

# Novel Electrocatalyst Support Materials for HT-PEFC

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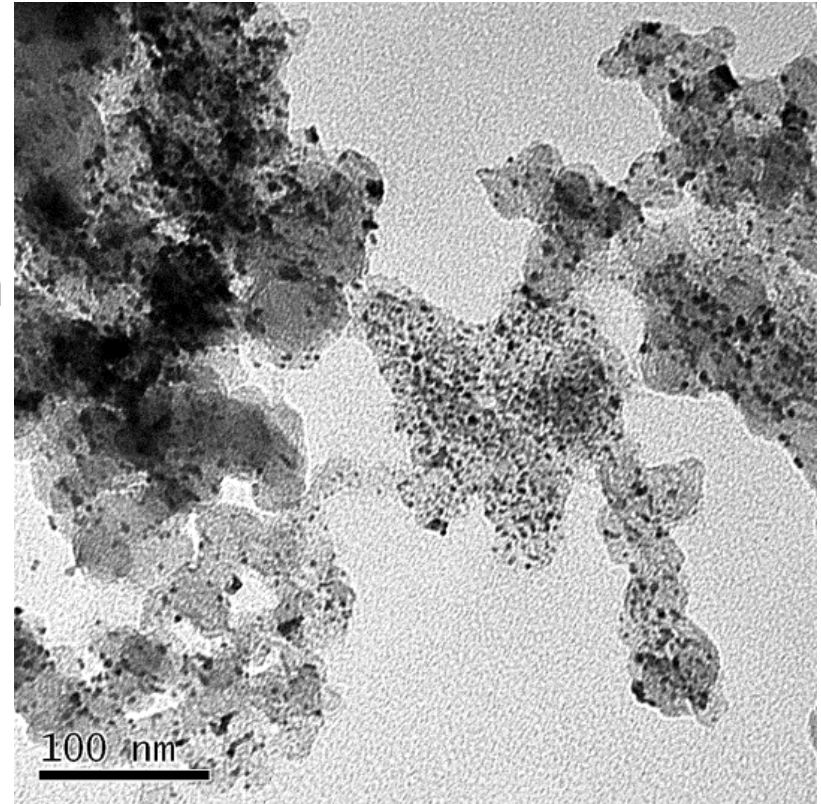
# Outline

1. Introduction
2. Synthesis Procedure
3. Characterisation
4. Testing
5. Conclusions and Future Work

# Introduction

Ideal Support:

1. Electrical Conductivity
2. Catalyst Support Interaction
3. Large Surface Area
4. Mesoporous Structure  
maximising TPB

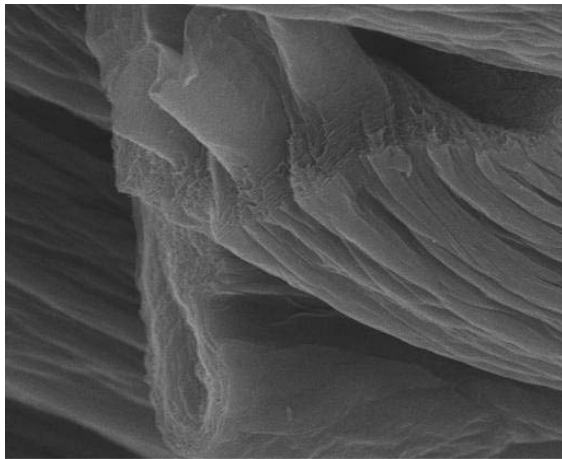


TKK Pt/C

# Reduced Graphene Oxide

- High CO tolerance
- Good Particle Distribution
- Hydrophilicity

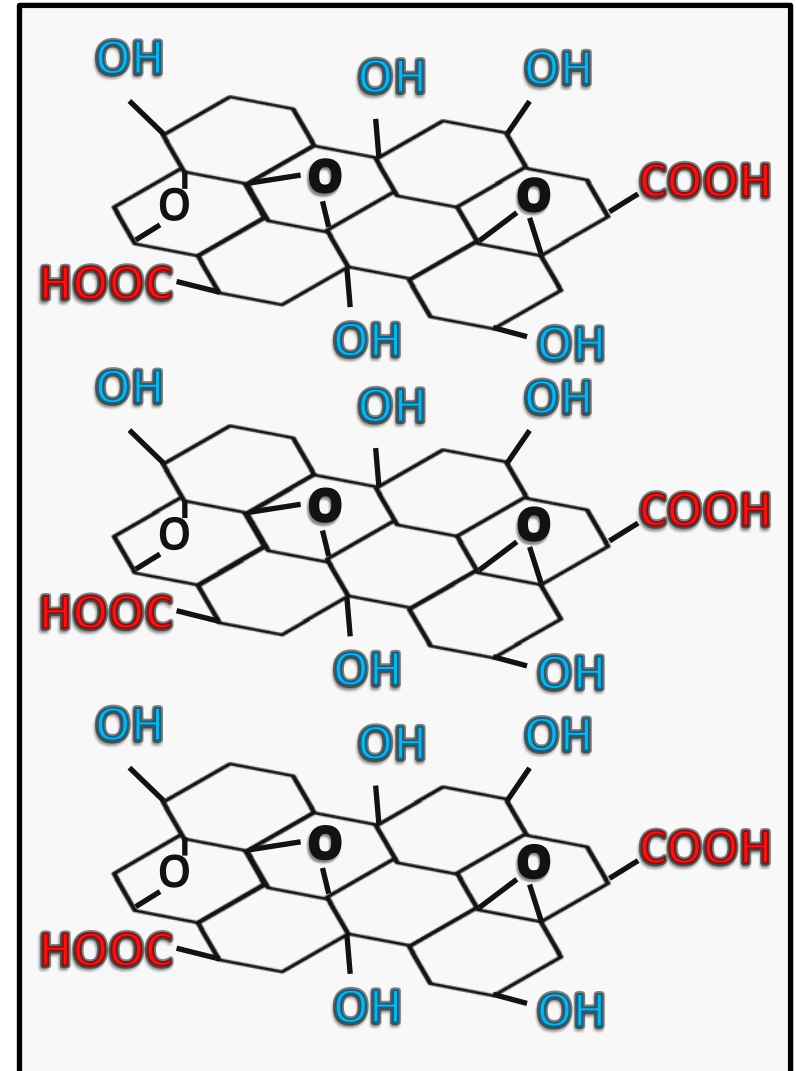
## Improved Activity



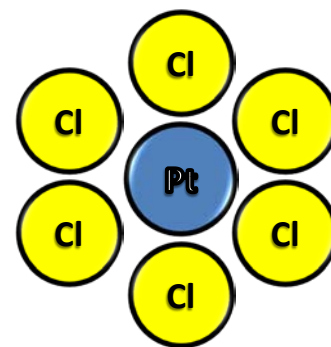
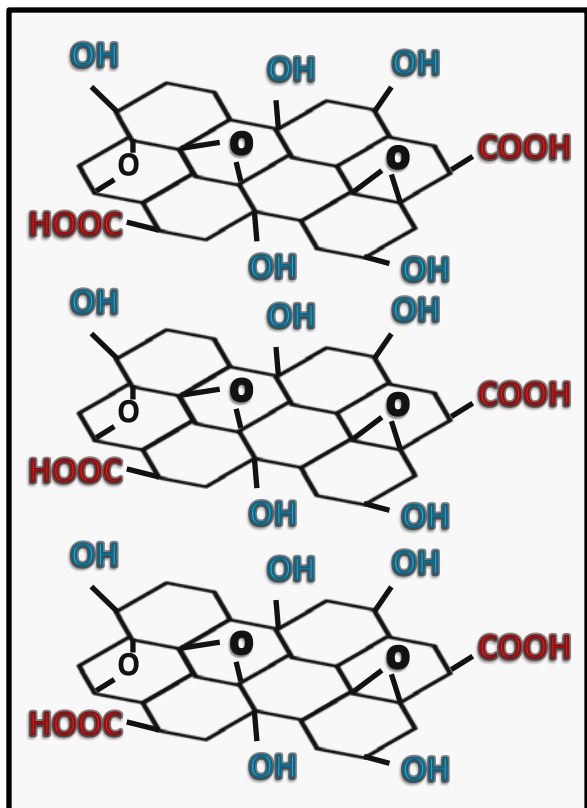
10µm

Yoo, E., *et al.*, *Nano Letters*, 2009. **9**(6): p. 2255.

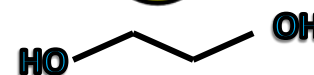
Chartarrayawadee, W., *et al.*, *Electrochimica Acta*, 2012. **60**(0): p. 21



# Synthesis Procedure

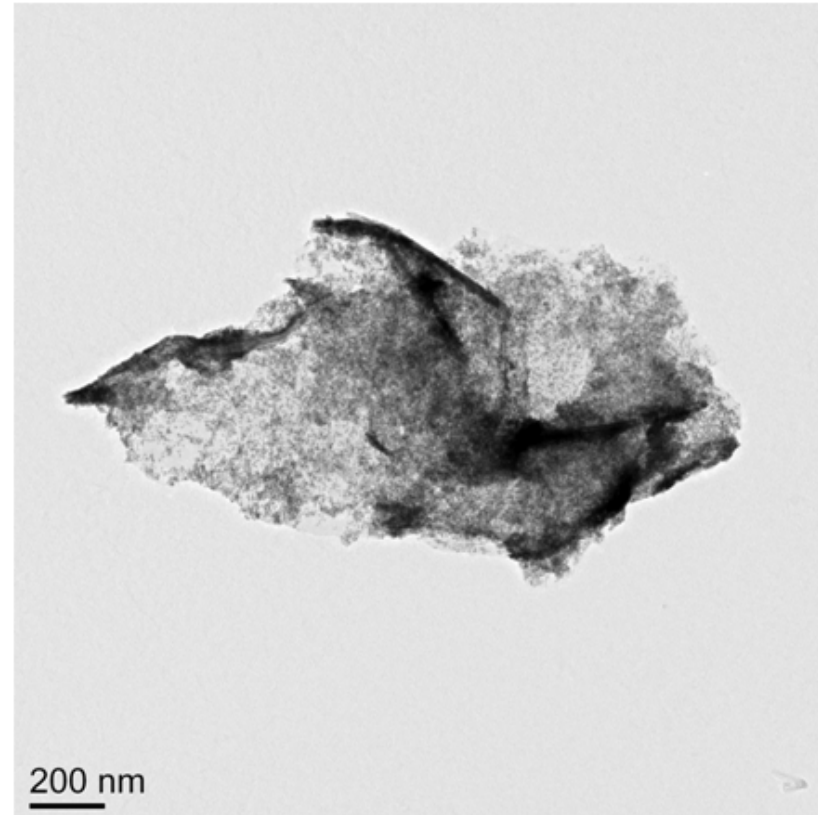
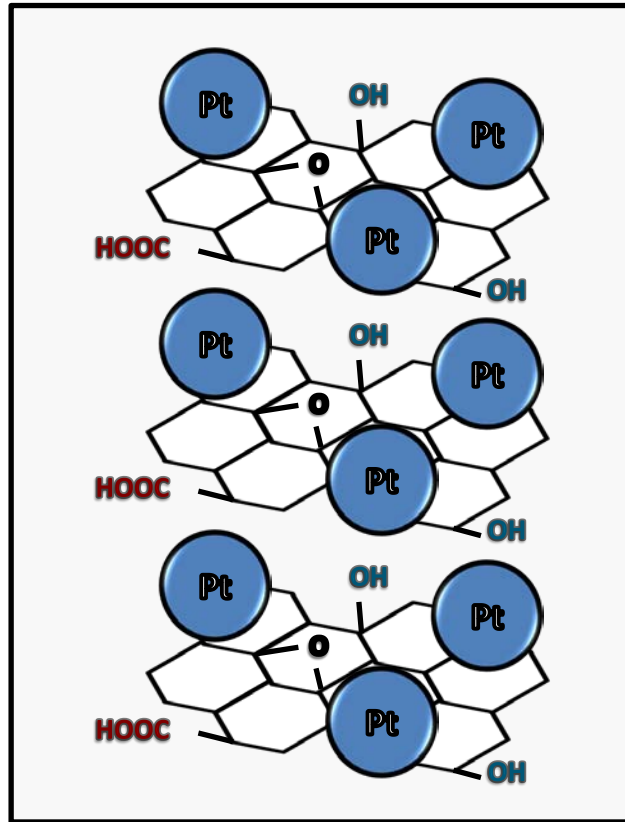


Ethylene Glycol



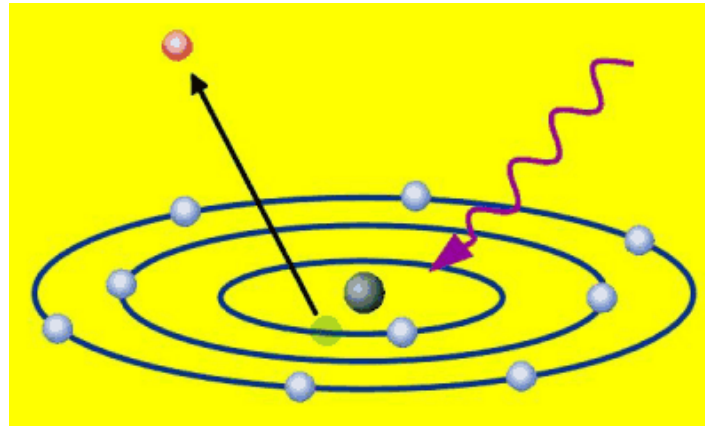
Microwave  
50s - 100s  
700 W

# Synthesis Procedure



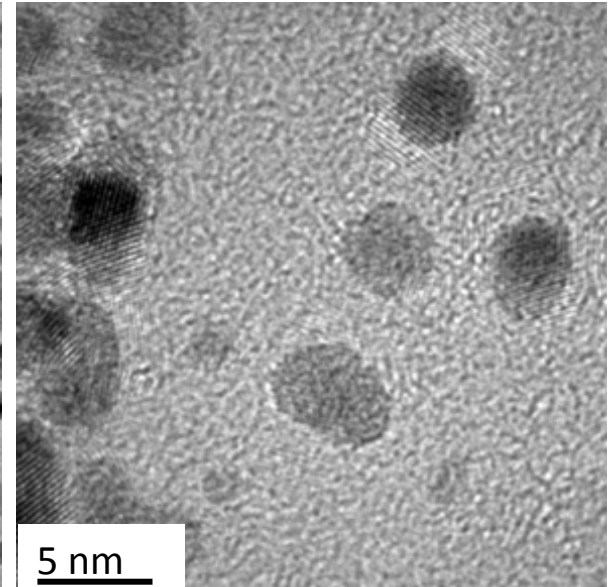
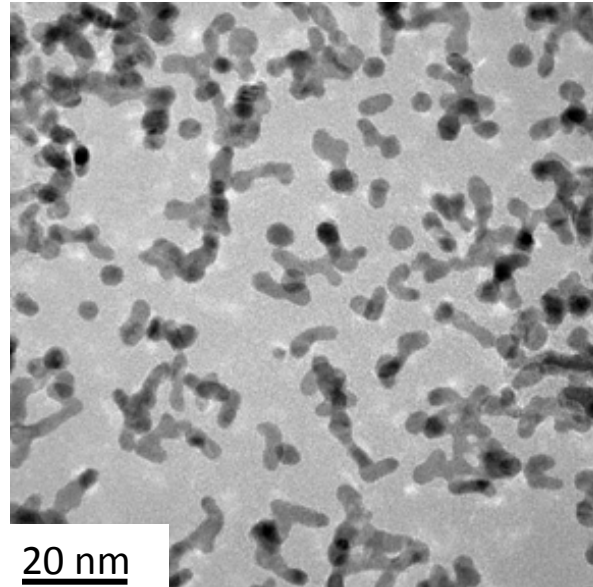
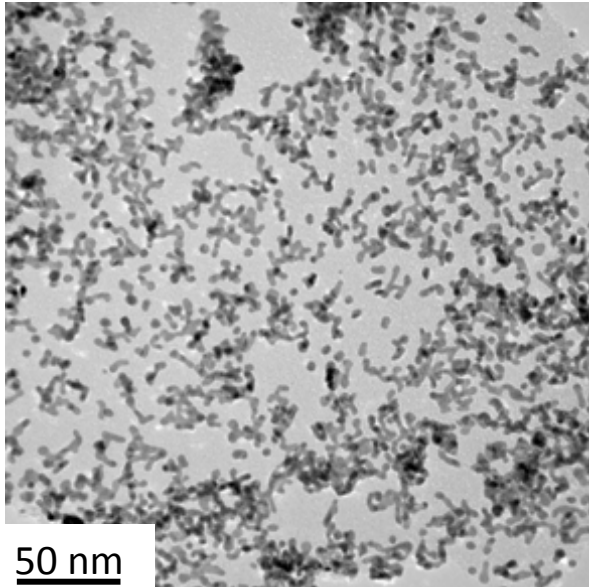
- Established Procedure

Y.-Y. Chu, Z.-B. Wang, D.-M. Gu and G.-P. Yin, *Journal of Power Sources* **2010**, *195*, 1799-1804;  
W.-X. Chen, J. Y. Lee and Z. Liu, *Materials Letters* **2004**, *58*, 3166-3169.

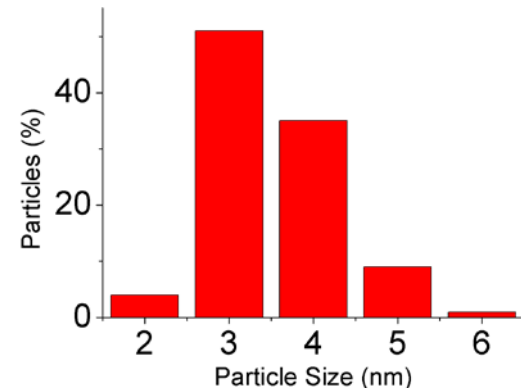


# CHARACTERISATION

# Microscopy Analysis: TEM

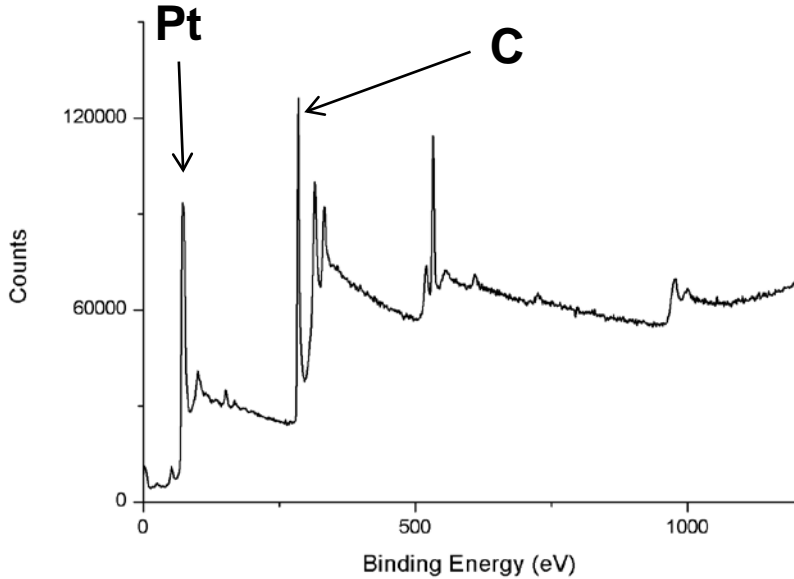


- Well Distributed Pt Particles
- Uniform Particle Shape
- 2-6 nm

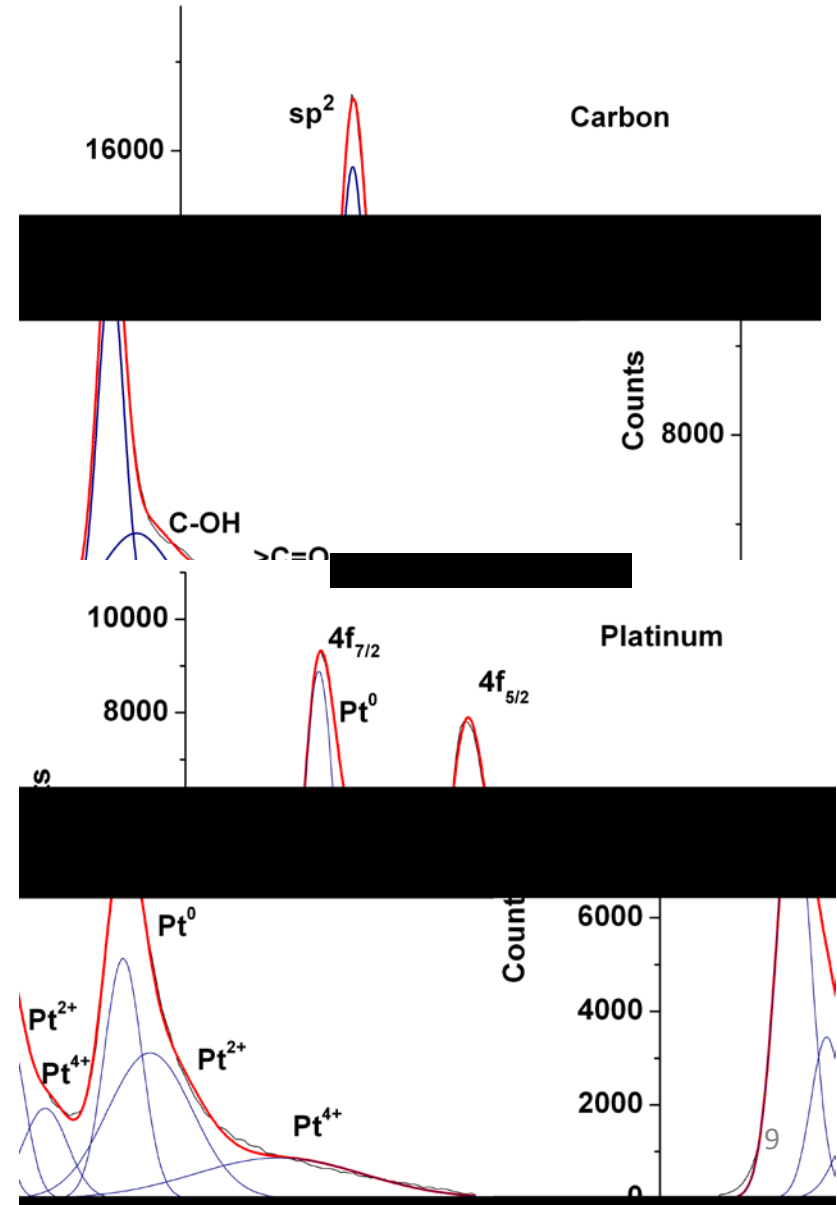




# XPS (X-ray Photoelectron Spectroscopy)



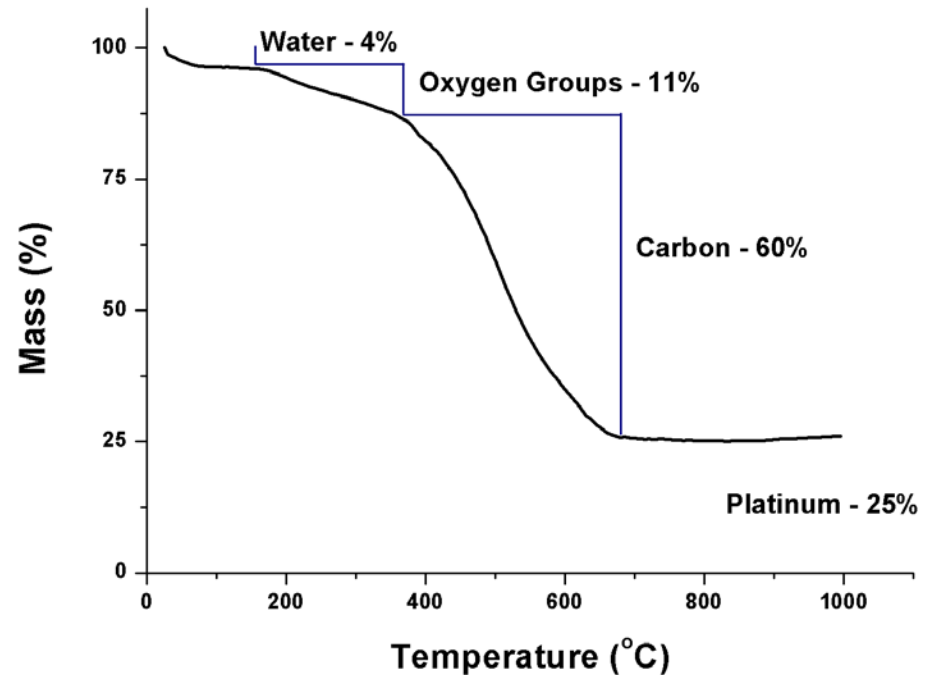
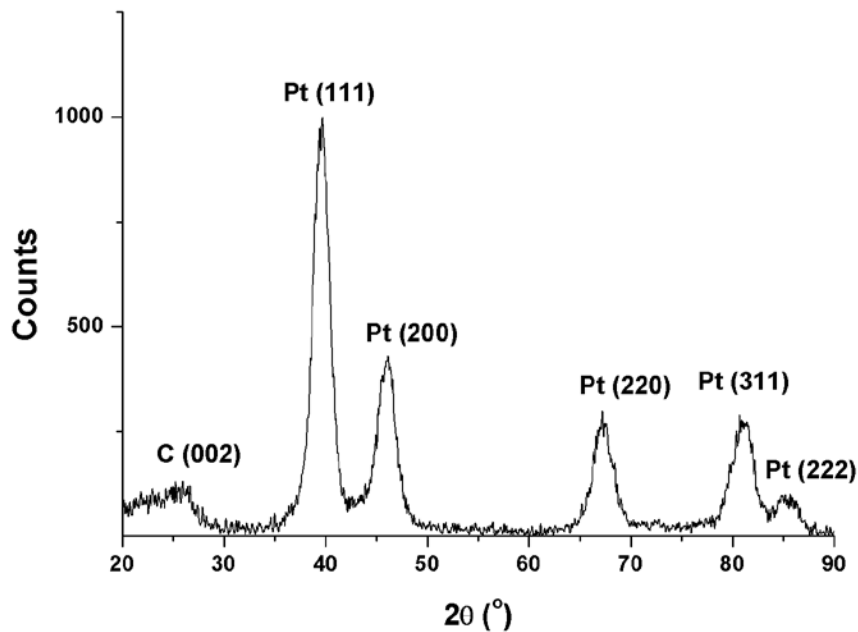
- Platinum particles successfully grown
- Small amounts of oxygen remain



# XRD & TGA

(X-ray Diffraction)

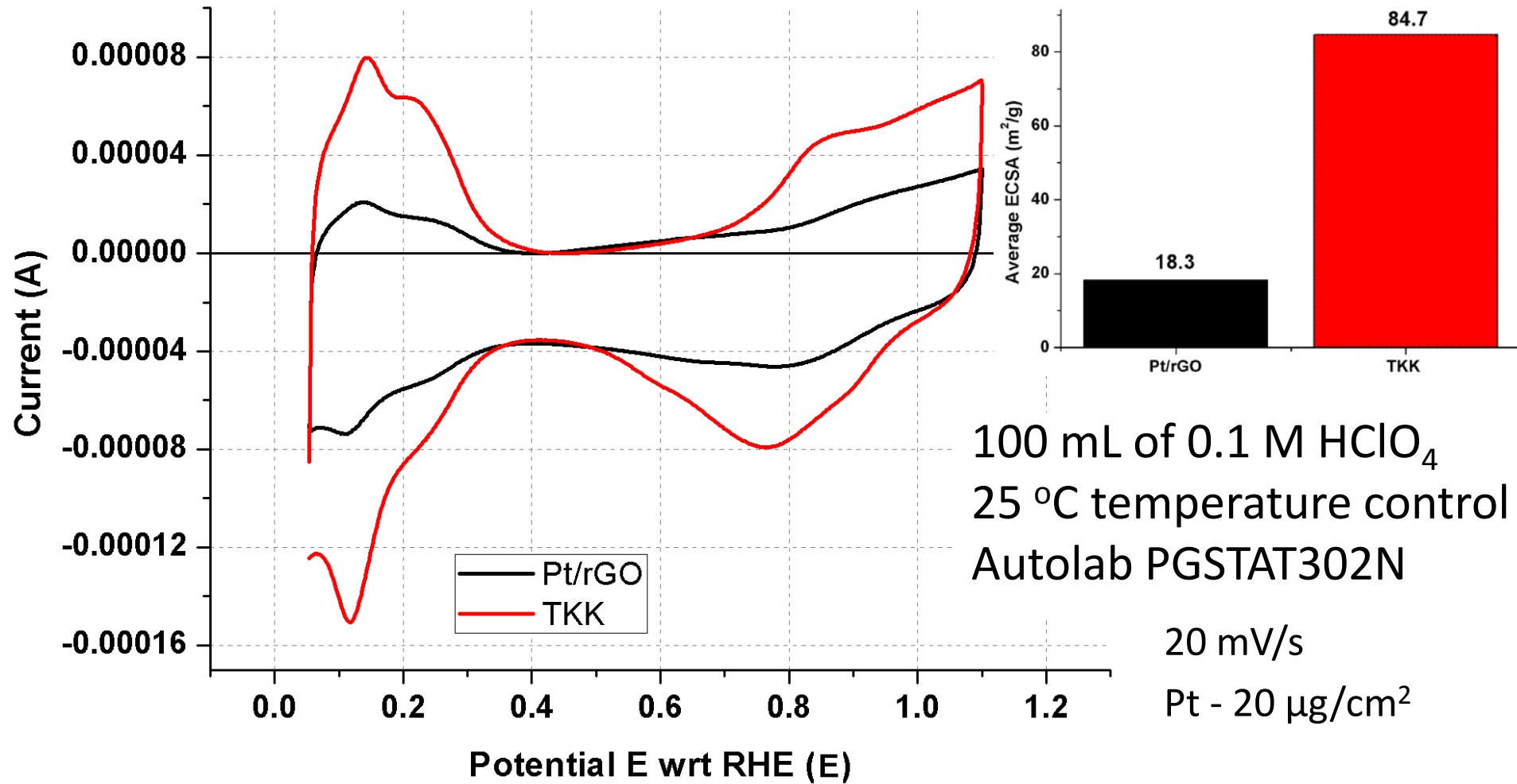
(Thermogravimetric Analysis)



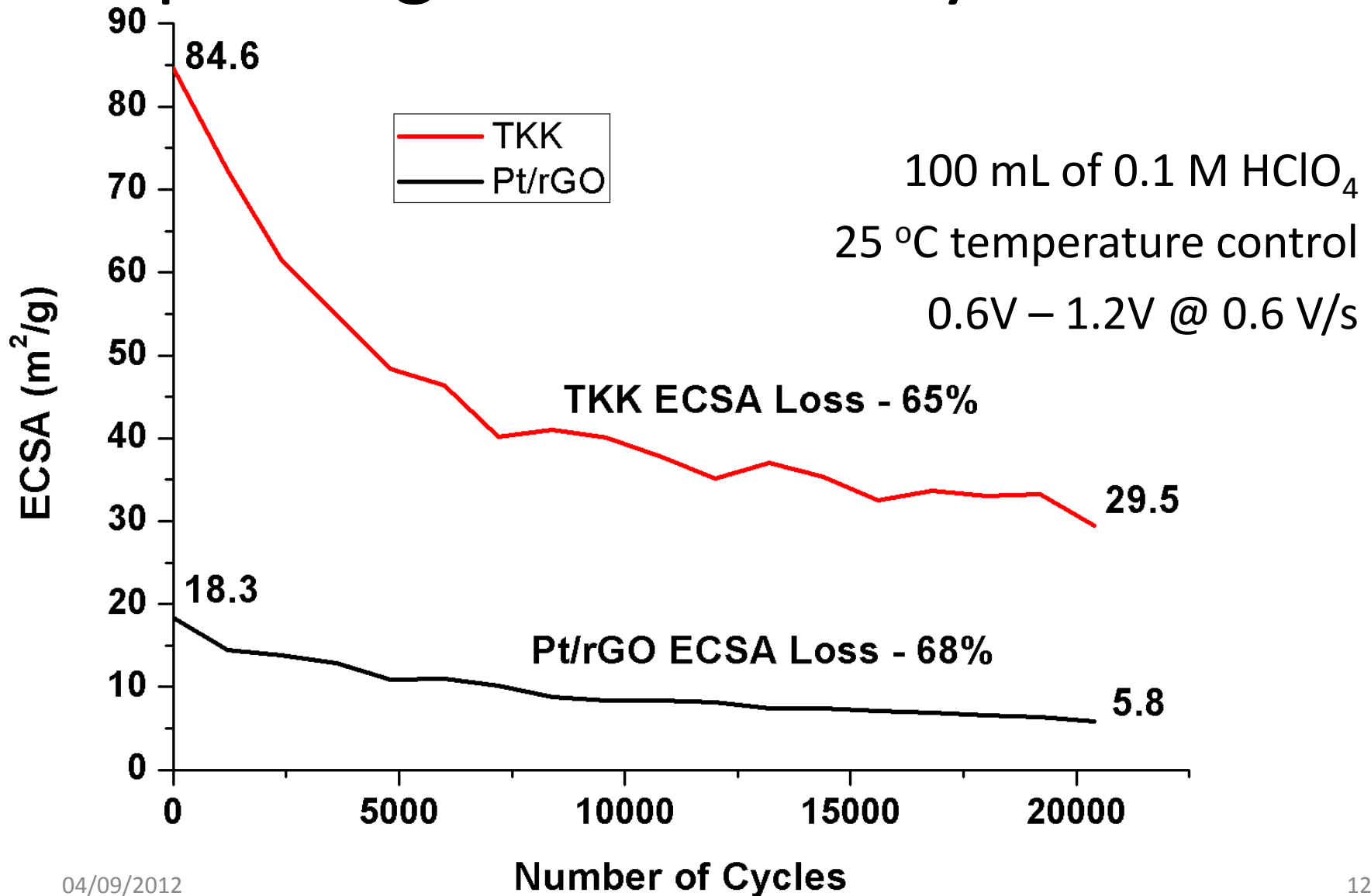
- XRD confirms catalytically active Pt
- TGA confirms Pt loading of 25%

30  $^{\circ}$ C/min ramp rate  
30 cc/min of N<sub>2</sub> and Air

# Cyclic Voltammogram



# Rapid Degradation Study

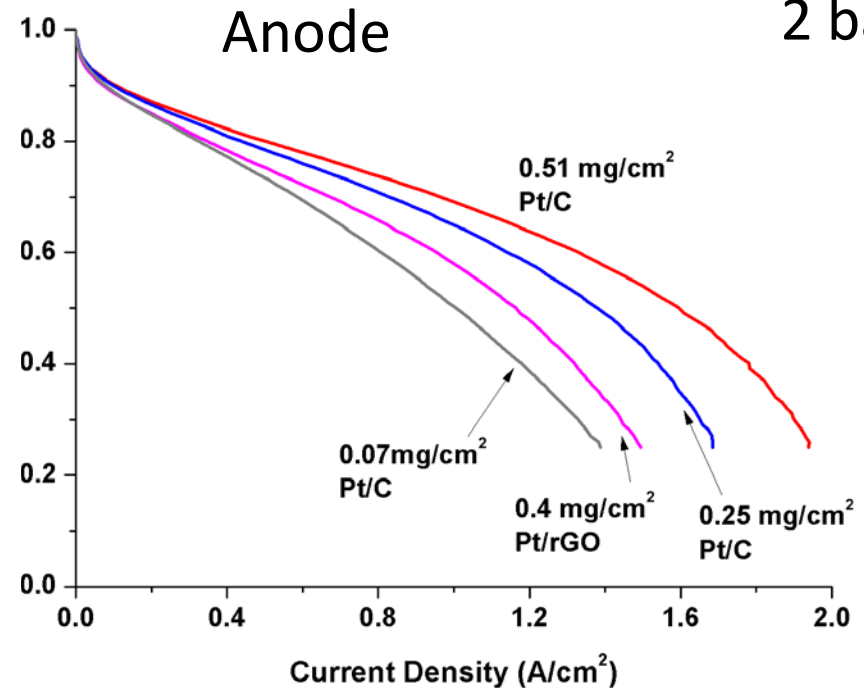
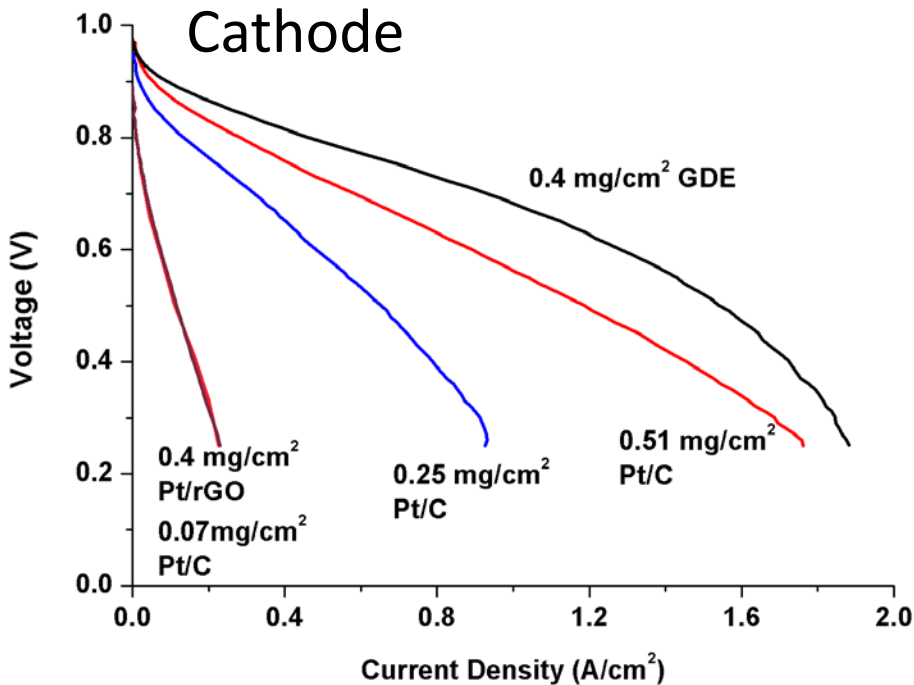


# MEA Testing

1.3 H<sub>2</sub> / 2.40 Air

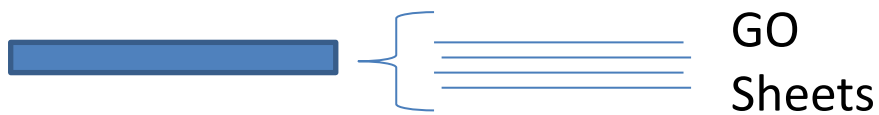
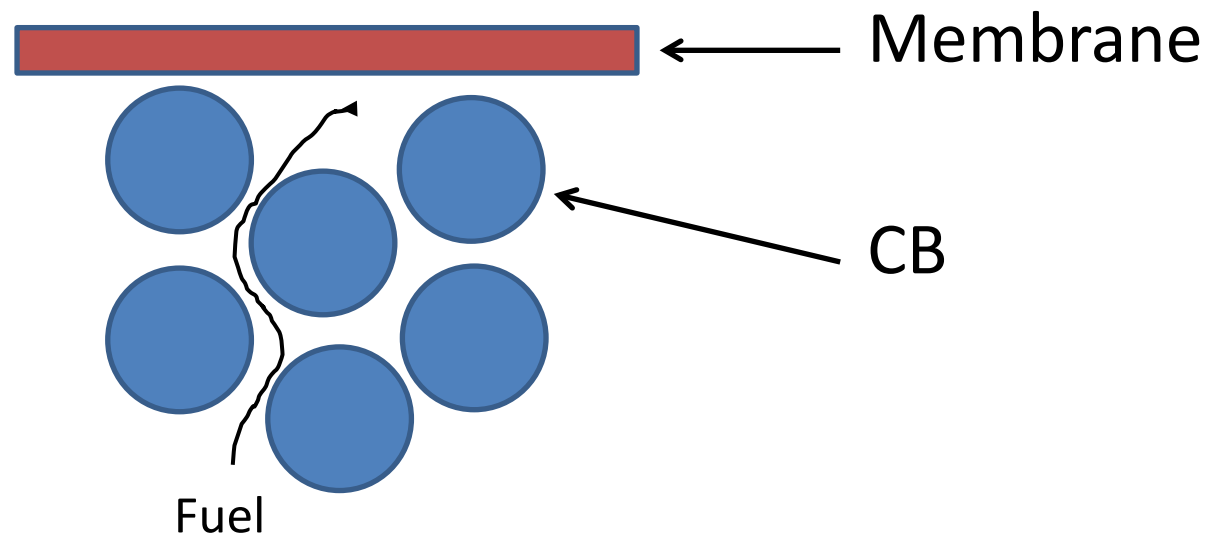
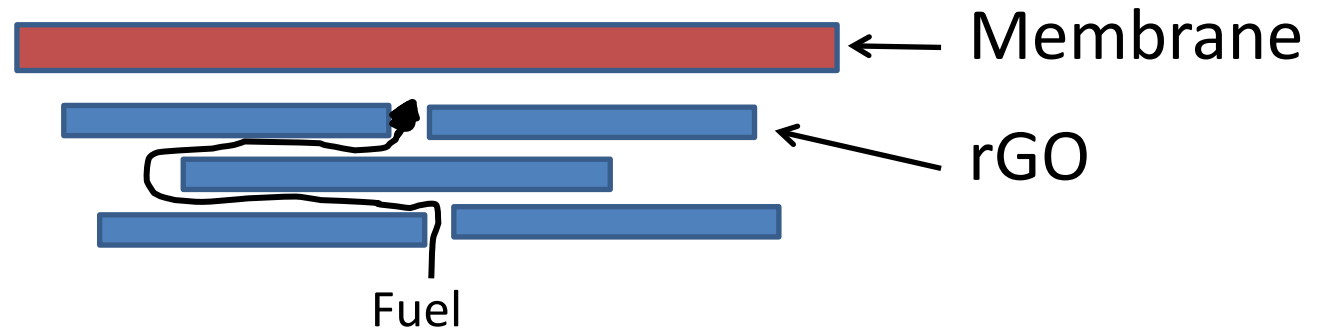
70 °C 100% RH

2 bar

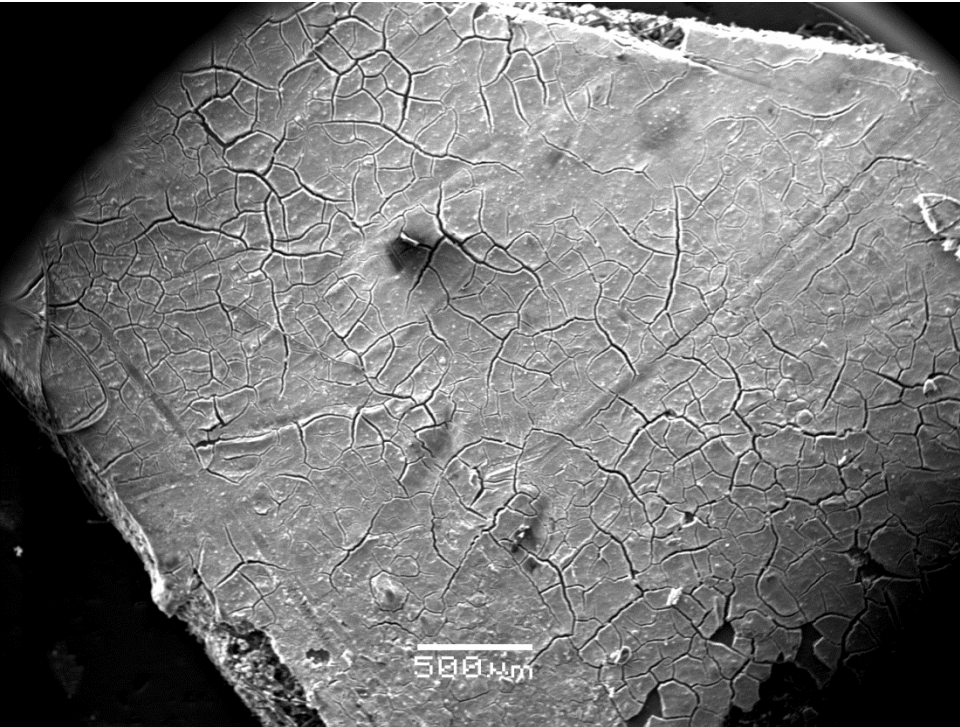


- Cathode – similar performance to 0.07 mg/cm<sup>2</sup> of Pt/C

# Hypothesis

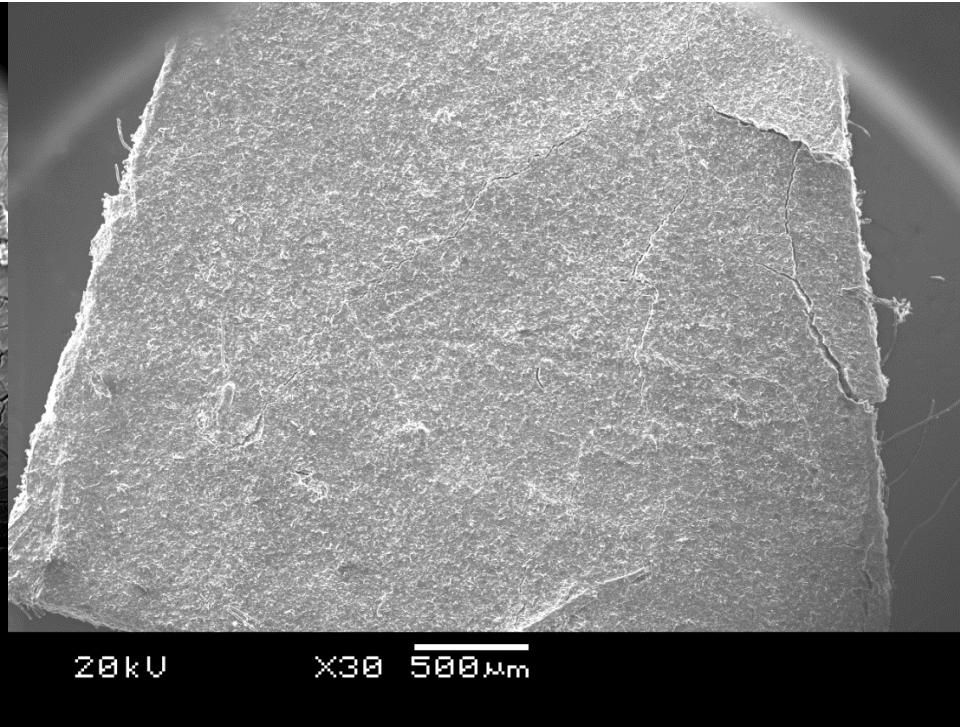


# Microscopy Analysis: SEM



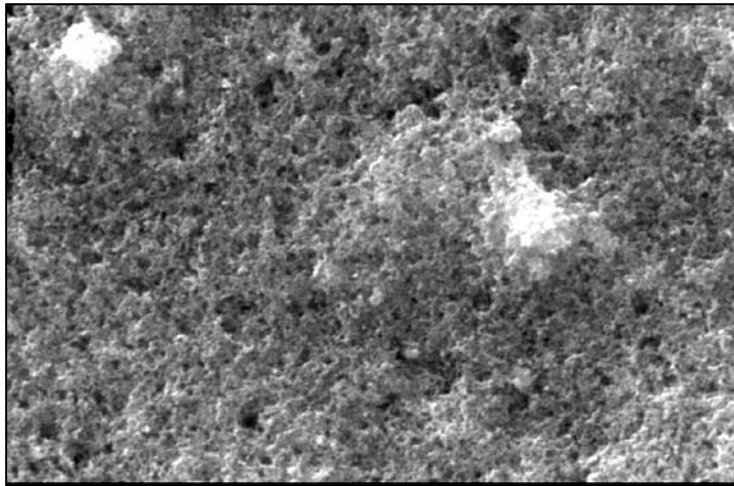
Pt/C

- Pt/C – Cracked surface
- Pt/rGO – Cohesive surface



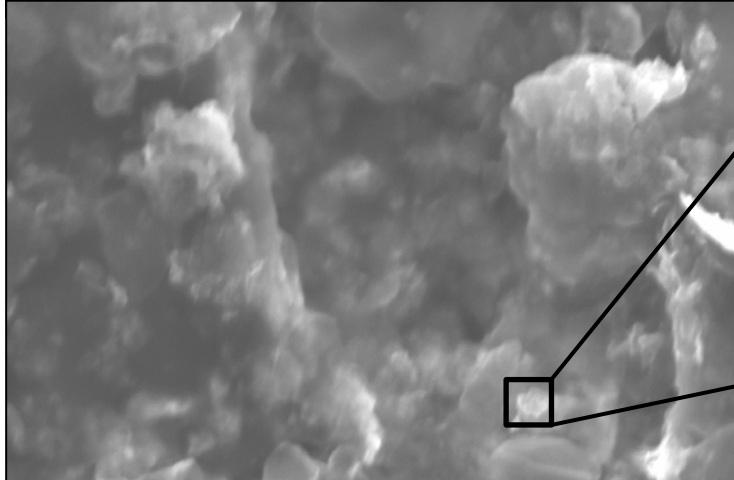
Pt/rGO

# Microscopy Analysis: SEM



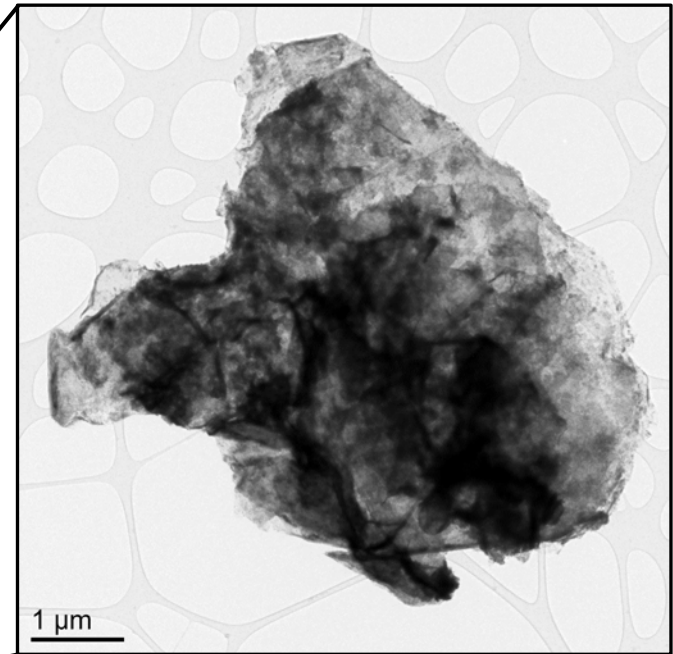
Pt/C

20kV X4,300 5μm 09 56 SEI



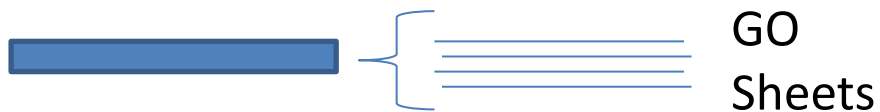
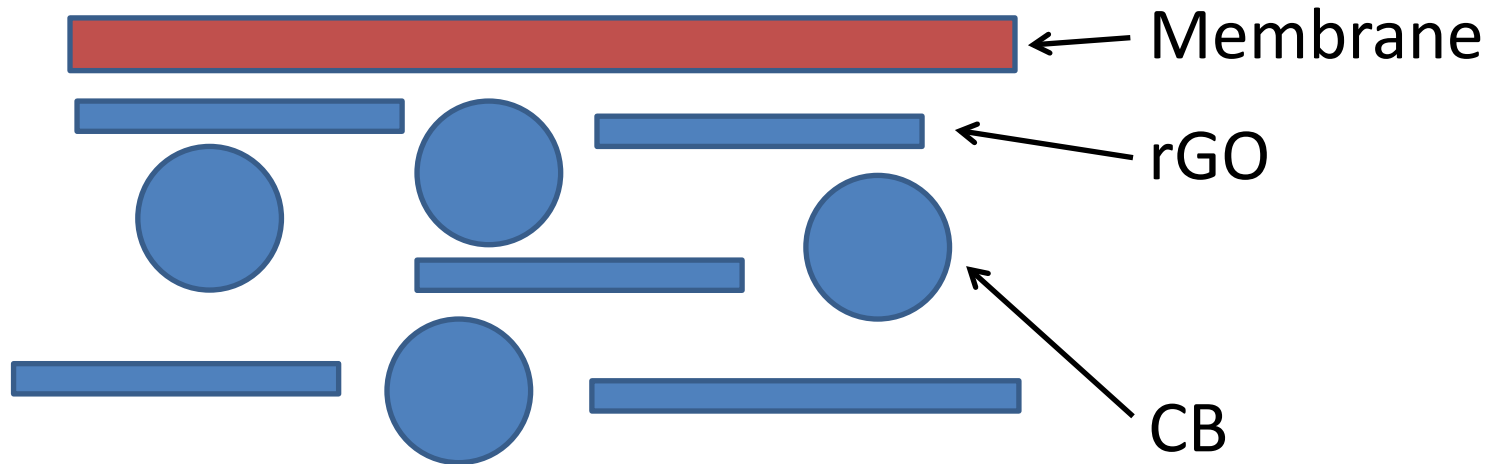
Pt/rGO

20kV X3,300 5μm



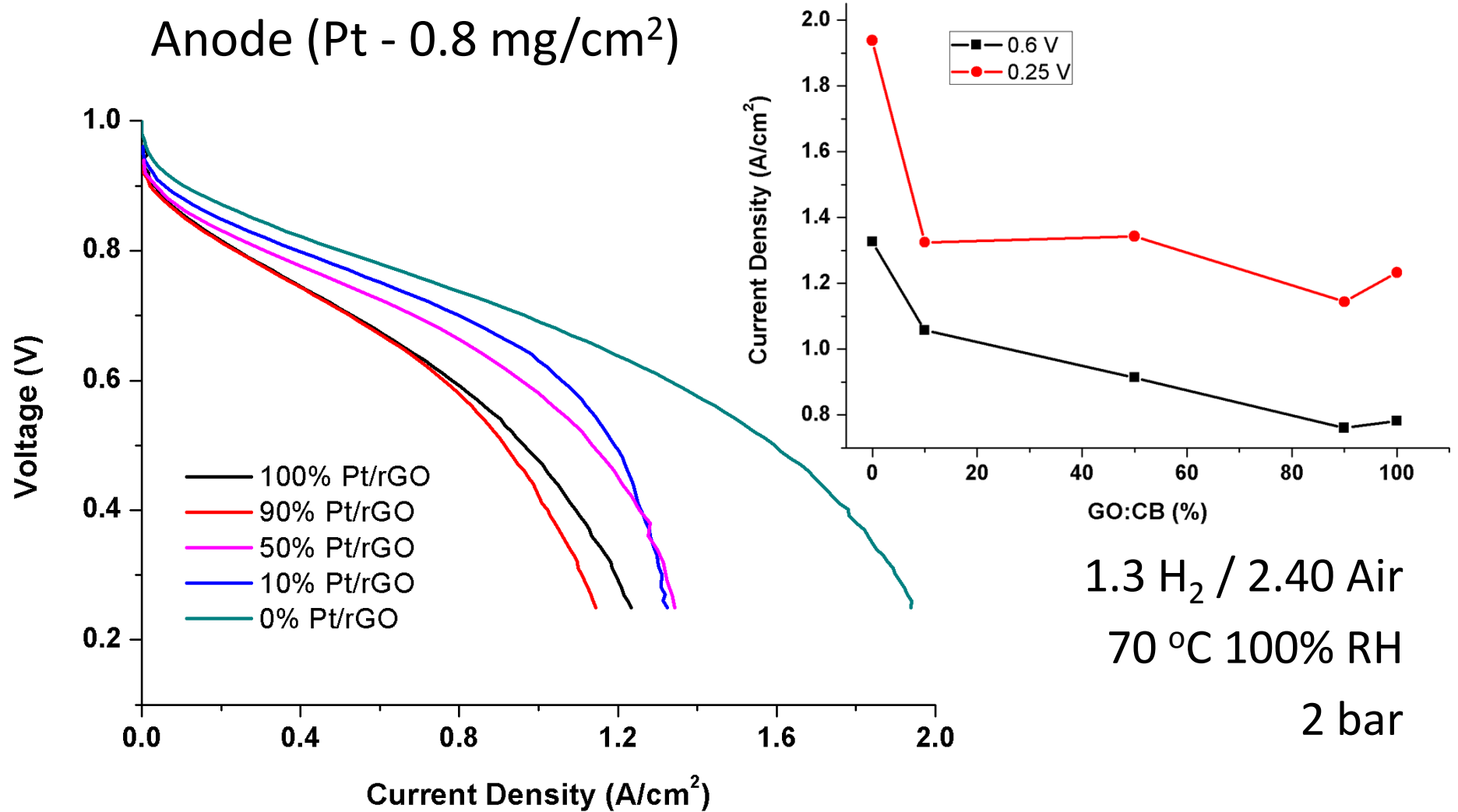


# Next Step: Blends



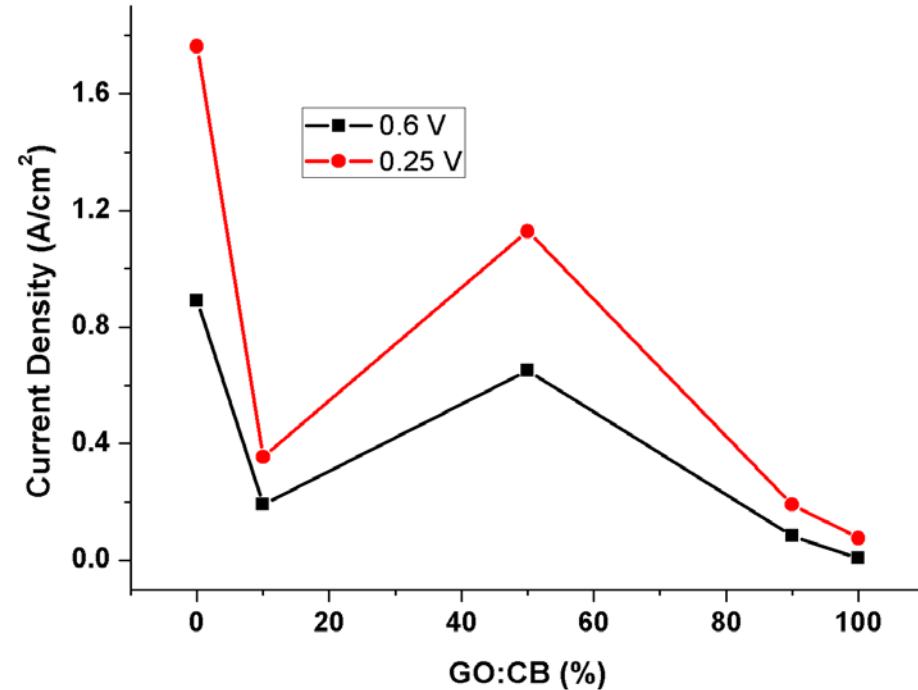
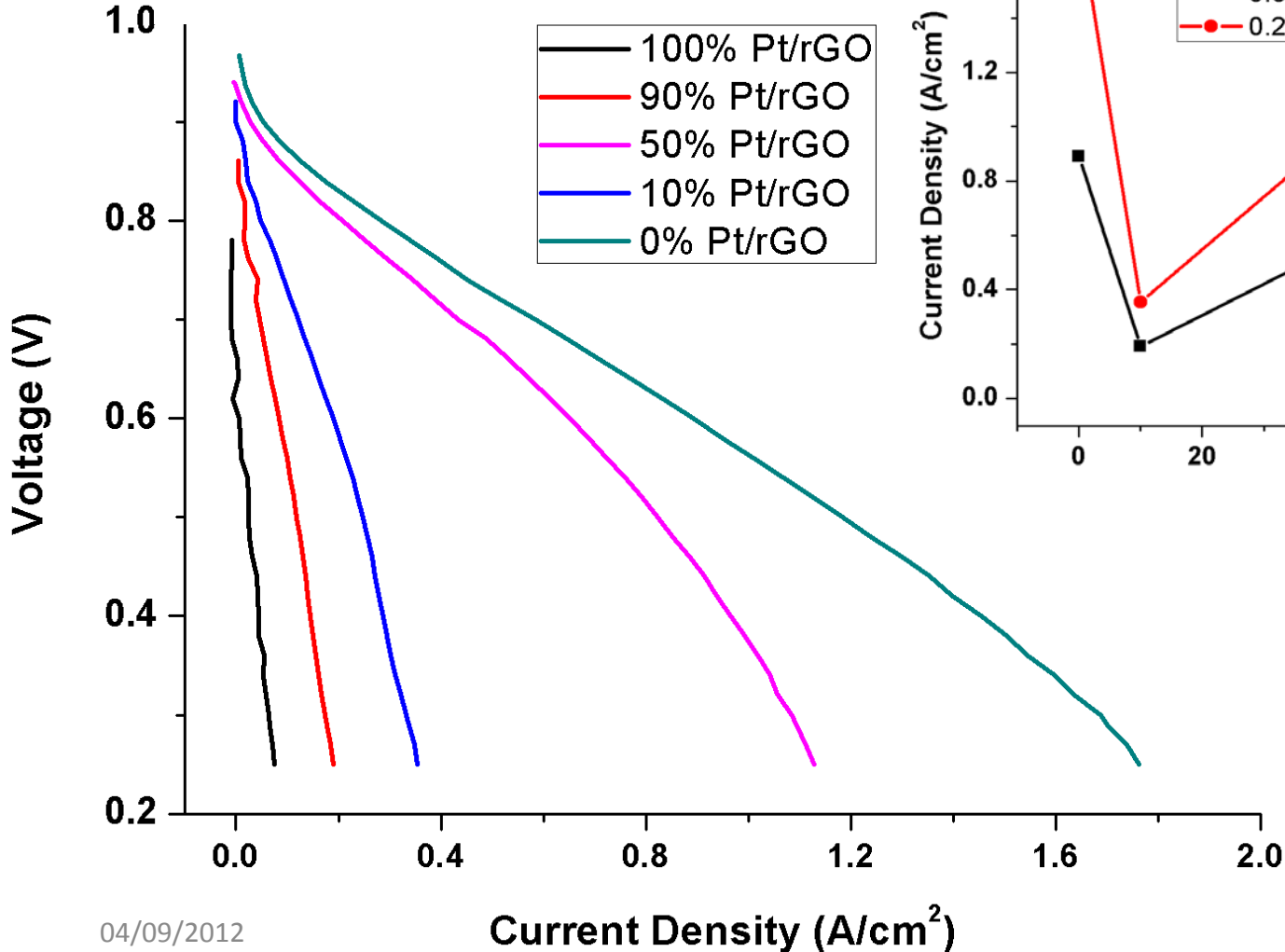
# MEA Testing: rGO:CB

Anode (Pt - 0.8 mg/cm<sup>2</sup>)



# MEA Testing: rGO:CB

Cathode (Pt - 0.8 mg/cm<sup>2</sup>)



1.3 H<sub>2</sub> / 2.40 Air

70 °C 100% RH

2 bar

# Conclusions

- Baseline Analysis of Pt/rGO
- Promising ex-situ results
- MEA results aren't optimistic

# Future Work

- CO tolerance testing
- Investigating water retention
- Testing at high temperatures

# Acknowledgements

- Professor Robert Steinberger-Wilckens
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Research Councils UK

**Energy**



For a Low Carbon Future



**TATA**



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# Thank You For Listening!

Any Questions?

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