the fuel cell stack.
- Although most of the research, testing, and, development was performed at the CME fuel cell lab, the team still needed to travel to ARL to make the membrane electrode assemblies (MEA) for each fuel cell stack.
- This is the first year that mechanical engineering students have been able to participate in a capstone which required extensive testing, development, and construction of fuel cells. This capstone is a progressive project that will continue over the next few years. At the end of the school year our tem will pass this project on to members of the class of 2005.

BACKGROUND

Direct Water Methanol Fuel Cell

$CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$

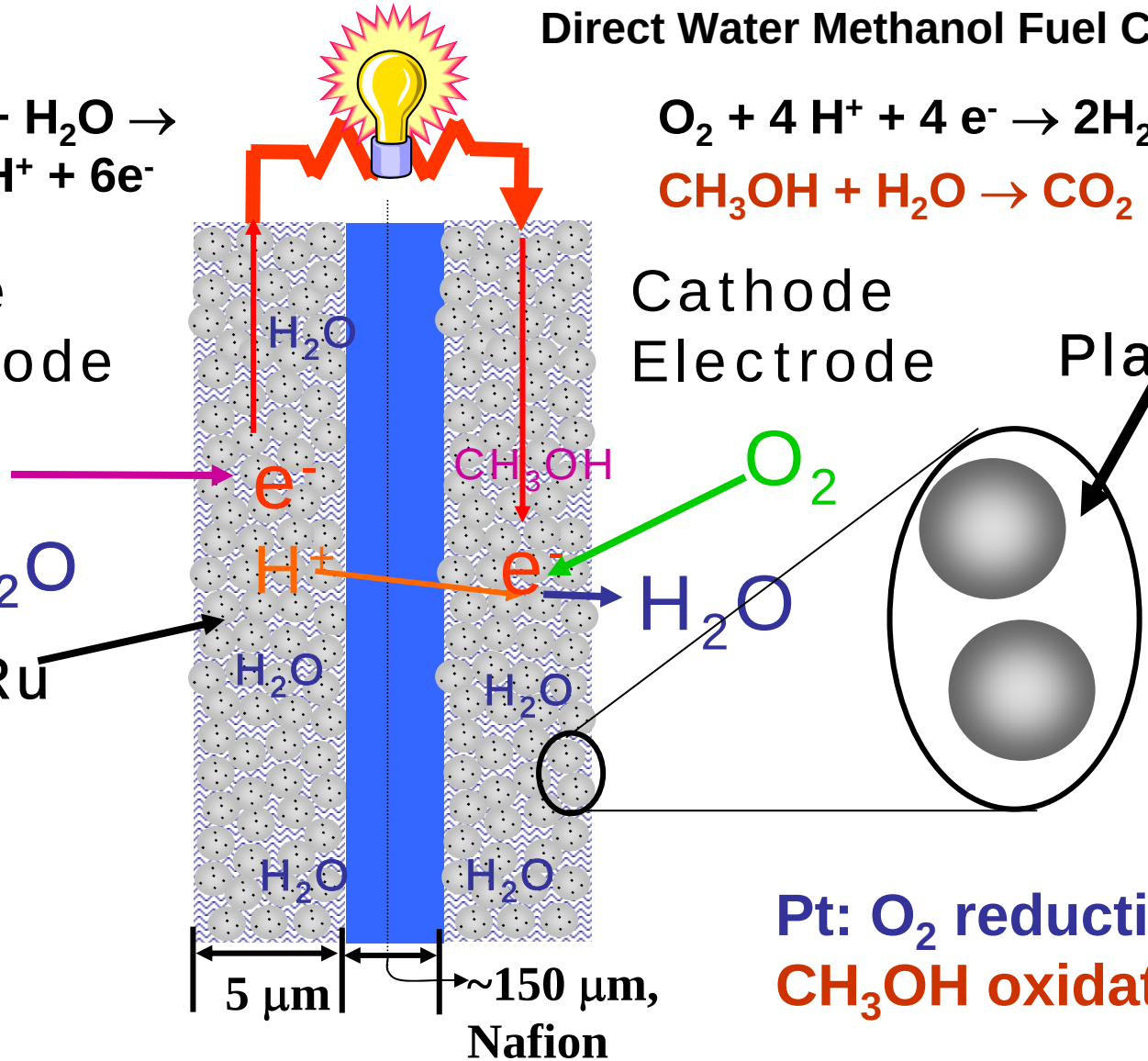
$O_2 + 4\,H^+ + 4\,e^- \rightarrow 2H_2O$

$CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$

Anode Electrode

Cathode Electrode

Platinum



with H_2O

Pt-Ru

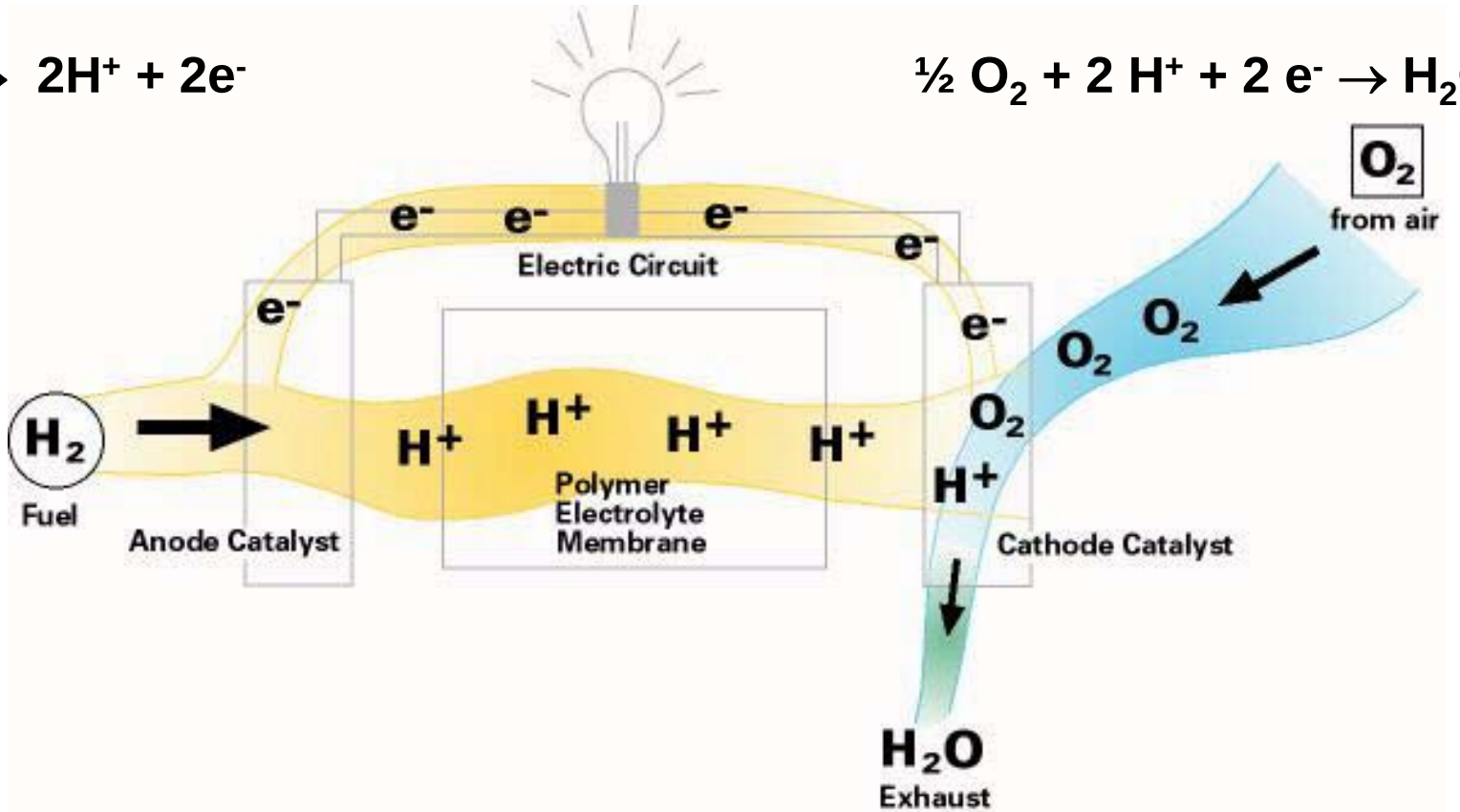
Pt: O_2 reduction and CH_3OH oxidation

BACKGROUND

Hydrogen Fuel Cell

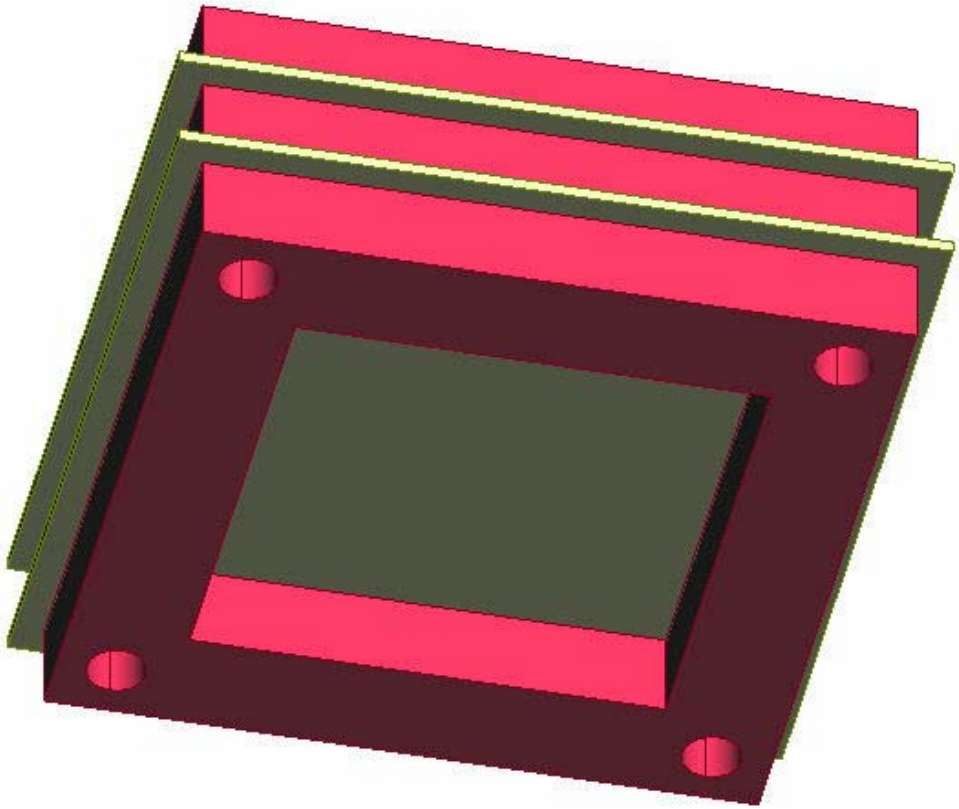
$H_2 \rightarrow 2H^+ + 2e^-$

$\frac{1}{2} O_2 + 2 H^+ + 2 e^- \rightarrow H_2O$



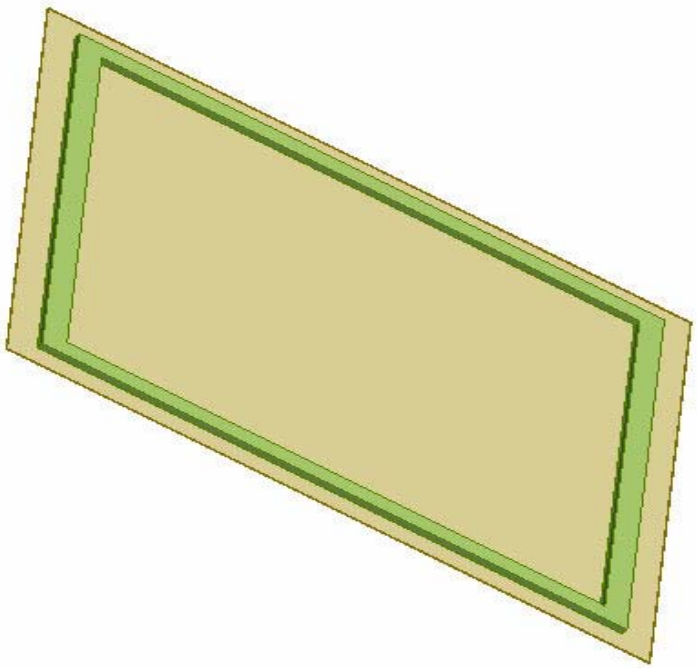
BACKGROUND

Preliminary Design #1



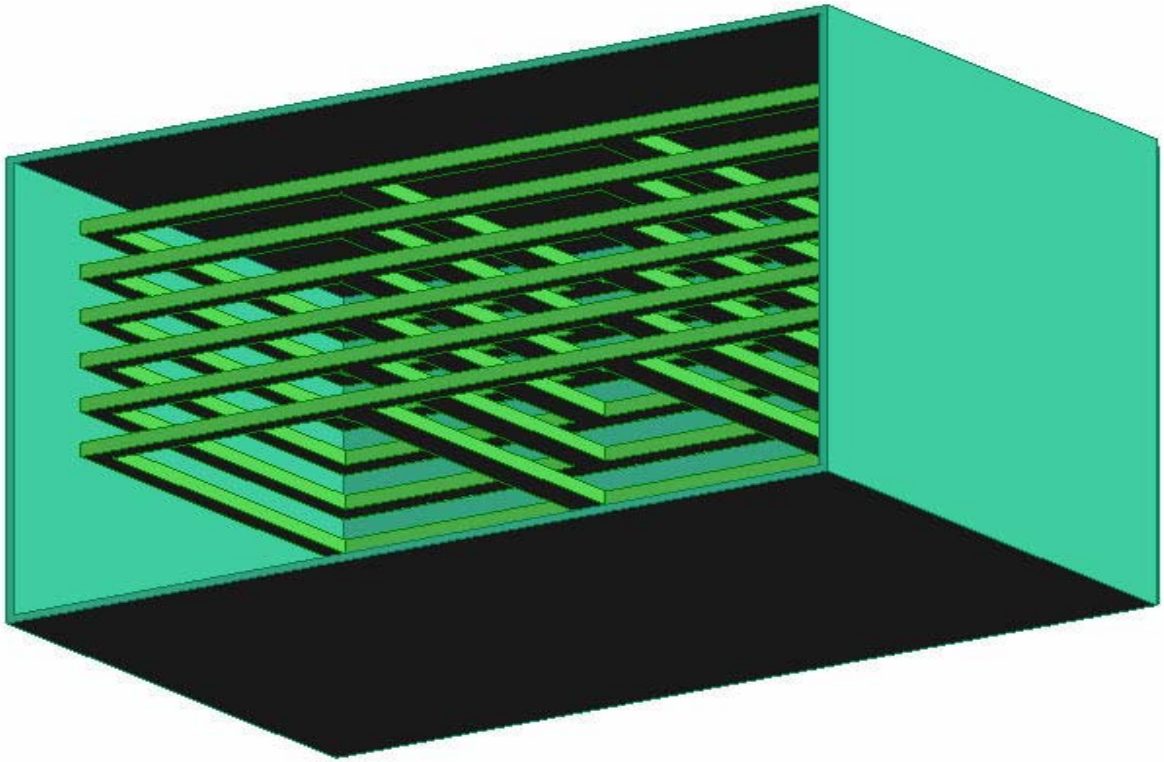
BACKGROUND

Preliminary Design #2



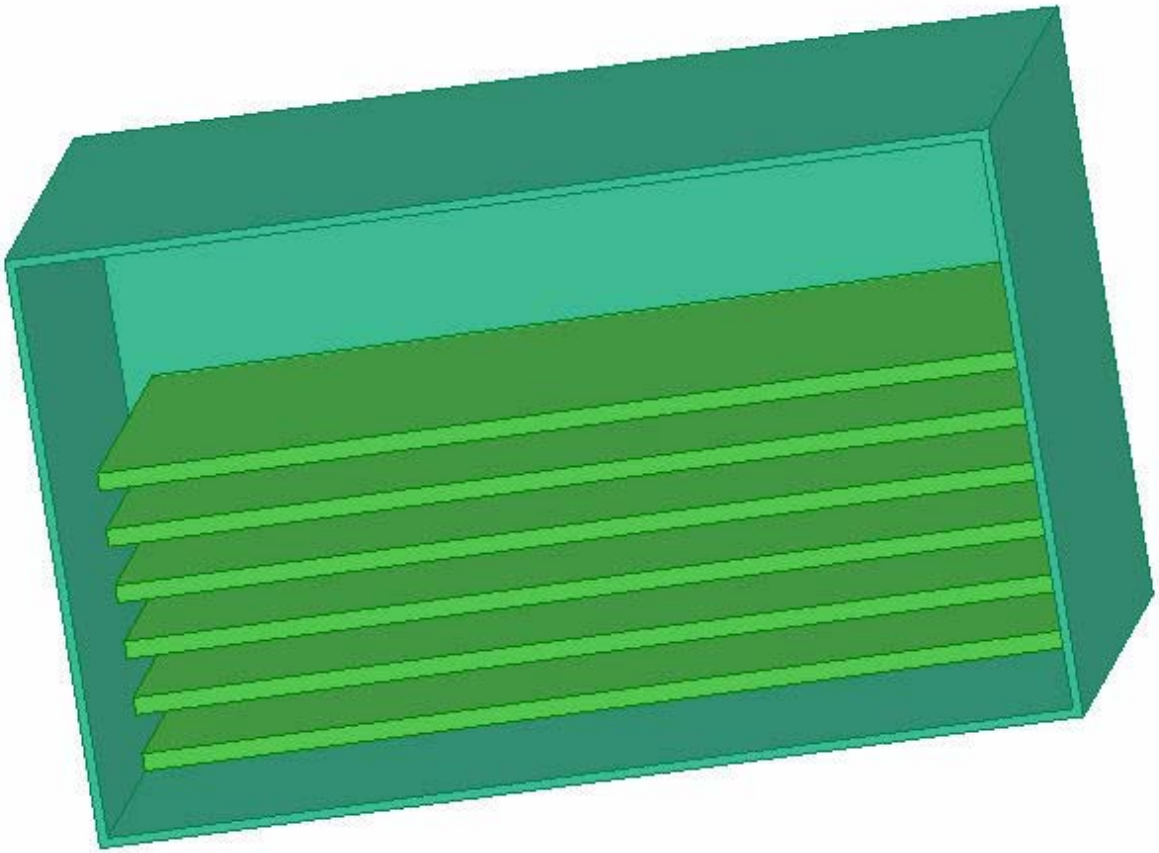
BACKGROUND

Preliminary Design #3

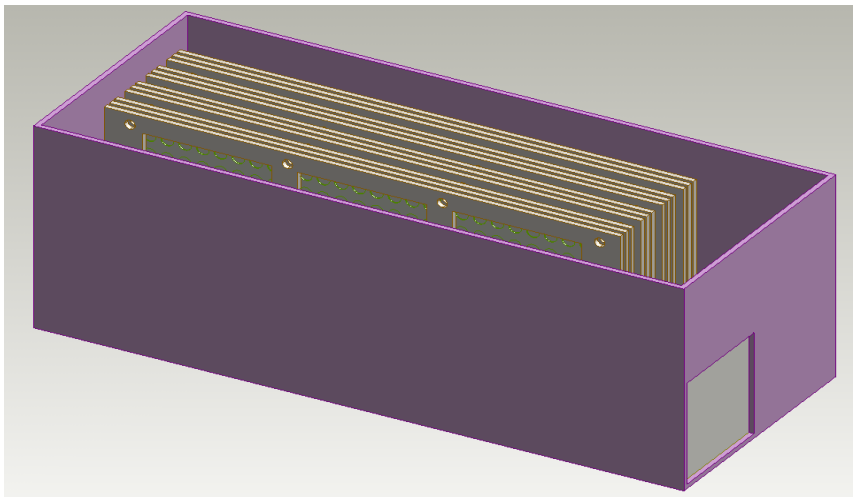


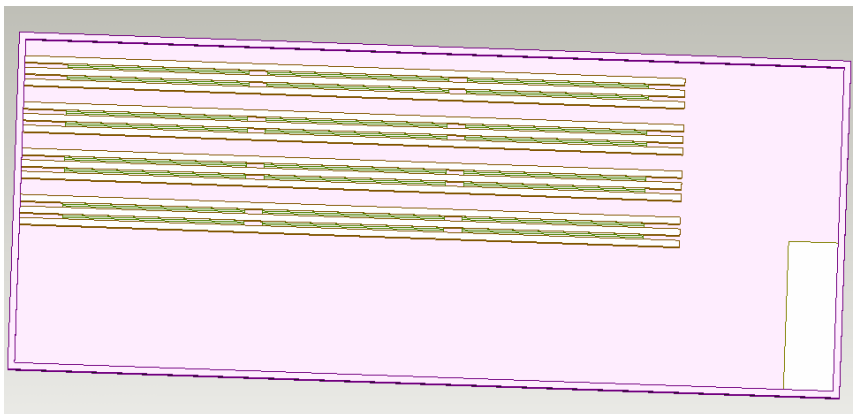
BACKGROUND

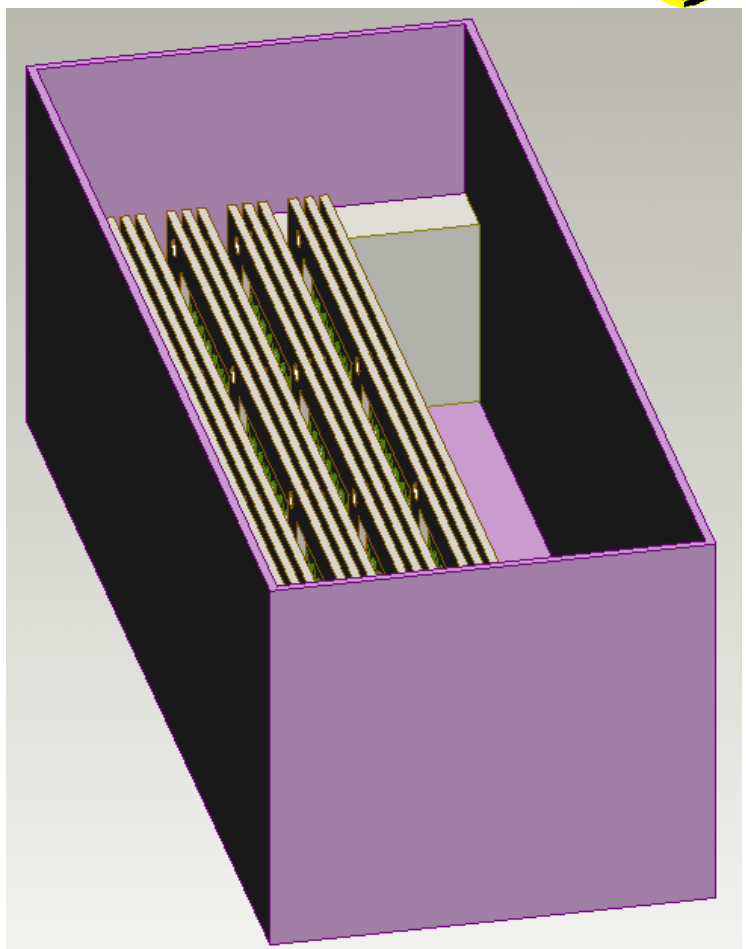
Preliminary Design #3
(from last semester)



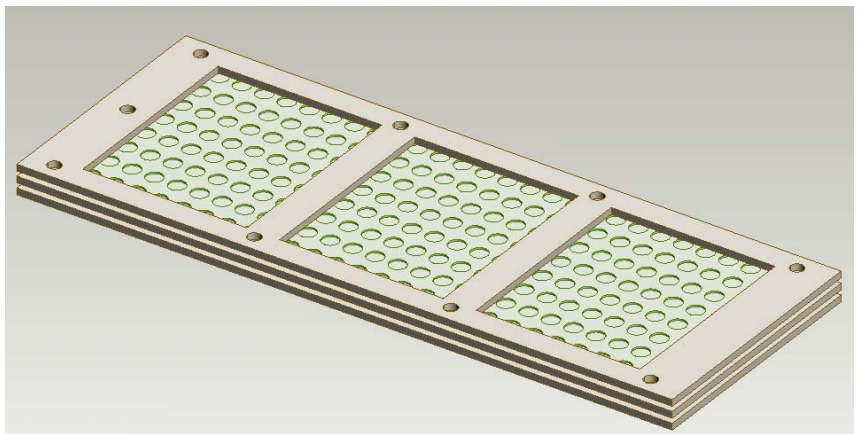
BACKGROUND

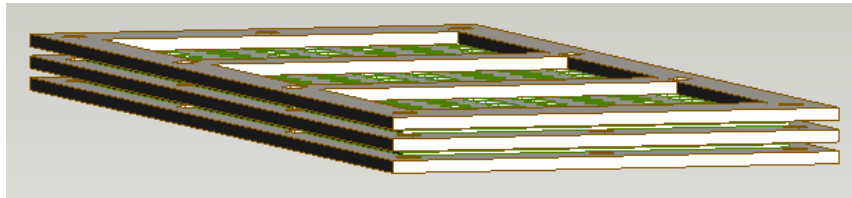


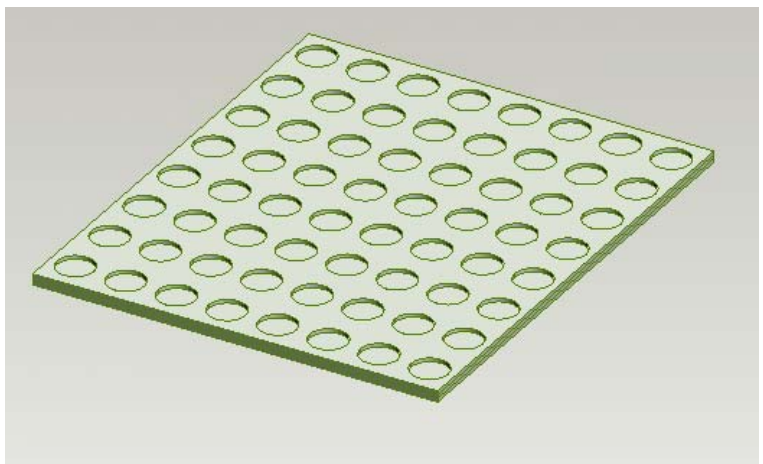


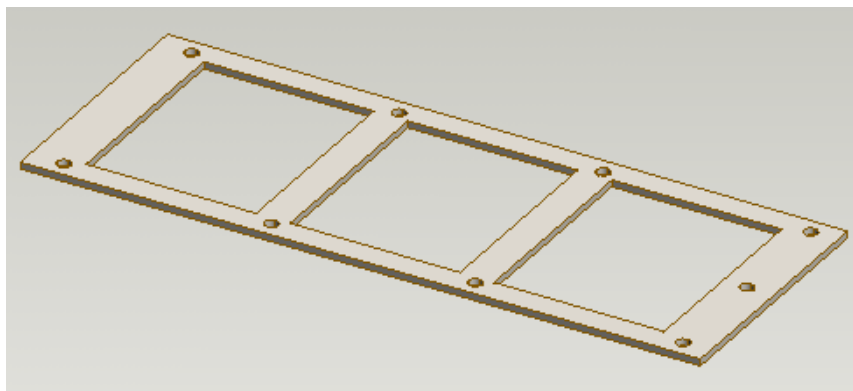


BACKGROUND
Stack Design



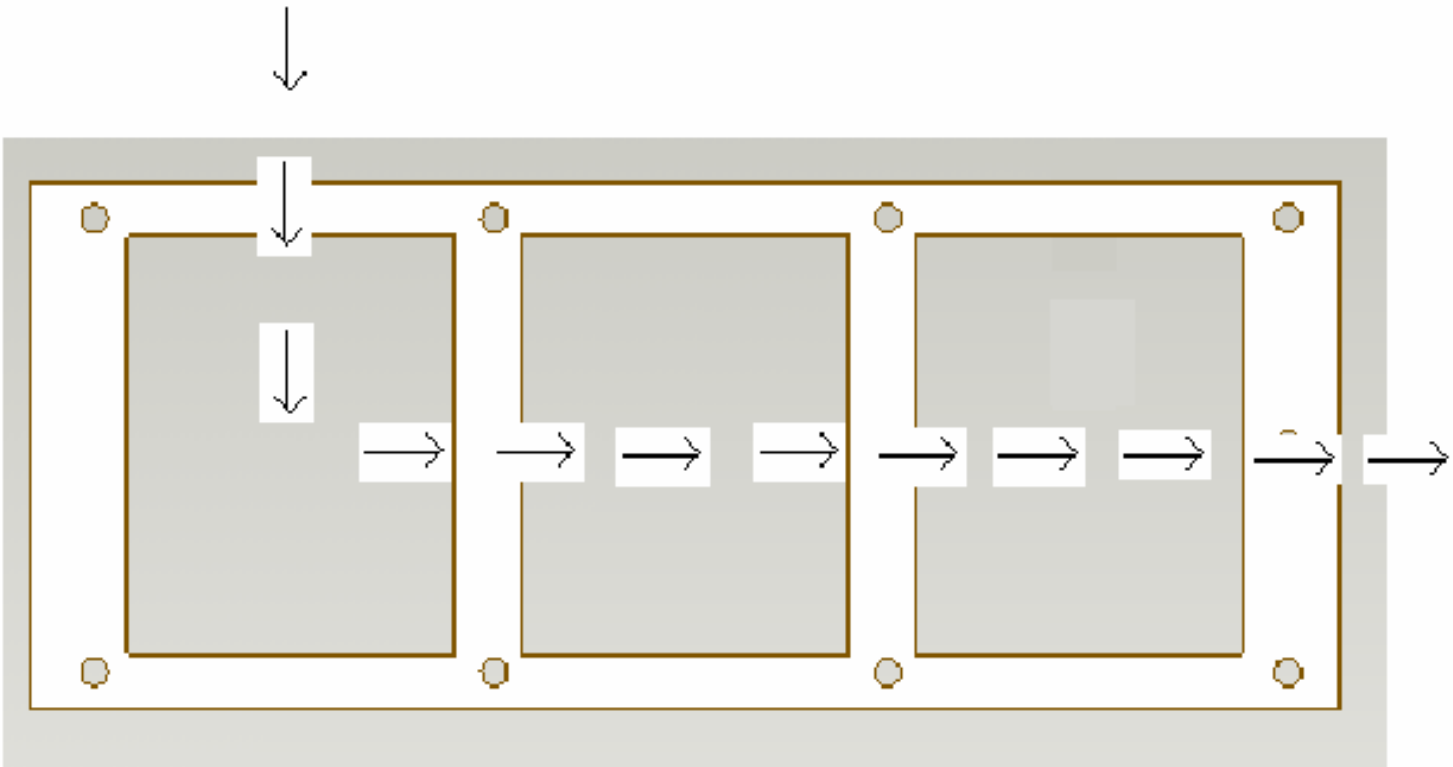






BACKGROUND
Fuel Flow Path

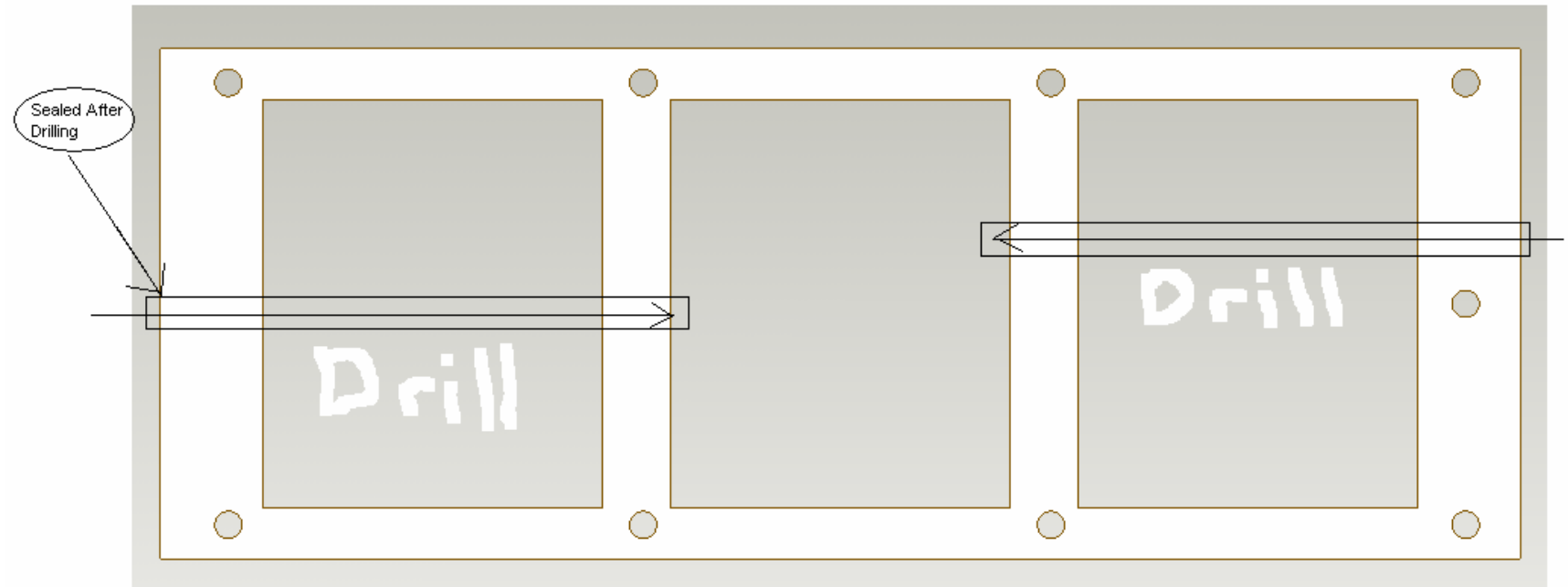
- Works with methanol or hydrogen
- Drill holes with 8in. Bit



BACKGROUND

Drilling Plan

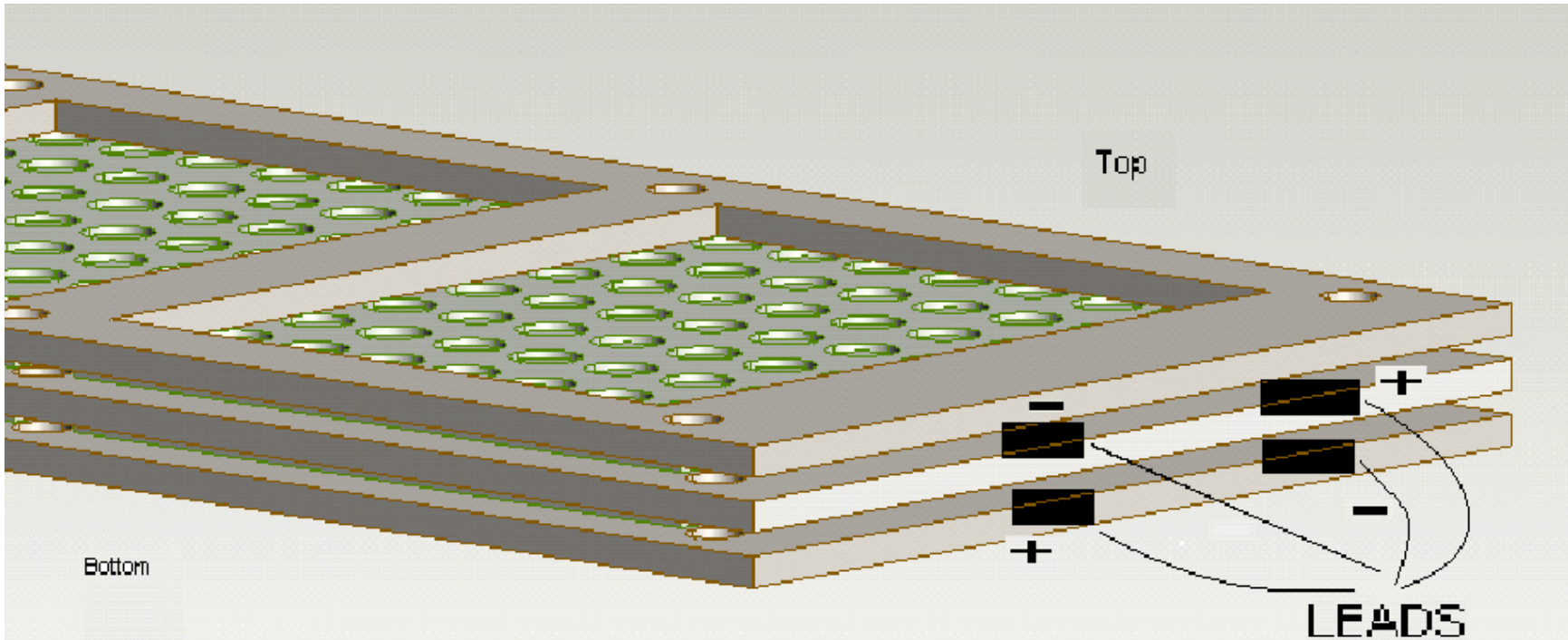
- We will drill through the Lexan
- We will then seal the first hole (how TBD)



BACKGROUND

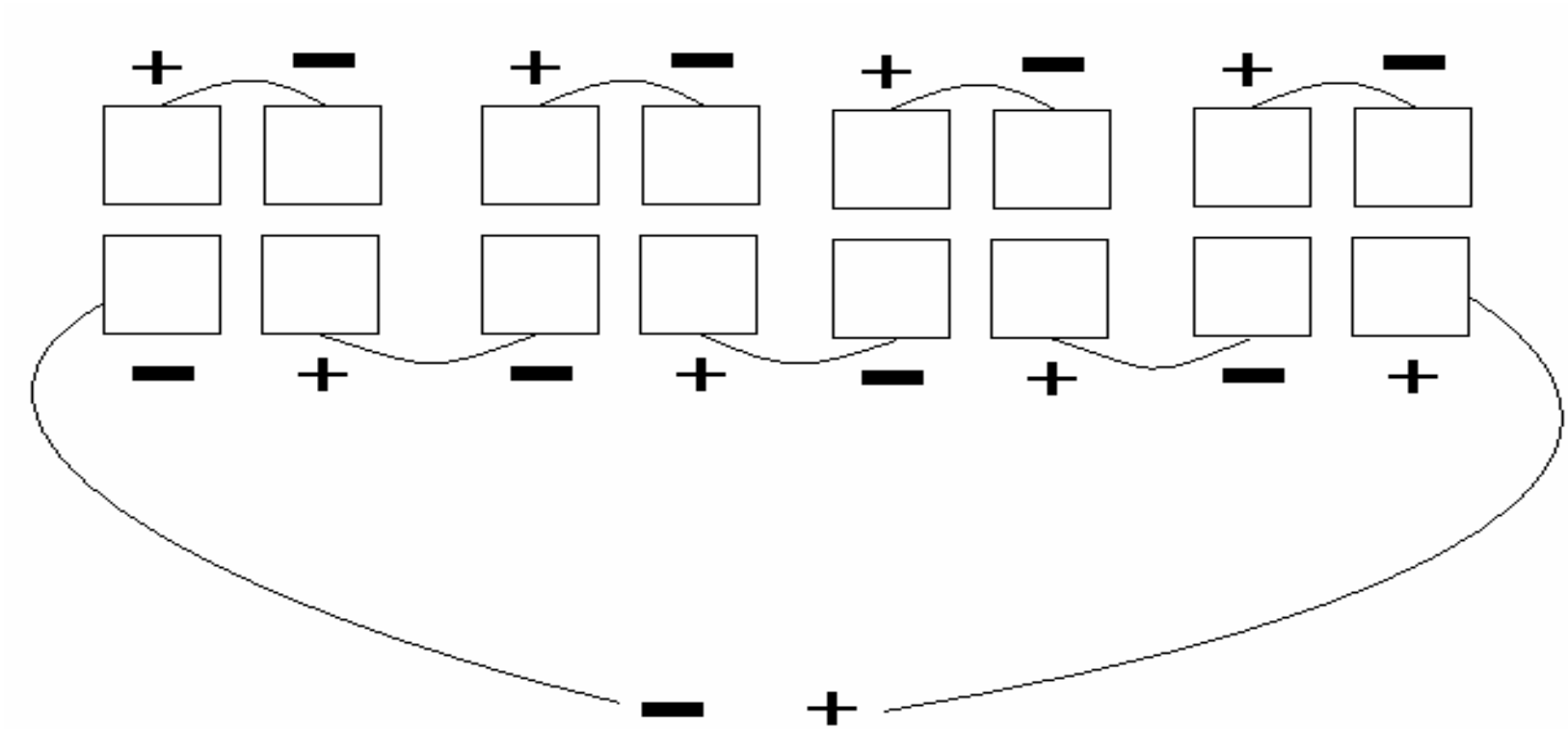
Wiring Diagram

- One side of each stack will have four leads
- The charges will be shown as below



BACKGROUND

- Plates are connected to each other in series
- Two leads come out for the power



CONSTRUCTION

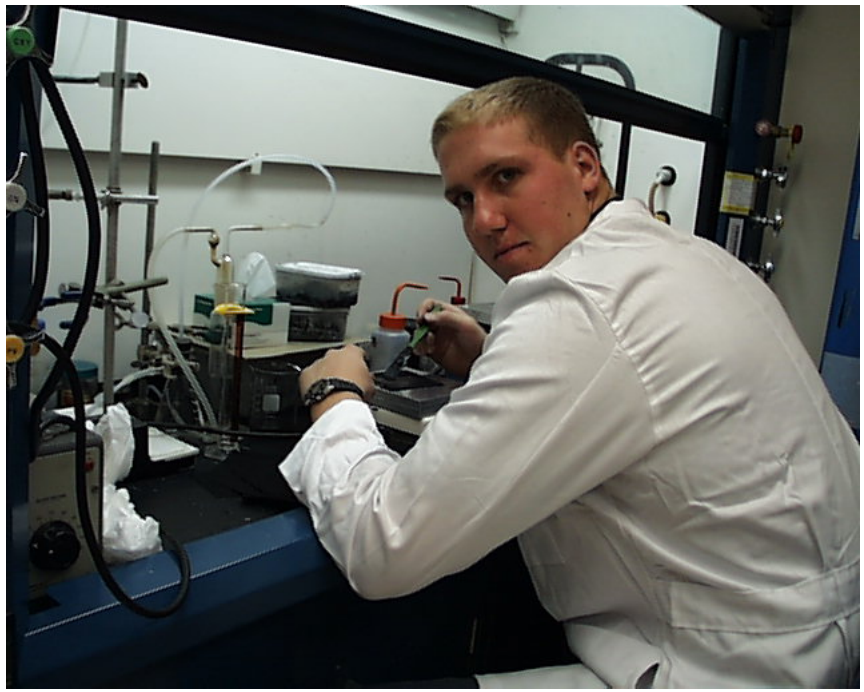
- **The fuel used in this particular type of fuel cell is water and methanol. The percentage of water versus methanol can range from 90% water and 10% methanol or 80% water and 20% methanol by volume**

- **The equipment and materials needed for fuel cell construction are:**

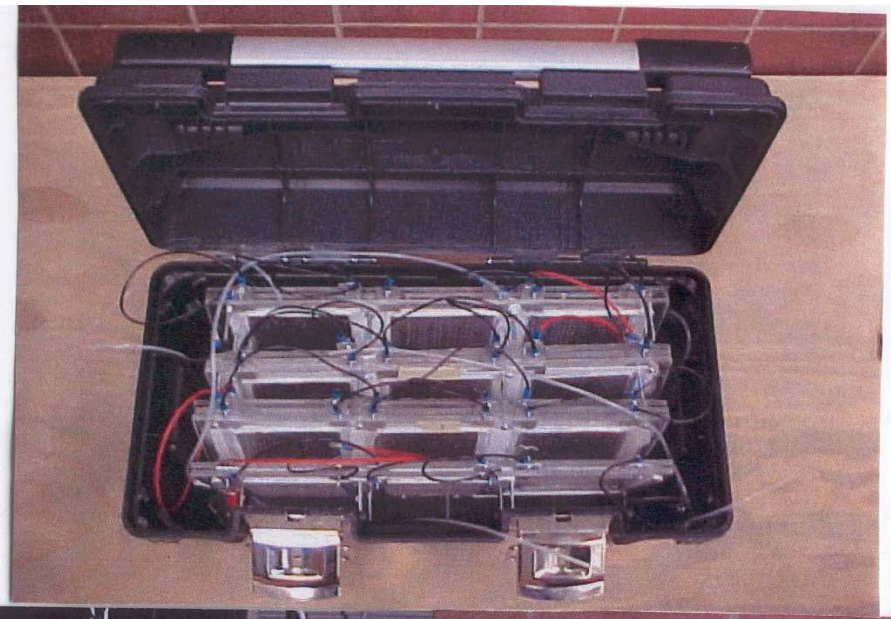
Teflon paper
Platinum
Alcohol
Distilled water
Temperature regulated vacuum
Titanium mesh or Graphite mesh
Nafion polymer
Ruthenium
Carbon gas diffusion material
Temperature regulated press
Plexiglas

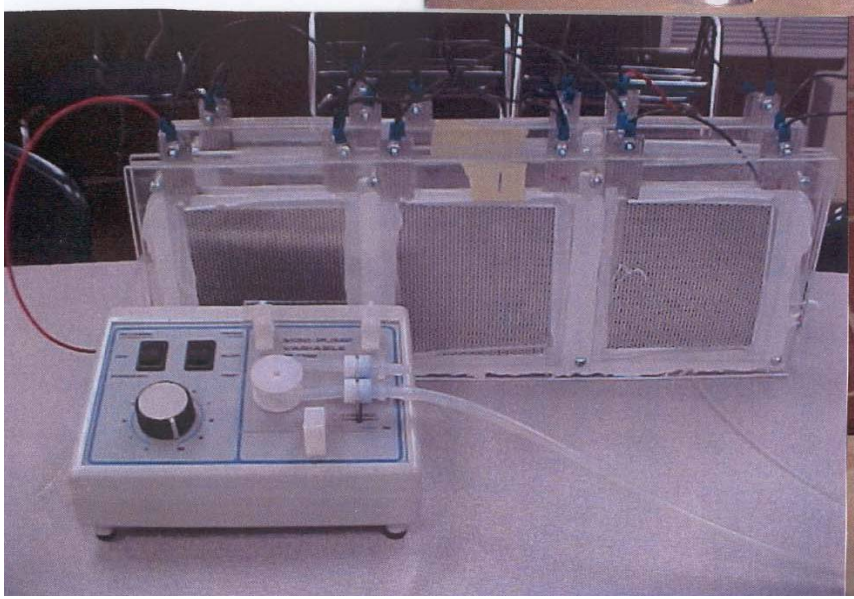
CONSTRUCTION

- **MEA construction began with cutting two 3cm by 3cm pieces of Teflon paper and then coating one Teflon square with platinum black ink solution (Pt) and the other with platinum ruthenium black ink solution (PT-Ru)**



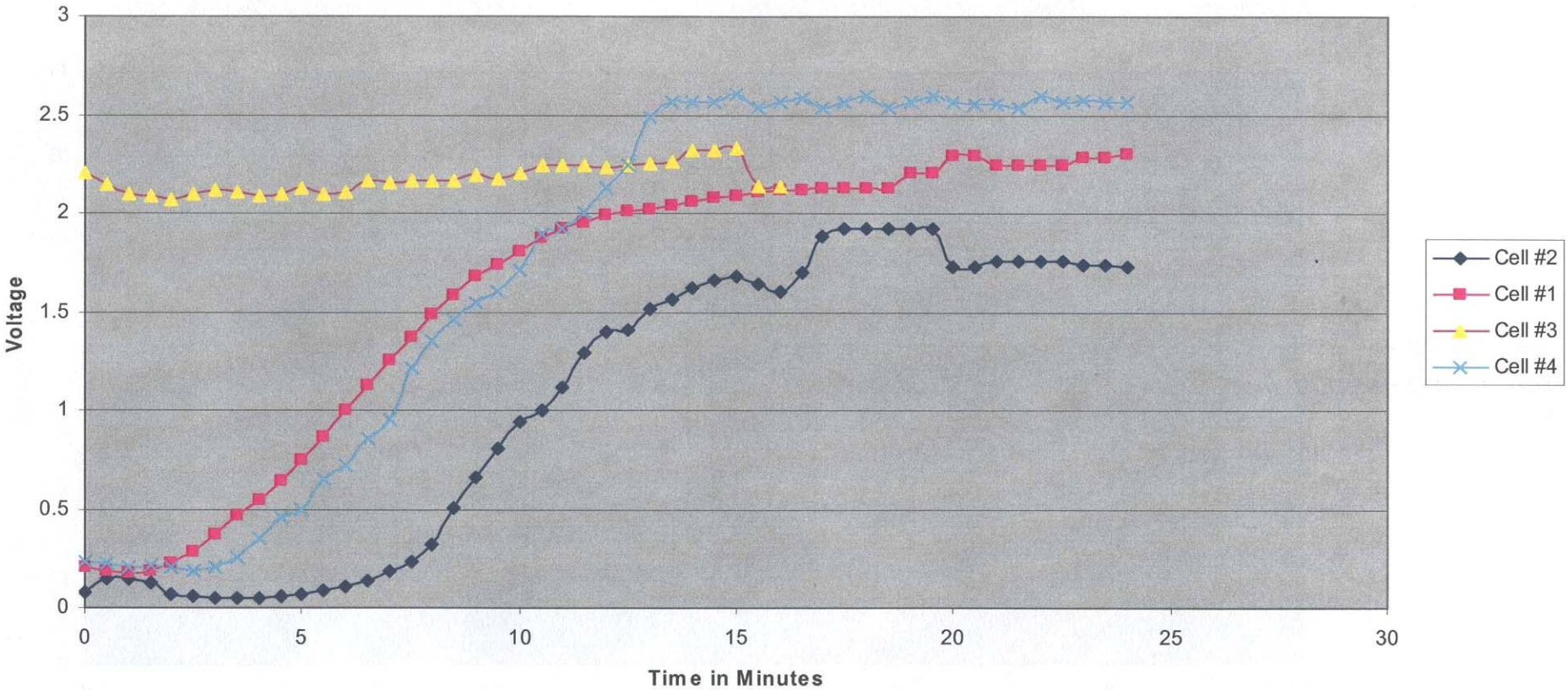
RESULTS



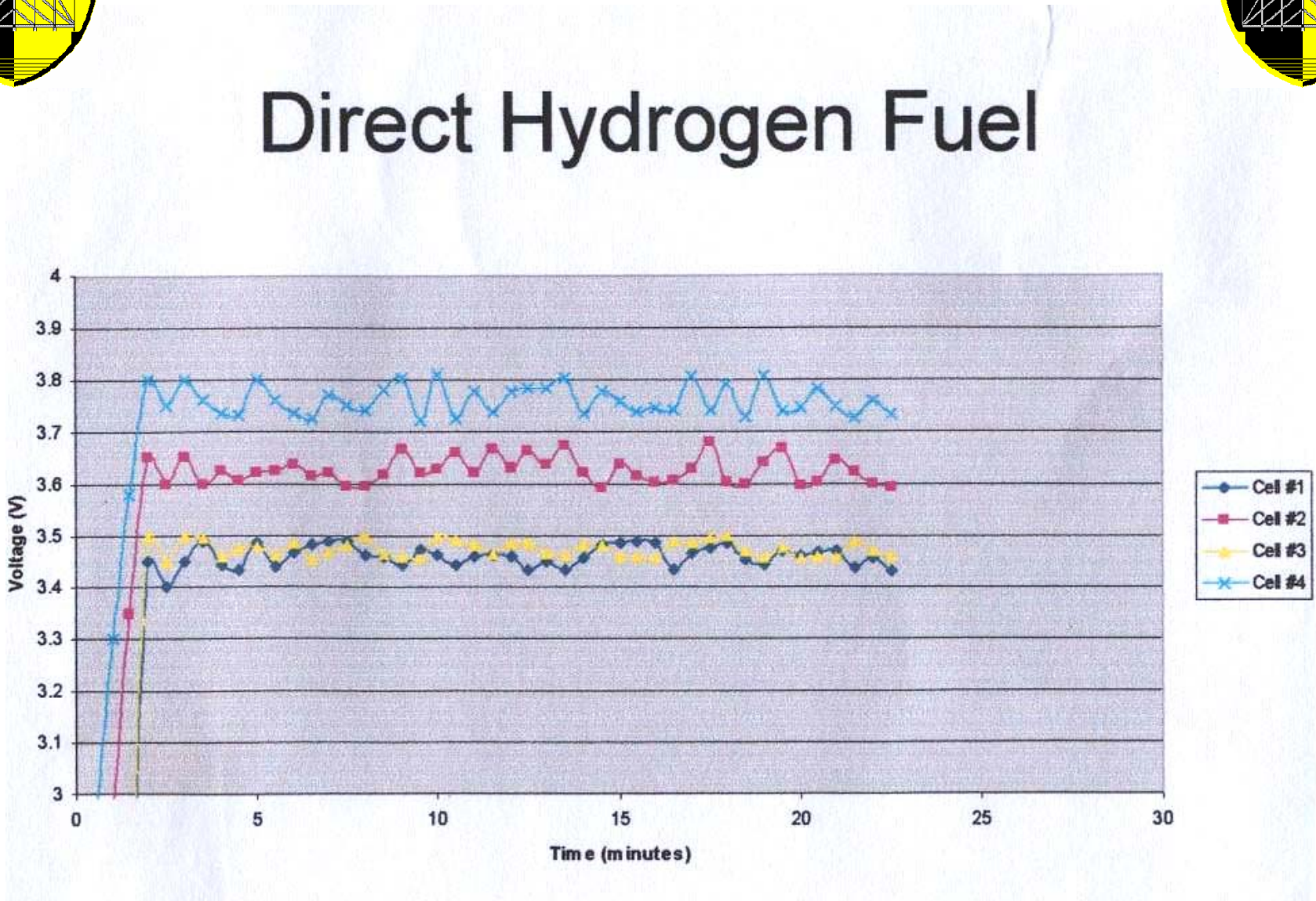


RESULTS

Direct Water Methanol

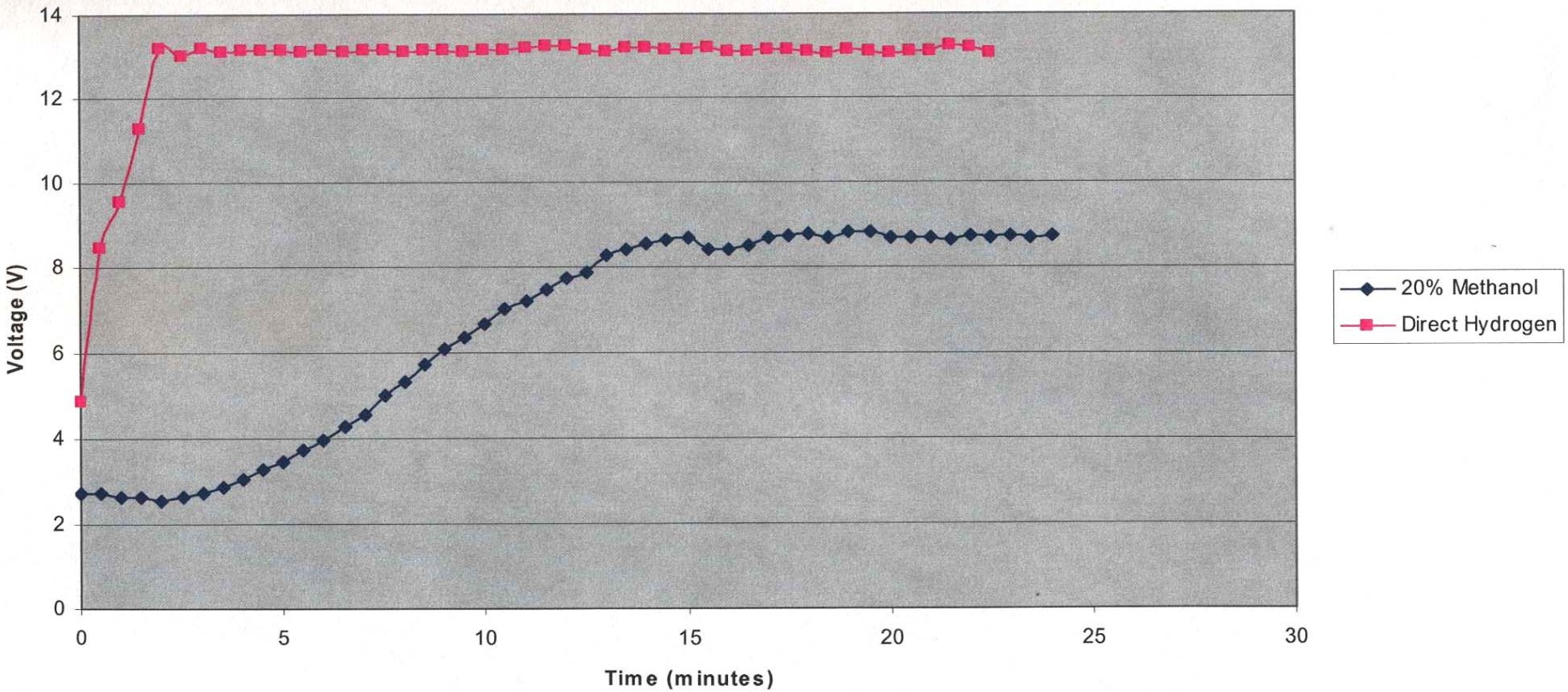


RESULTS


Direct Hydrogen Fuel
Voltage (V)
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
0
5
10
15
20
25
30
Time (minutes)
Cell #1
Cell #2
Cell #3
Cell #4

RESULTS

Entire Fuel Cell Performance



CONCLUSION

- The design objectives for the fuel cell stack were achieved: To develop a fuel cell stack system that will run on both hydrogen and methanol that can produce 12 volts and 12 watts. However the 12 volts was only achieved with hydrogen as the fuel source.

- Increasing the surface area of the MEA did not increase the output voltage of the fuel cell.

- The overall design of the fuel cell stack that had 6 membranes per stack should have been increased to 12 or even 24 smaller MEA's.

- The project was not finished in time for integration with the electrical engineering capstone.