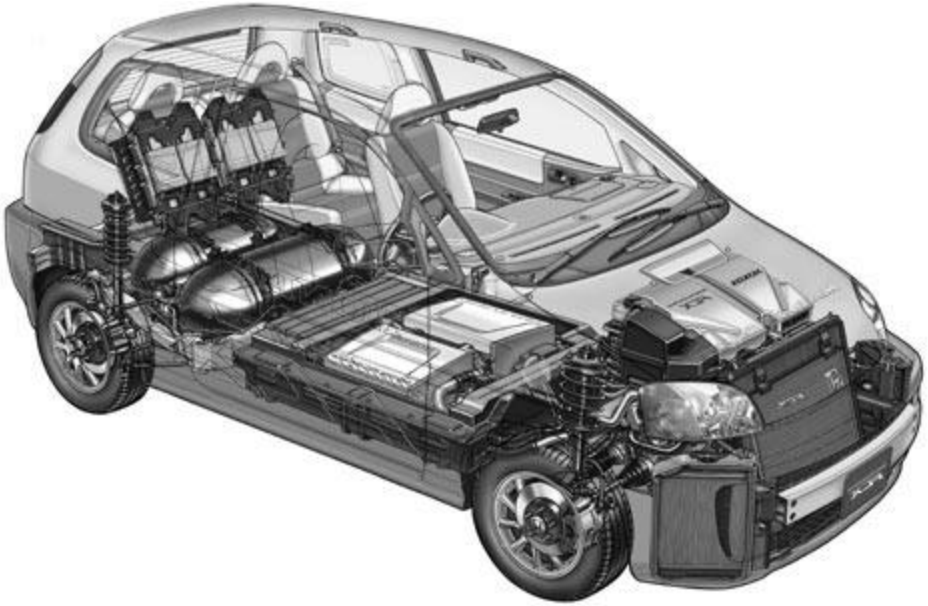
Bi doped MnO_2 serves as the ORR catalyst in ZAFC

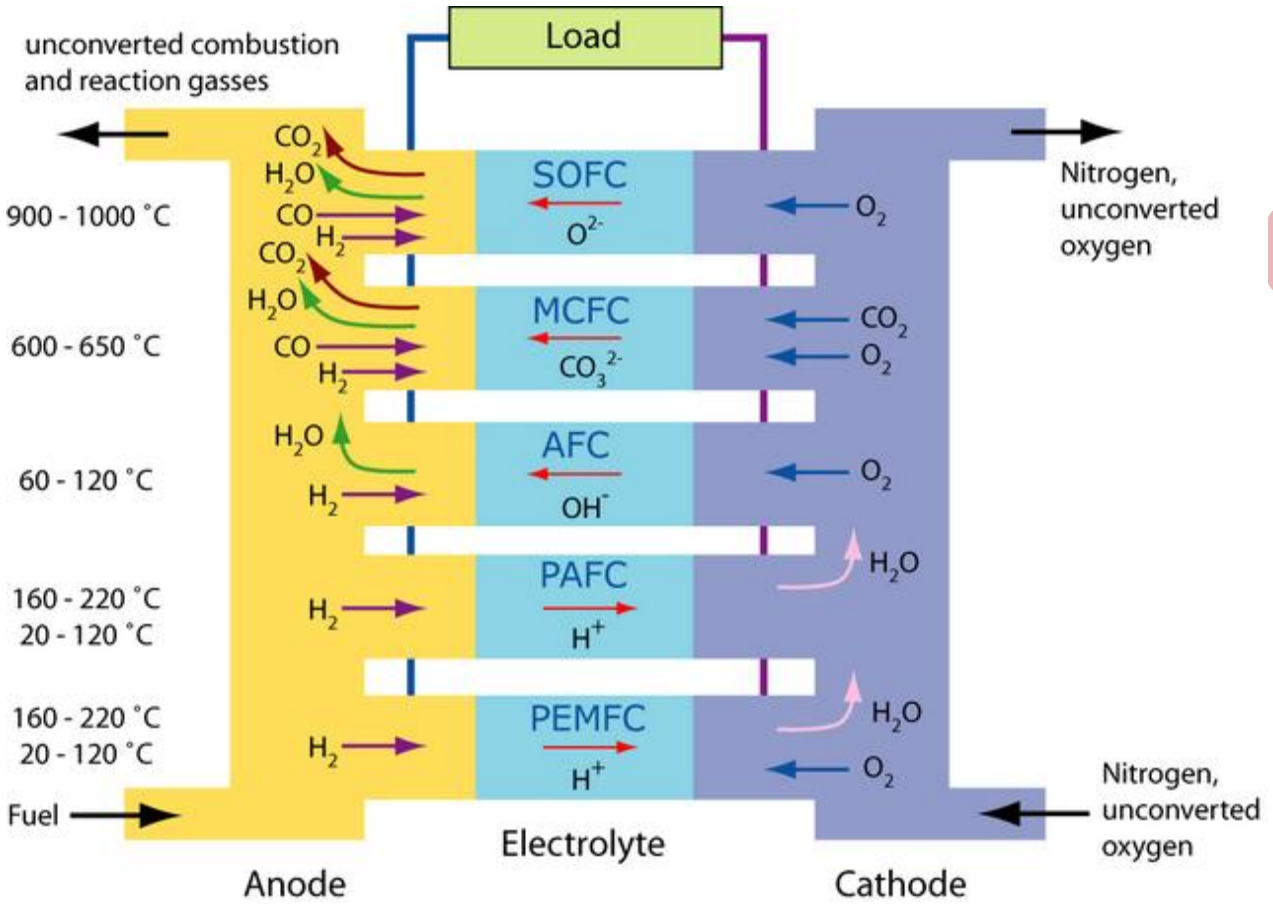


Quan Li

11-18-2011

Wind
geothermal
Nuclear
Solar
Biomass
Fuel Cell

Fuel Cell



Hydrogen compression

Methanol crossover

ZAFC

0 - 60°C

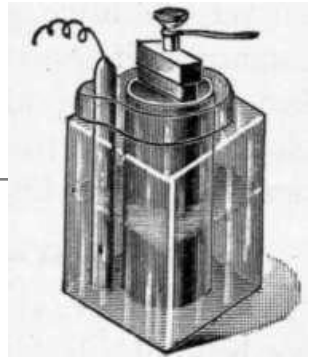
History

Georges Leclanché

Heise and Schudmacher made commercial product

Hearing aid application

1868 | 1932 | 1970s | 1980s



Large primary Zinc-air cells

Mechanism

Anode: $Zn + 4OH^- \longrightarrow Zn(OH)_4^{2-} + 2\,e^-$ ($E^\Theta = -1.216$ V)

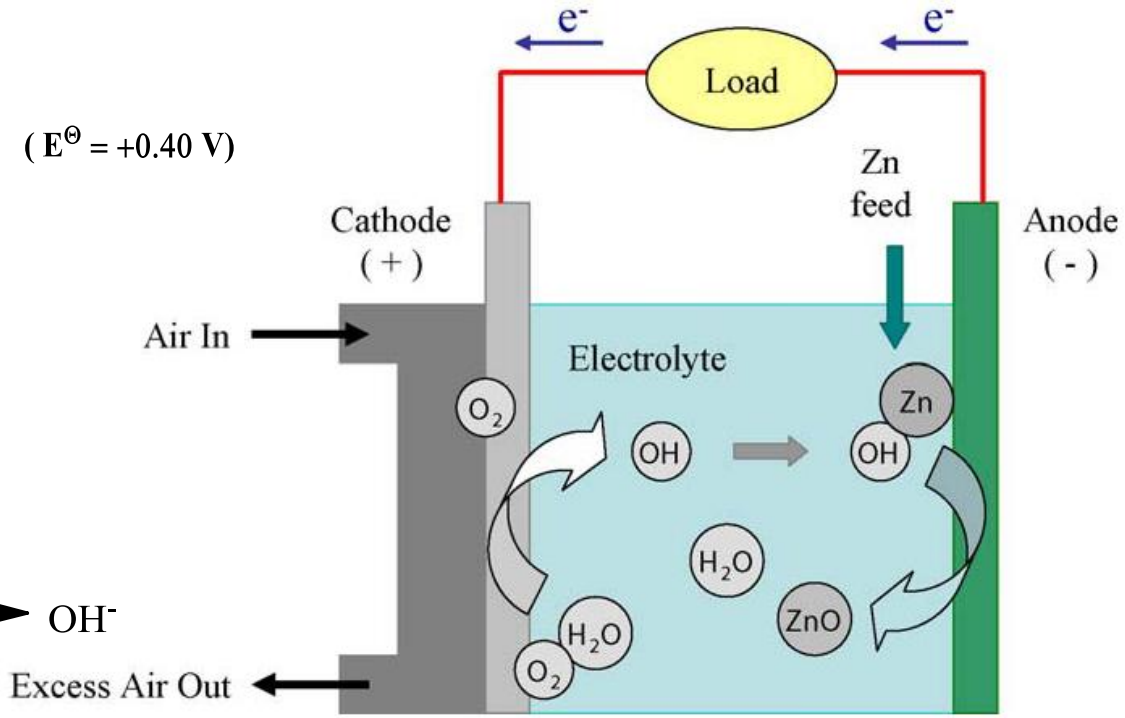
$Zn(OH)_4^{2-} \longrightarrow ZnO + 2OH^- + H_2O$

Cathod: $O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$ ($E^\Theta = +0.40$ V)

$E_{emf} = E^\Theta$ (cathode) - E^Θ (anode)

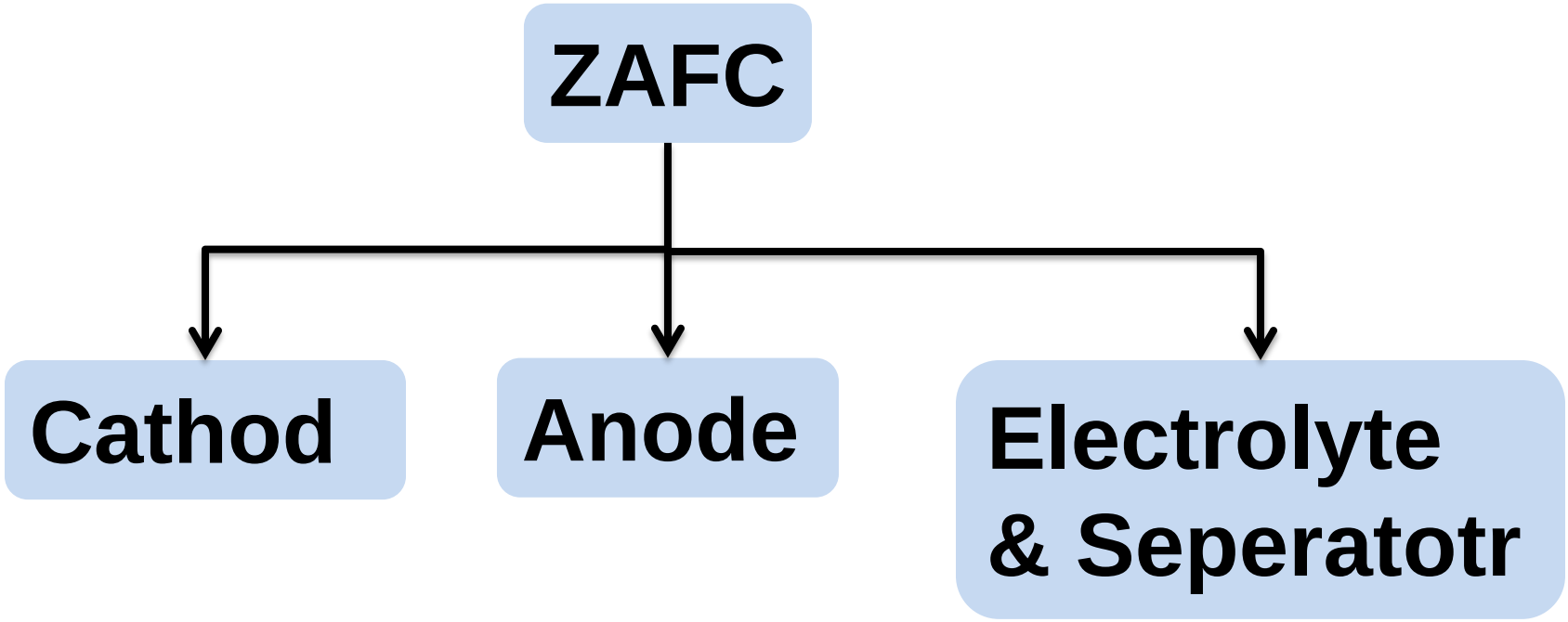
4 e^- pathway: $O_2 \longrightarrow OH^-$

2 e^- pathway: $O_2 \longrightarrow HO_2^- \longrightarrow OH^-$

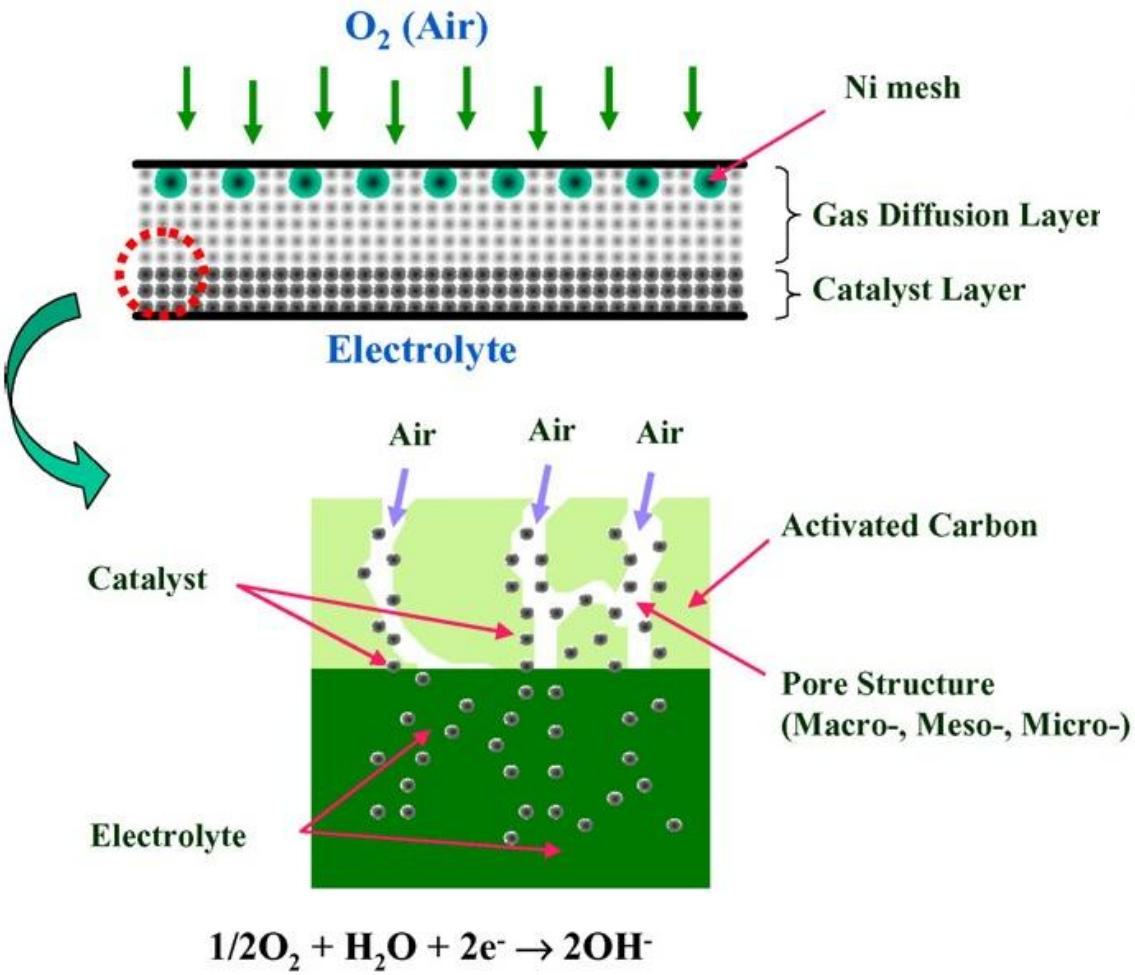


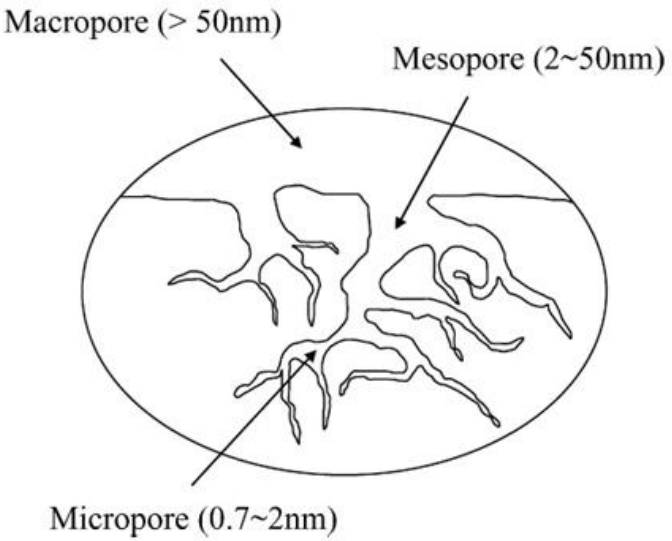
P. Sapkota, H. Kim, *Journal of Industrial and Engineering chemistry* 15 (**2009**) 445-450

Materials



Cathod





E.Yeager, J. *Mol Catal*. 38(**1986**)5

S.-W. Eom et al. *Electrochimica Acta* 52 (**2006**) 1592–1595

Catalyst

- MnO_2
- Ag
- Metal tetra-methoxylphenyl porpyrine based ORR catalysts (Fe Co)

MnO2 baesd Cathod

- The most common ORR catalyst for primary ZAFCs
- 2 electron pathway
- General design of air cathode

Number	Component
1	Microporous Teflon membrane with high air permeability. It limits the maximum ZAFC current to 100 mA cm^{-2}
2	Current collector
3	Gas diffusion layer.
4	Catalyst layer (MnO_2)

J.Yang, J.J.Xi, *Electrochem. Commum*. 5(**2003**)306

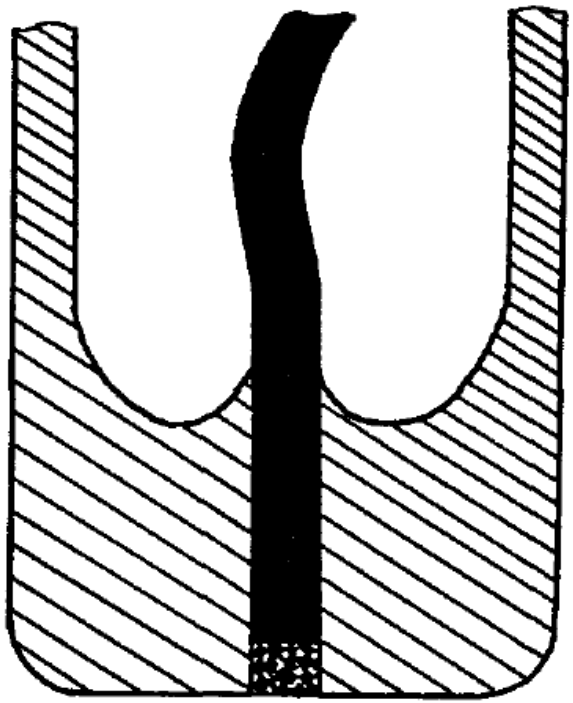
Powder Microelectrode

Powder Microelectrode

- **Study easily and rapidly**
- **High reversibility**

$$I_d = \frac{nF}{v_i} D_i \frac{c_i^0}{\delta_i}$$

$$I = \frac{4nFDC^\circ}{\pi r} \qquad \delta = \frac{\pi r}{4} \qquad \delta = \frac{\pi r}{4} + l$$



Powder Microelectrode

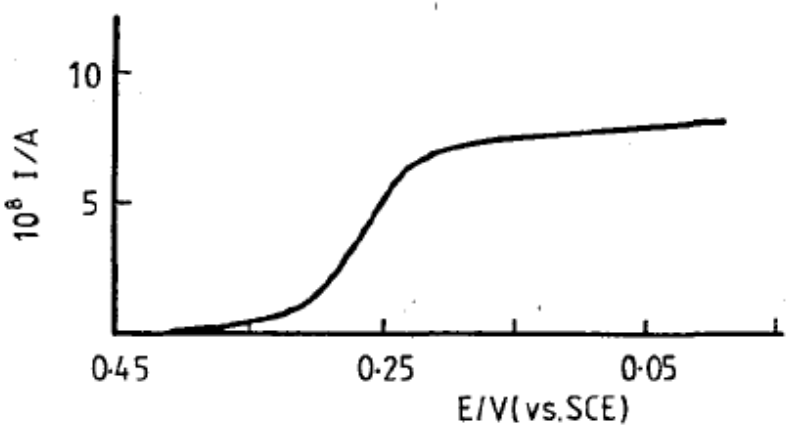


Fig. 3. Steady-state polarization curve measured for an acetylene-black-packed microelectrode ($r_0 = 35\ \mu$m) in 10 mM $K_3Fe(CN)_6$ + 1 M KCl solution ($v = 2$ mV s^{-1}).

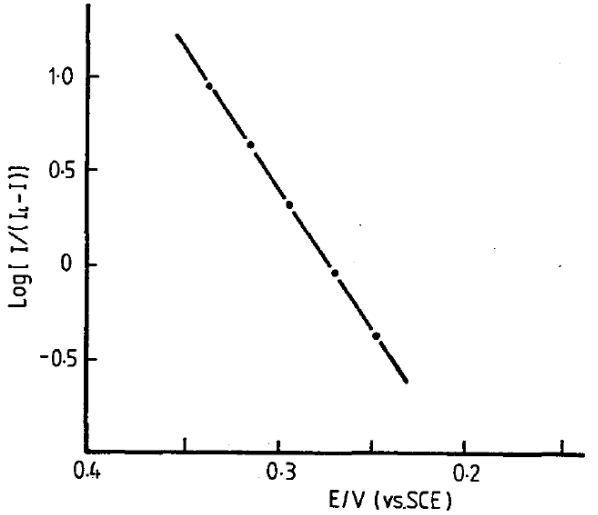


Fig. 4. Tafel plot of the polarization curve shown in Fig. 3.

C.S. Cha, C.M. Li, H.X. Yang and P.F. Liu, *J. Electroanal. Chem,* 368 *(***1994***) 47-54*

Powder Microelectrode

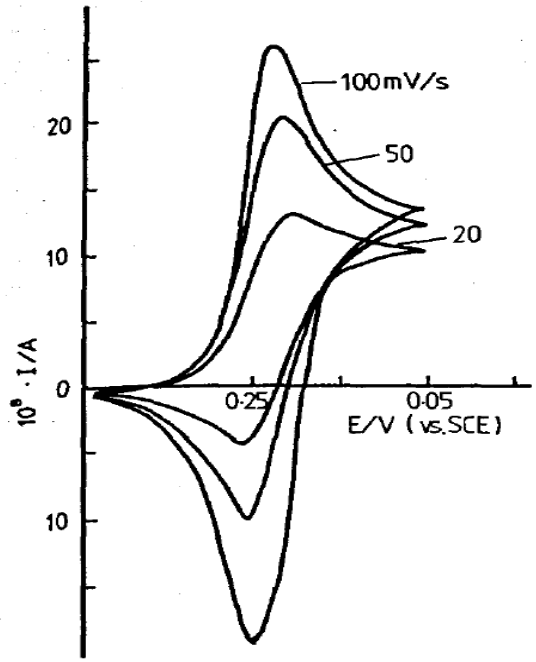


Fig. 5. CVs measured at different potential scan rates. Other experimental conditions are as in Fig. 3.

$$I = I_D + I_T = K_D v^{1/2} + K_T v$$

C.S. Cha, C.M. Li, H.X. Yang and P.F. Liu, *J. Electroanal. Chem,* 368 *(***1994***) 47-54*

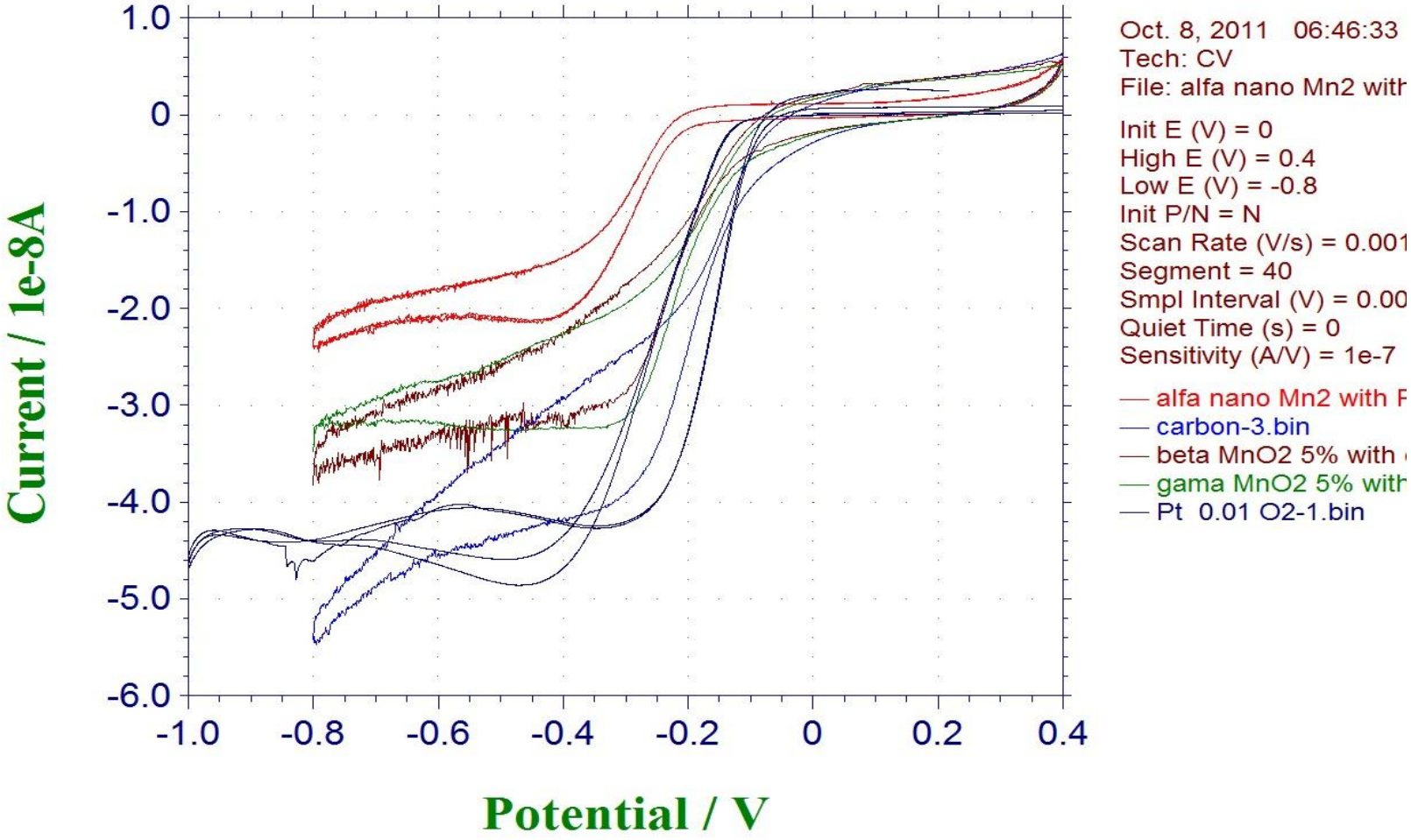
Experiment and Data

Electrode:

- **Working Electrode: Pt loaded with activated carbon**
- **Reference Electrode: Hg/ HgO**
- **Counter Electrode: Pt wire**

Electrolyte: 1M KOH, O2

Experiment and Data



What's next?

- Further characterization such as XRD ICP SEM needed
- To explore the performance of the catalyst in the super capacitor

Thank you!