DOE Hydrogen Program

2008 DOE Hydrogen Program Review
Platinum Recycling Technology Development

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Project ID #
FCP3

This presentation does not contain any proprietary or confidential information

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Overview

DOE Hydrogen Program

Timeline

- Project start Aug 2003
- Project end Aug 2008
- Percent complete: 90%

Budget

- Total project $3.31M
  - DOE share: $2.65 M
  - Contractor: $0.66 M
- FY07: $0.6 M
- FY08: $0.4 M

Barriers

- Barriers addressed
  - B: Stack Materials and Manufacturing Costs
  - A: Durability
    - (vitality measurements of materials recovered from end-of-life components will identify failure modes)

Partners

- DuPont, Delaware State University, NIST, Ballard, BCS Technology, Plug Power, Queens University

Objectives

- To assist the DOE to demonstrate a cost effective and environmentally friendly recovery and re-use technology for PGM containing materials used in fuel cell systems.
- Use new processes that can also separate and recover valuable ionomer materials
  - DOE 2010 *targets* for membrane costs indicate membrane has value equal to the PGM

Milestones

- Water based solutions containing recycled /purified ionomer were successfully re-manufactured into fuel cell membranes
- These re-manufactured membranes were rebuilt into a GENCORE™ 5kW fuel cell stack. Even recycled catalyst was used on some of the cells.
- New test developed for testing oxygen reduction reactivity of recovered catalyst particles.

Approach

- Use solvents to “dissolve” ionomer and physically separate catalyst from ionomer solution in 1-5 sq meter batch sizes.
- Make best attempt to re-manufacture catalyst coated membrane with recovered materials; although may not be commercially acceptable
- Will learn failure modes of MEA materials used in fuel cells; ionomer and catalyst
- Use analytical techniques to determine the differences between used and virgin materials
- Determine the limits of separation technologies
- Economic analysis at pilot scale equipment will be used to determine feasibility of approach.
- Value of recovered NAFION® will likely be found in different application other than fuel cells; e.g. acid catalysis for organic synthesis.

Technical Accomplishments/ Progress/Results

- Re-manufactured membranes were made in large quantity from water based dispersion processing of the MEAs and show good performance in fuel cell

- Study of used catalyst shows marginal catalyst activity for re-use in fuel cells

- Economic analysis indicate process costs represent less than 5 % of the PGM content of the 2015 DOE Target MEA specification

Technical Accomplishments

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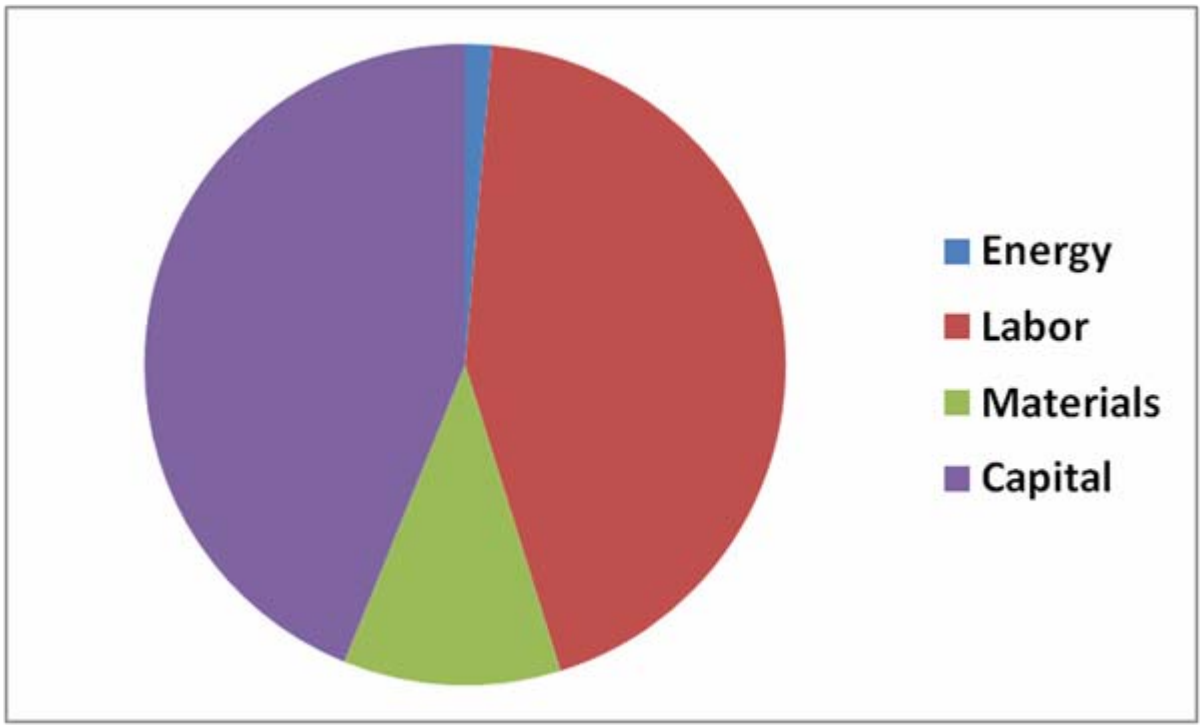
Processing Costs for a 30 kg Batch of DOE 2015 Target MEAs (1 mil membrane, 0.2 mgPt/cm^2)



$451
Total Cost

Output Yields ~ $20,000 worth of Pt ($2000/try oz)

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Technical Accomplishments

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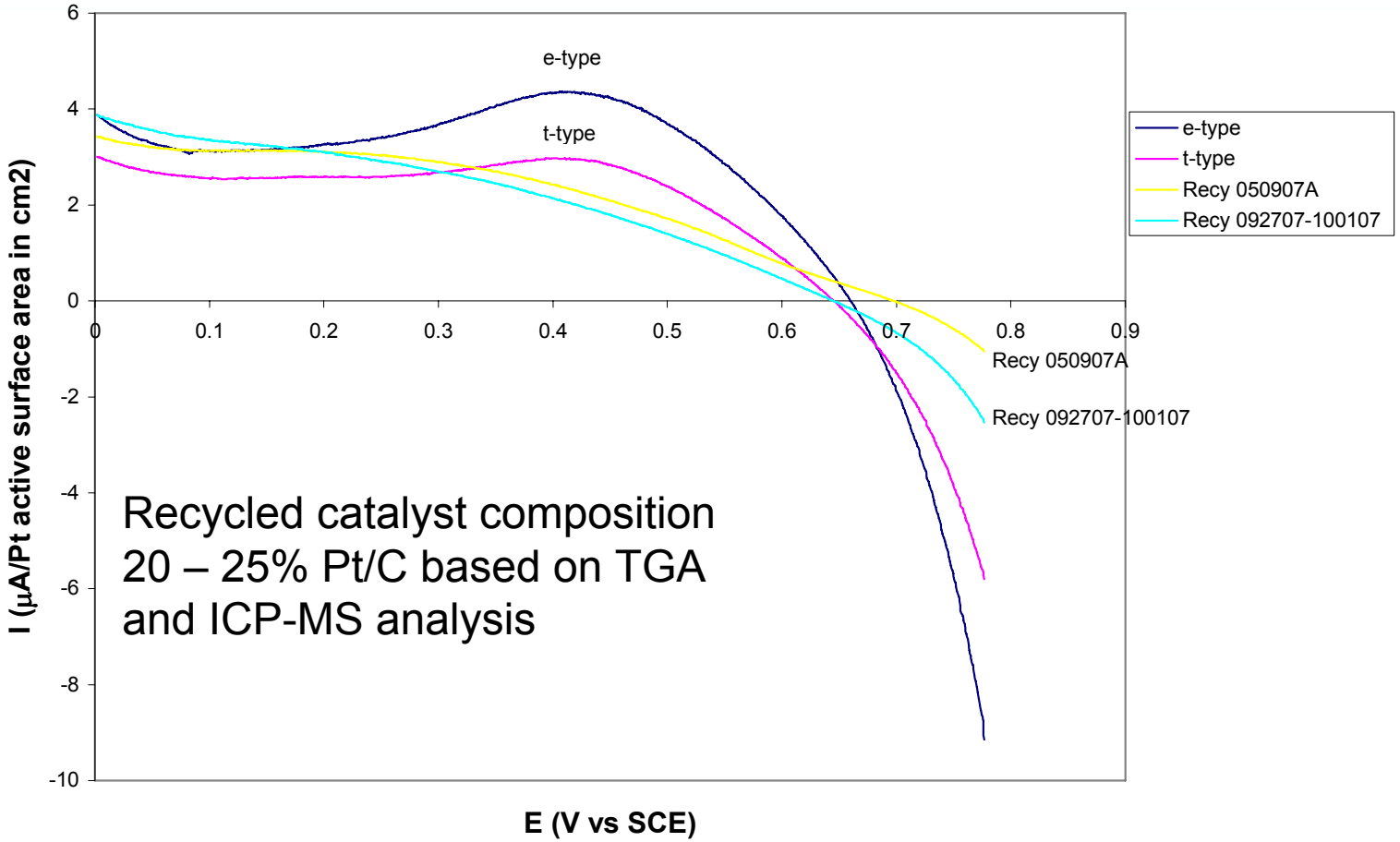
Oxygen Reduction Reactivity of Recycled Catalyst and Two Types of New Catalysts



Conclusion: Recycled Catalyst has “good” mass activity for ORR

Shape of curve is different, as compared to New Catalyst, could be due to low Pt/C ratio

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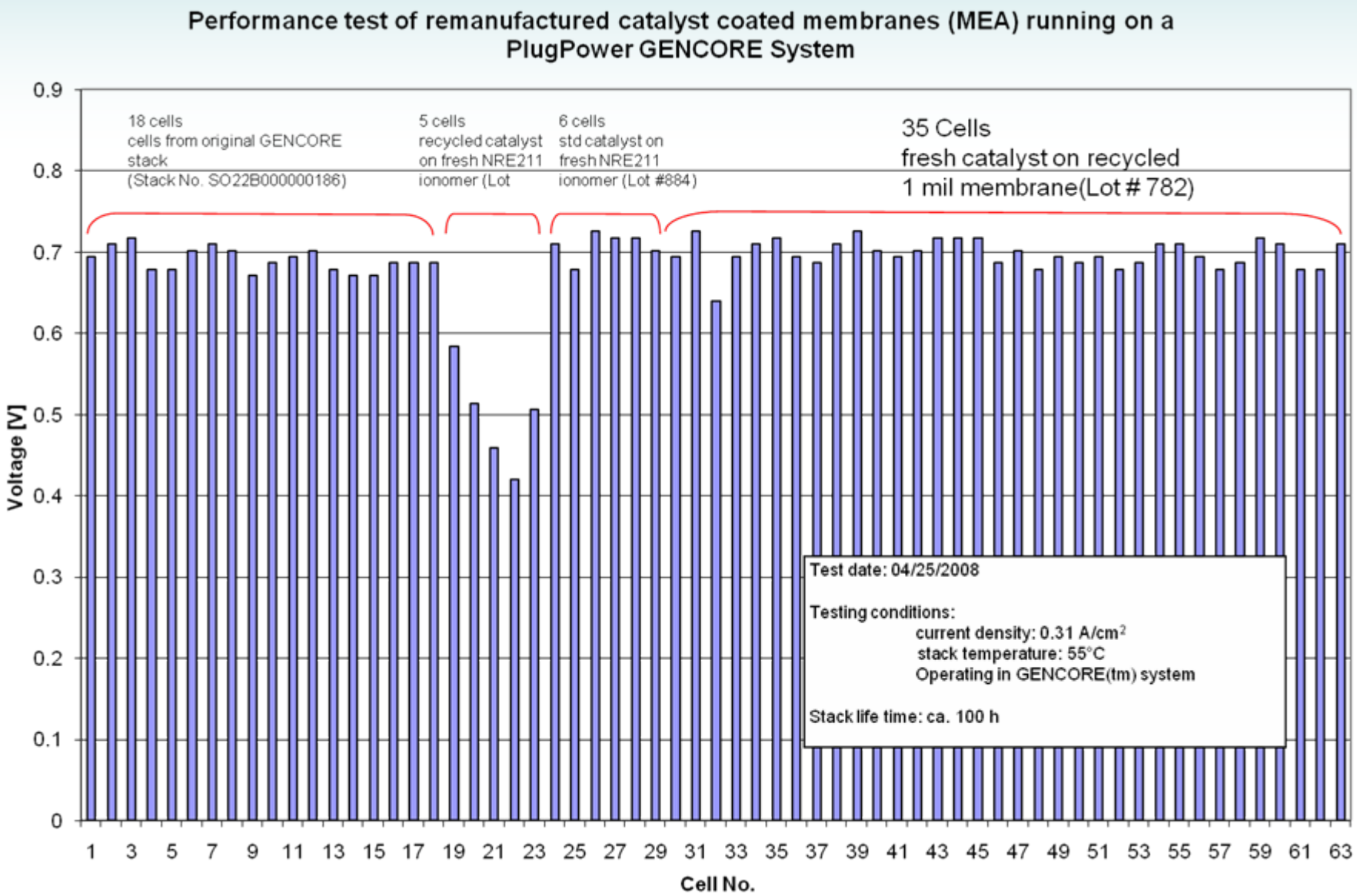
Technical Accomplishments



Conclusion: Re-manufactured membranes operate equal to new membranes,
Recycled Catalyst is lower in Power Density

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5kW GENCORE operating on Re-manufactured MEAs

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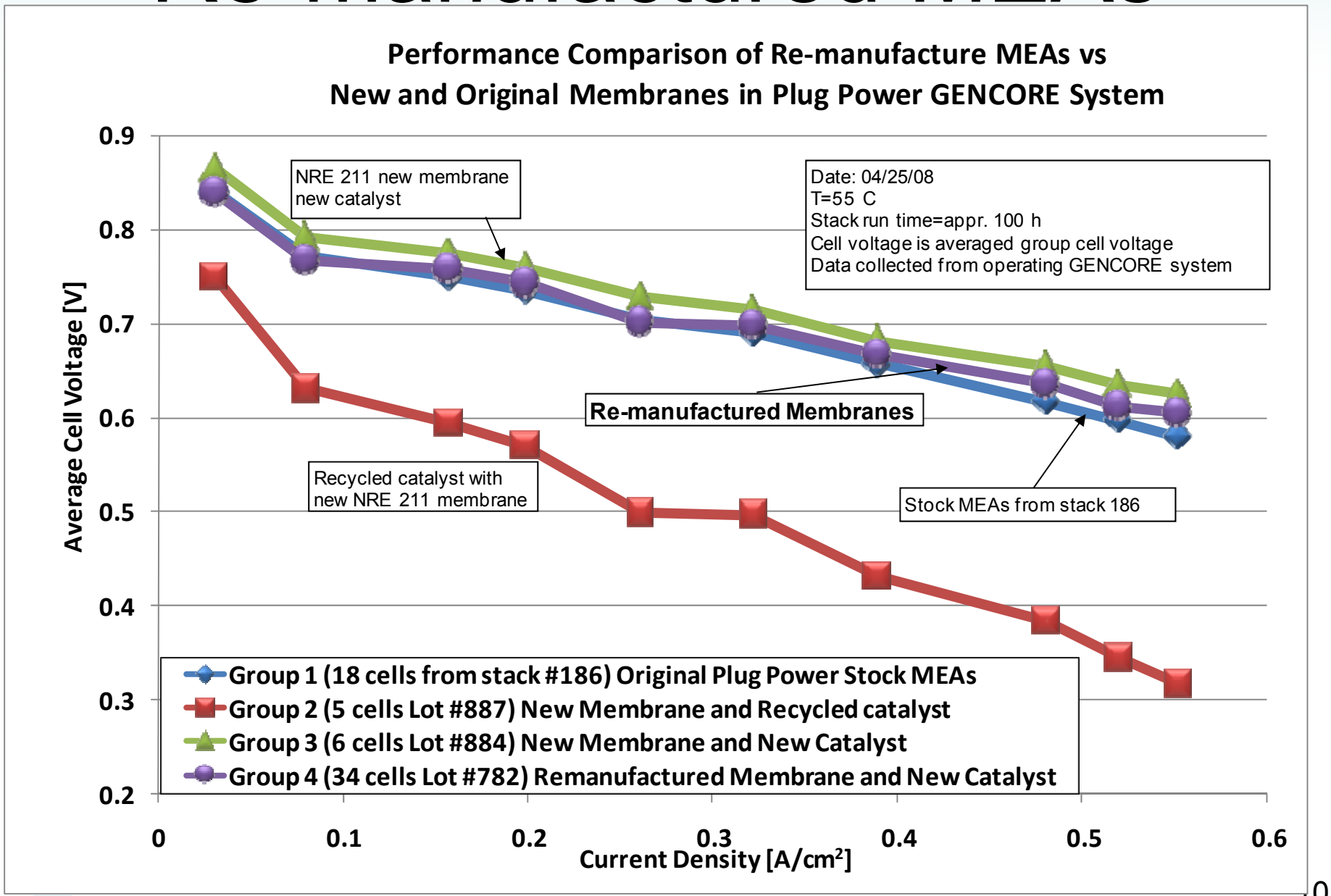

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Future Work

- FY08: Further development needed to remove all PGM from diffusion media,
  - Target is being set at 0.05 wt% PGM remaining on diffusion media

Project Summary

- Recovery and separation work at scale-up has been demonstrated. Good recovery rates are being achieved
- Recovered Polymer can be re-manufactured into fuel cell membranes.
- Effective removal of trace amounts of PGM from diffusion media needs more development