

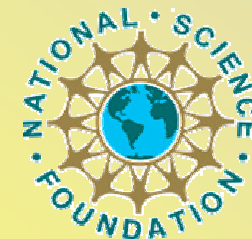
# SYNTHESIS OF PLATINUM NANOPARTICLES USING NAFION MEMBRANES AS TEMPLATE

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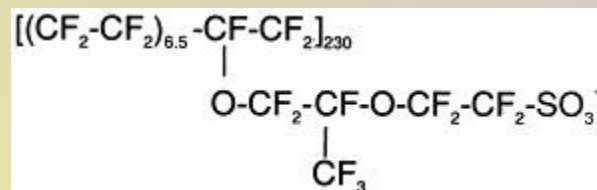
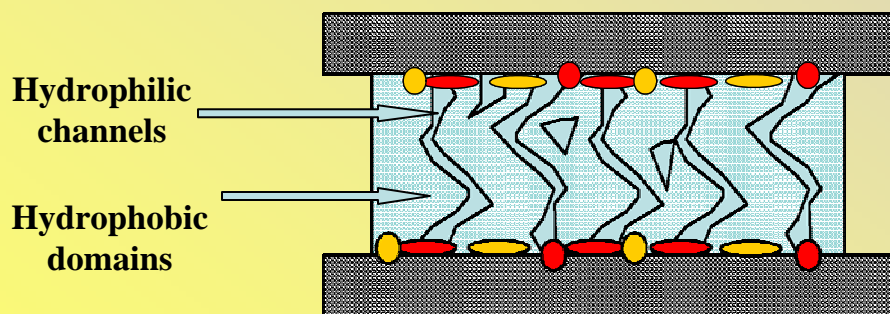
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(Faculty Advisor)



# The Bigger Picture...

## Fuel Cells and the Industry

- ⊙ Use Platinum, or other expensive metals/metal oxides as catalyst (Ru, WO<sub>3</sub>)
- ⊙ Not all of these metal catalysts are effectively being used



Nafion structure

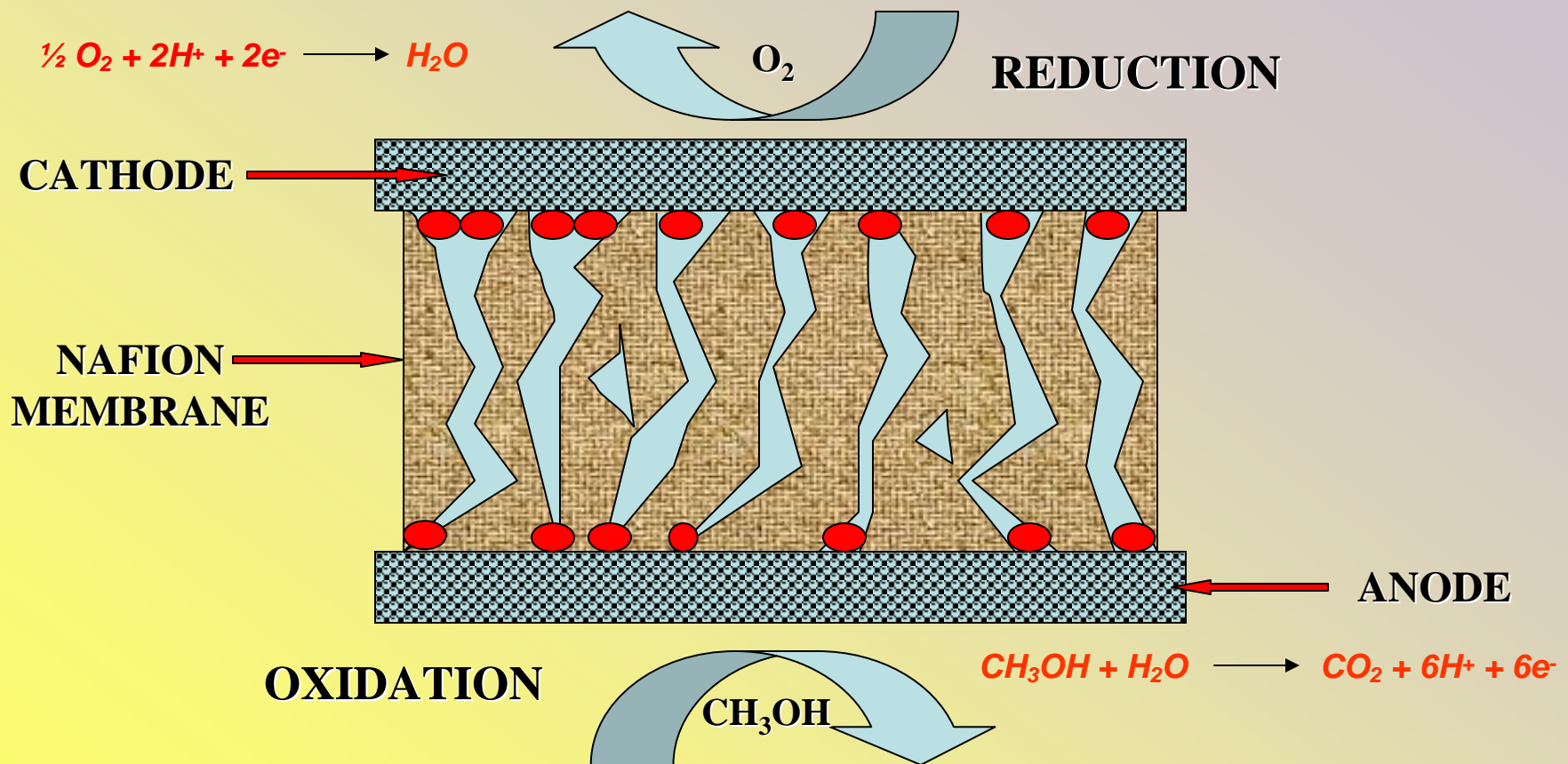
## What we are doing...

- ⊙ Decrease the waste of the unused catalyst by depositing the catalyst through the hydrophilic domains onto the substrate

## We expect to see...

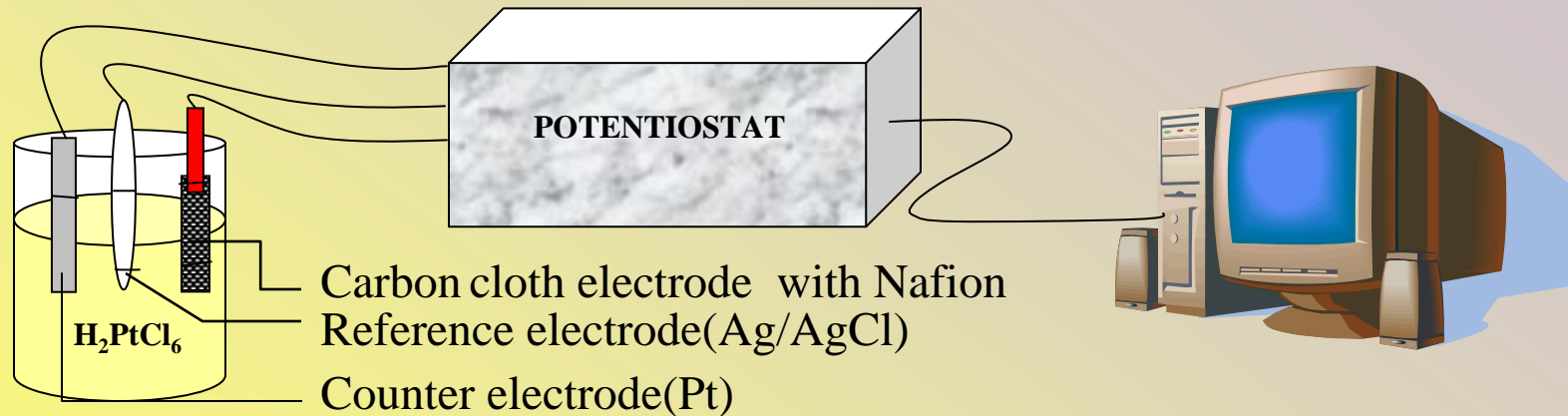
- ⊙ Maximum utilization of the catalyst with a minimum amount

# Project Goals



- ⊗ electrochemically deposit Platinum (Pt) through commercially available Nafion membranes on to carbon cloth
- ⊗ construct a **mini direct methanol fuel cell** (DMFC) and study its characteristics

# EXPERIMENTAL



## Potensiostat

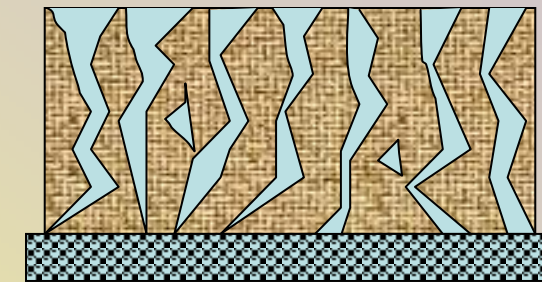
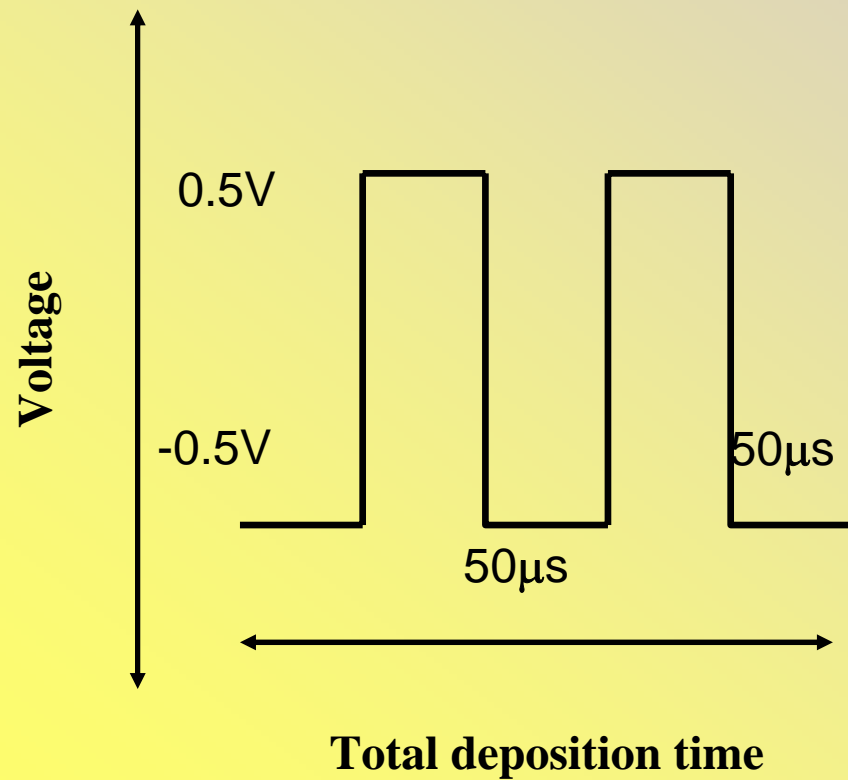
- ⊙ an electronic equipment that regulates the programs for **pulse deposition** and cyclic voltammetry (CV)

## Characterization

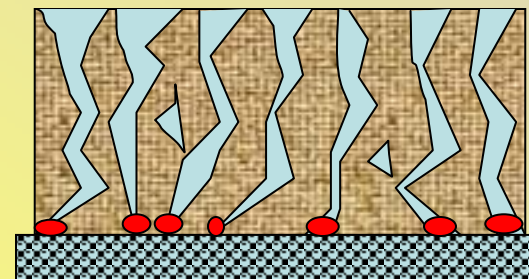
- ⊙ Cyclic Voltammetry
- ⊙ Scanning Electron Microscopy (SEM)

# Pulse-Deposition

- ⊙ electrochemical deposition of the Platinum through the hydrophilic channels or the active sites on to the substrate



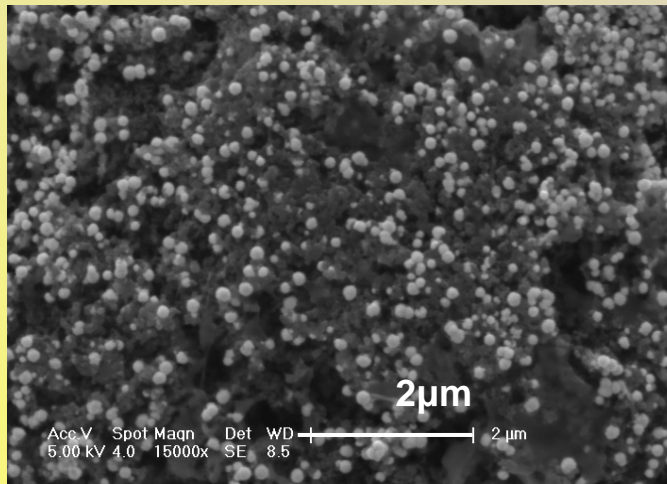
Pt<sup>4+</sup> Pt<sup>4+</sup> Pt<sup>4+</sup> Pt<sup>4+</sup> Pt<sup>4+</sup> Pt<sup>4+</sup> Pt<sup>4+</sup>



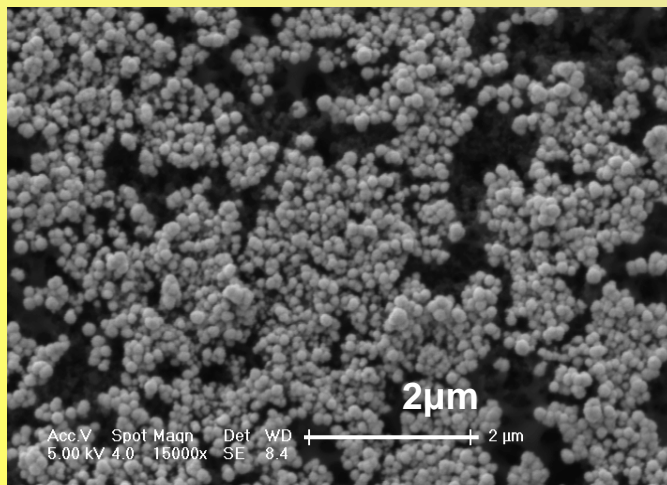
# SEM IMAGES

Pt deposition on carbon cloth  
only

3 min

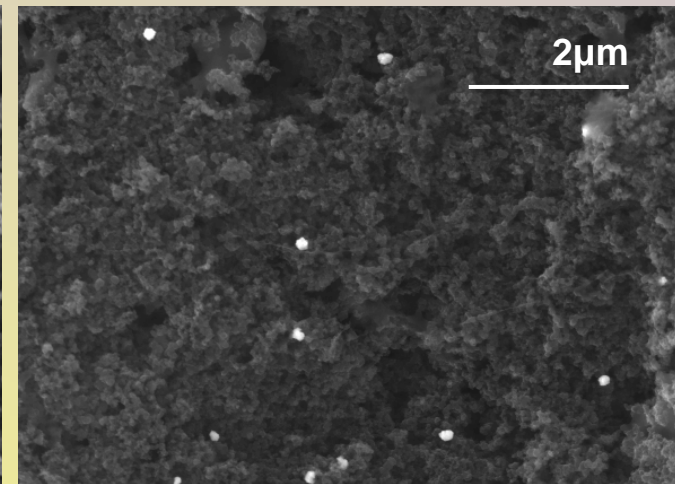


8 min

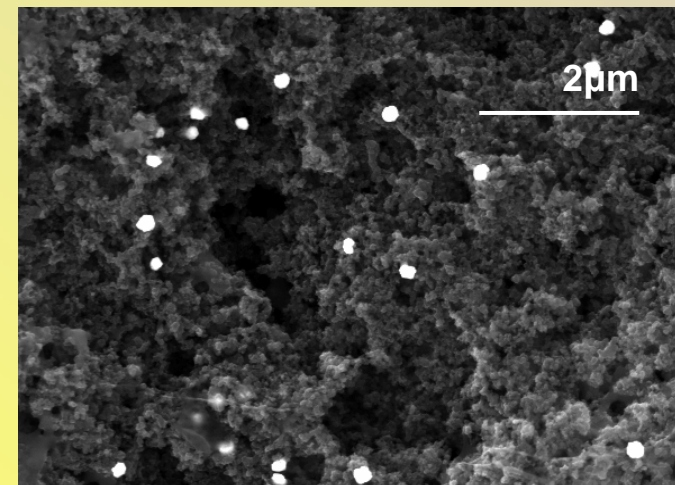


Pt deposition on carbon cloth  
through Nafion membrane

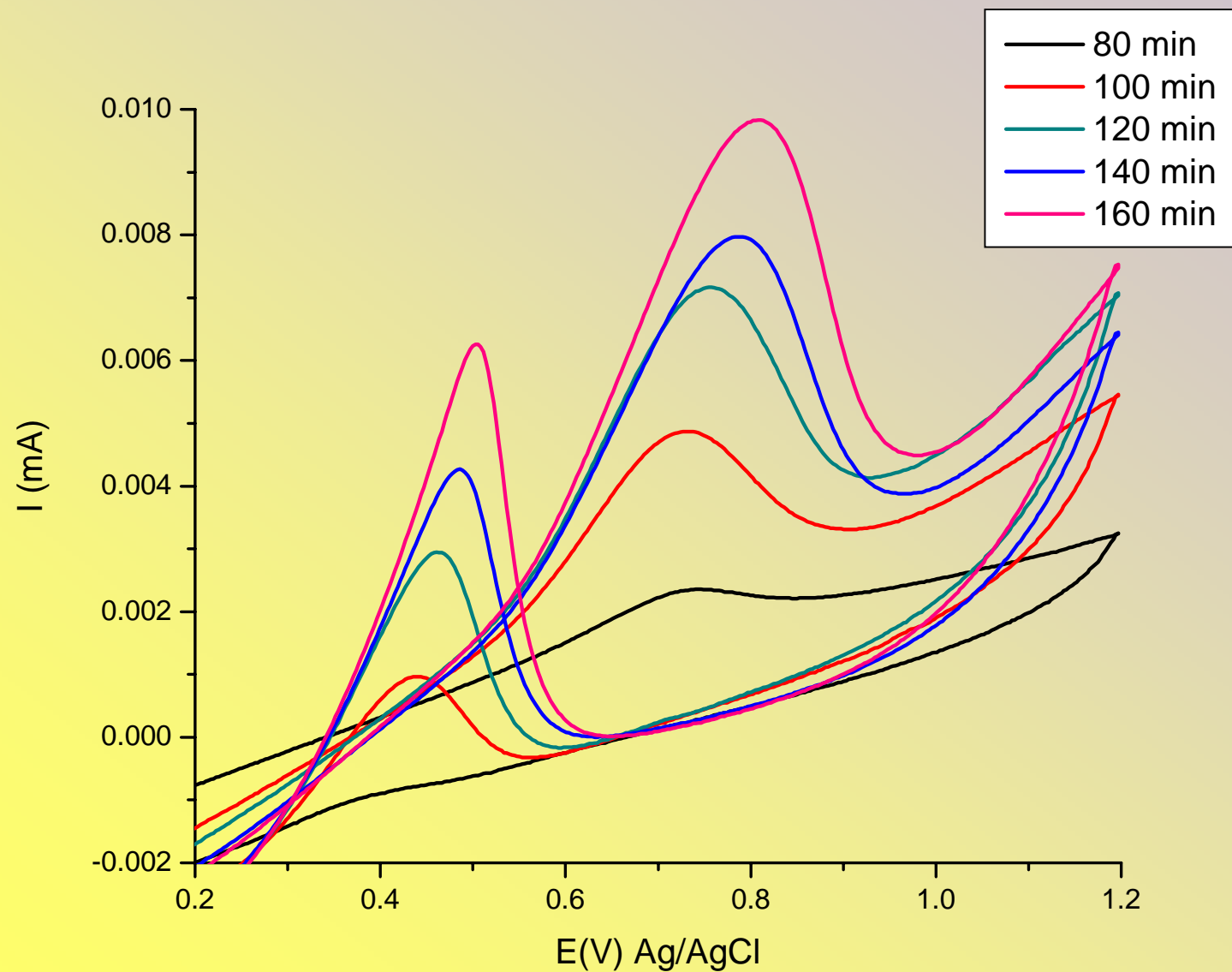
3 min



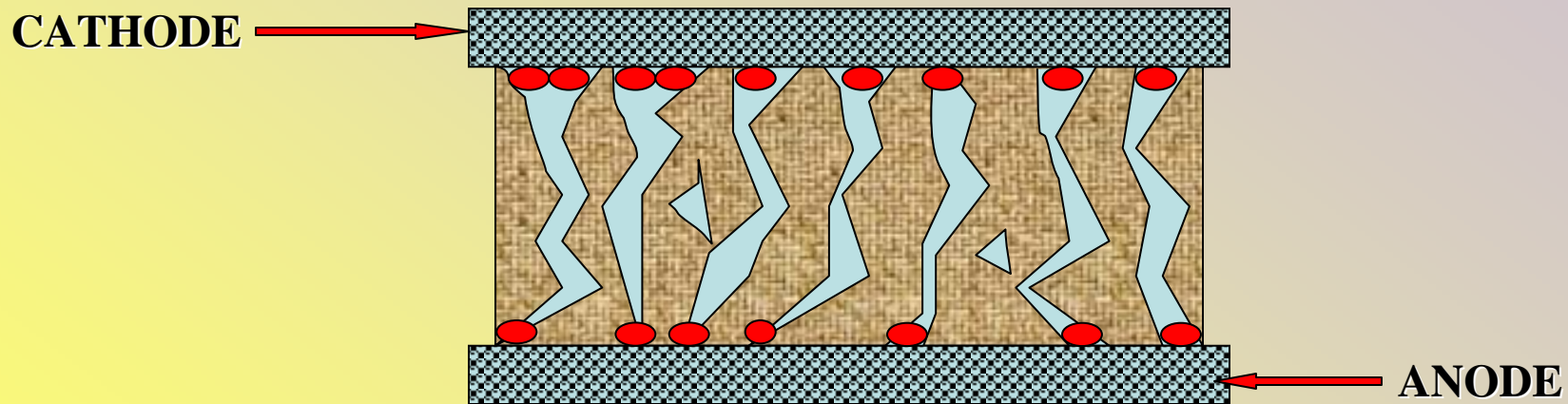
8 min



# Cyclic Voltammogram of Methanol Oxidation on Pt deposited through nafion (117, thickness = 175 $\mu$ m)



# My Mini Fuel Cell



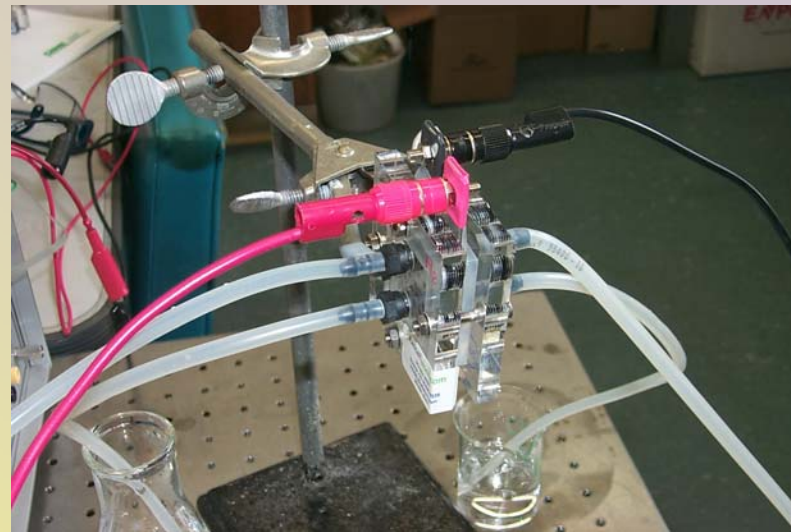
© SIZE =  $1.54 \text{ cm}^2$  (2.2 x 0.7)

© DEPOSITION TIME: 160 min for each side

© AMOUNT OF PLATINUM DEPOSITED:  $2.0896 \text{ } \mu\text{g}$



# My Progress to date...



Fuel cell	My mini fuel cell	
Type	H <sub>2</sub> and O <sub>2</sub>	DMFC
Size	0.7 x 2.2 cm <sup>2</sup>	
Pt Loading	1.3569 μg/cm <sup>2</sup>	
Voltage	0.1 mV	0.4 mV

# Next Step...

- ⊙ Construct a larger fuel cell
  - ⊙ SIZE: 3 X 3 cm<sup>2</sup> (same surface area as the commercially available f.c.)
- ⊙ Compare its efficiency with the commercially available fuel cell systems
- ⊙ Determine the available Pt surface area by Cu underpotential deposition method

# What I've learned...

- ⊙ Electrochemical deposition techniques
- ⊙ Cyclic voltammetry (CV)
- ⊙ Scanning Electron Microscopy (SEM)
- ⊙ Construction and operation of fuel cell systems  
(i.e. DMFC and H<sub>2</sub> fuel cells)

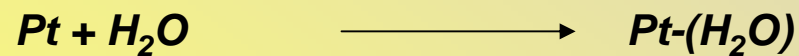
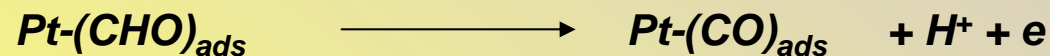
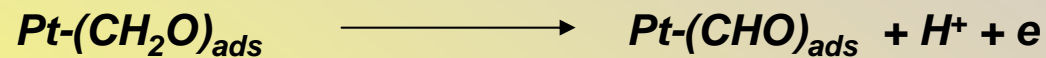
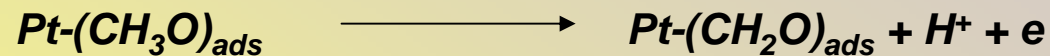
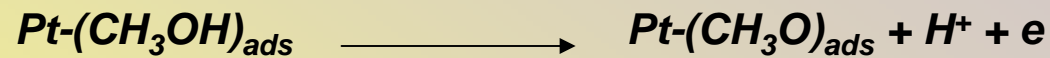
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**Thank You**

## Methanol oxidation Process



### Net Reaction



## Calculation of the amount of Pt deposited

From Faraday's Laws

$$W = (M_w It) / nF$$

$M_w$ - molecular wt./rel. atomic mass (195.09 for Pt)

I- current

t- time (160 mins)

n- no. of electrons ( $\text{Pt}^{4+} + 4e \rightleftharpoons \text{Pt}$ )

F- Faraday's const (96500 C)

By integration of the I Vs t graph;

Total area (Integral I dt) = 51674.29196 mA\* $\mu$ s

$$W = 2.0896 \mu\text{g} \text{ (amount of Pt deposited)}$$