

In-situ investigation of the cathode catalysts for PEM fuel cells using differential electrochemical mass spectrometry

Differential electrochemical mass spectrometry (DEMS) involves applying a potential across an electrochemical cell and measuring the resulting current while concurrently analyzing gas products with a mass spectrometer. We used DEMS to investigate the mechanism of carbon support corrosion (CSC) in-situ at the cathode of proton exchange membrane fuel cell (PEMFC). The cathode exhaust gases were sampled with a Hiden Analytical QIC-20 mass spectrometer. The spectra of gases were correlated in our laboratory for the first time to characterize most reactions that happen at the cathode in a real PEMFC. Moreover, the sensitivity and resolution of DEMS were improved significantly to enable study of a 5 cm² membrane electrode assembly (MEA), which makes it very convenient for researchers to compare different catalysts in PEMFC. To further understand the mechanism of CSC, oxygen was isotopically labeled by replacing regular water with oxygen-18 (¹⁸O) enriched water (H₂¹⁸O, 98%) in DEMS. Among many surprising results, we showed that water – not oxygen – was the main reaction intermediate in CSC. Knowledge of the CSC mechanism disclosed in our study will boost the design of new carbon supported catalysts for PEMFC with longer lifetime.

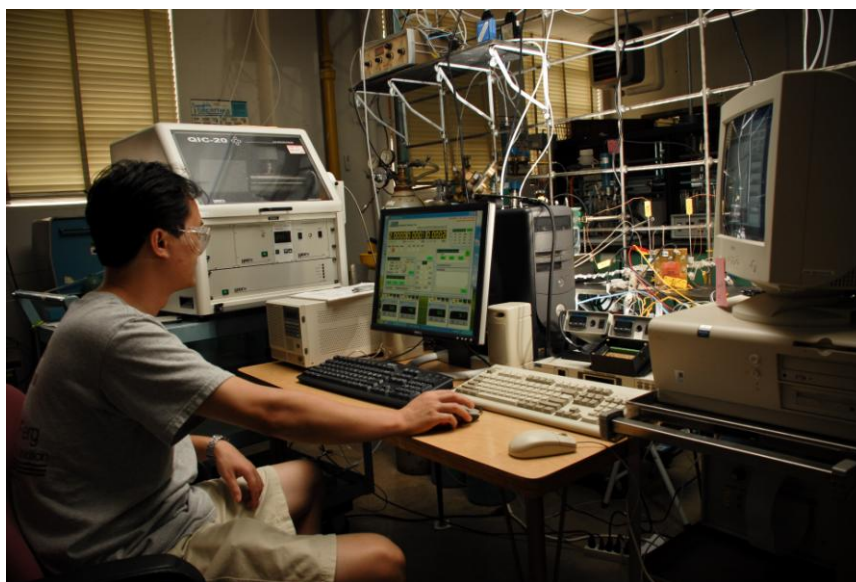


Fig 1. In the Lab with the Hiden QIC-20 Gas Analysis System

Hydrogen adsorption/desorption from solution is a common method to determine the electrochemically active surface area (ECSA) of a few transition metals. However, it is not straightforward because of the overlap between overpotential (HOPD) and underpotential deposited hydrogen (HUPD). We demonstrated for the first time how to resolve HOPD and HUPD by DEMS to determine the ECSA of the Pt electrode in a PEMFC. This method has the potential to be extended to other transition metals in acidic or basic media.

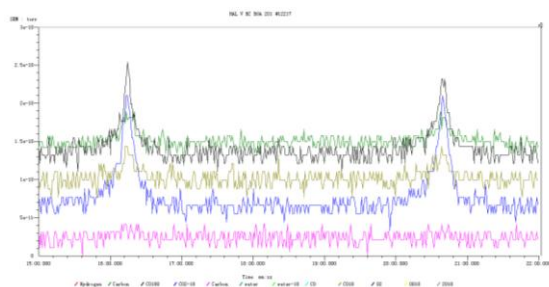


Figure 2. A screen shot of the MS spectra from an oxygen-18 labeled CSC experiment

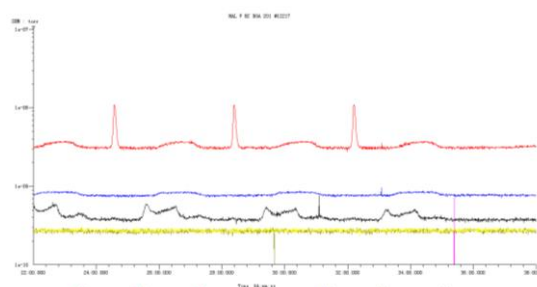


Figure 3. A screen shot of the MS spectra from an experiment for resolving the H_{UPD} and H_{OPD}.

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“Analysis of oxygen sources and reaction pathways of carbon support corrosion at the cathode in PEMFC using oxygen-18 DEMS” Electrochimica Acta, Volume 55, Issue 22, 1 September 2010, Pages 6926-6931

Hidden Product:

QIC-20 Gas Analysis System
(QIC-20 System now updated with the New QGA Atmospheric Gas Analysis System. This latest version was released in 2010).

Follow the link to the product catalogue on our website for further information:

<http://www.hiddenanalytical.com/index.php/en/product-catalog/181-gas-analysers-qic-series>