Fuel cell testing: an MEA manufacturer perspective

James Keating Test Team Supervisor

Technology Centre Blount's Court Sonning Common Reading RG49NH, UK

Keatij@matthey.com +44(0)118 924 2131





Johnson Matthey Plc



A long history in fuel cells...

 JM supplied platinum electrodes for the first fuel cell demonstration in 1839

JM catalysts have been used in space programmes since the 1960's

JM R&D on PEM fuel cells since 1992



Fig. 6

Fig. 7.



Products and Production Capability

- HiSPEC[®] Fuel Cell Components
 - Electrodes, 3, 5 and 7 layer MEAs
 - Hydrogen, reformate & direct methanol systems
 - Automotive, stationary & portable applications

HiSPEC[®] Fuel Cell Catalysts

- Hydrogen, reformate, direct methanol & phosphoric acid systems
- Supported and unsupported variants
- **Precious Metals Management**
 - Refining of MEAs and catalysts
 - Platinum purchasing options





JMFC Test Facility

- Customer focused
- Diagnostic critical to our work
- Performance and durability testing conducted on PEM, DMFC and PAFC
- Accurate and reproducible testing extremely important
- Automation allows testing to proceed 24 hours a day throughout the year



Customer Hardware and Test Protocols

Rapid screener testing (50cm²)

- Mass transport in GDL, microlayer and/or catalyst layer often hardware dependent
- Wide range of temperature, pressures and humidification required by customer (need accuracy across the range without the need for recalibration)
- Need to study full MEA behaviour not a simple acceptance test





Fast turn around, flexible screening tools used for initial component development

Scale-up to large single cell (generic and customer) once basic understanding achieved









Humidification Diagnostics



3-Way-Ox Diagnostic



JM Solution Johnson Matthey Fuel Cells

3-Way-Ox Diagnostic



Compression Diagnostics



Anode Diagnostics

Voltage loss with 25% N₂ Dilution





Reformate sensitivities



Voltage Loss with 75% H2/25% CO2/100 ppm CO



Cell Resistance

Important to use multiple techniques and not to be reliant on one single method





Reproducibility and Repeatability studies



The Importance of Calibration

Test stand calibrated annually for following parameters:

temperature pressure gas flow coolant flow current voltage hardware trips safety sensors





Johnson Matthey Fuel Cells *the power within*

Fuel Cell Test Facility PEM Diagnostics

- **3Wayox** Automated Current interrupt resistance - Automated AC resistance/ HFR- Automated **Reformate blending – Automated** Compression testing – Semi automated Humidity sweep - Automated Leak current - Semi automated Fluoride release rate sampling – Automated Water balance measurement – Automated **Drive cycles – Automated AC-Impedance Transient studies – Automated** Leak rate and short resistance – Use as QC tools
- Cyclic Voltammetry

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Mass spectrometer and micro GC



JM Fuel Cells - MEA Test Facility

- Reproducibility, Accuracy, Reliability ... RARE!
- R&R, E-stop frequency and calibration more critical than utilisation!
- Smart fully automated, validated, diagnostics need to form the basis of MEA testing
- In order to troubleshoot problems early important to keep variables to a minimum
- Smart troubleshooting tools and good support team essential to maintaining quality
- Continuous improvement program

