HIDEN ANALYTICAL

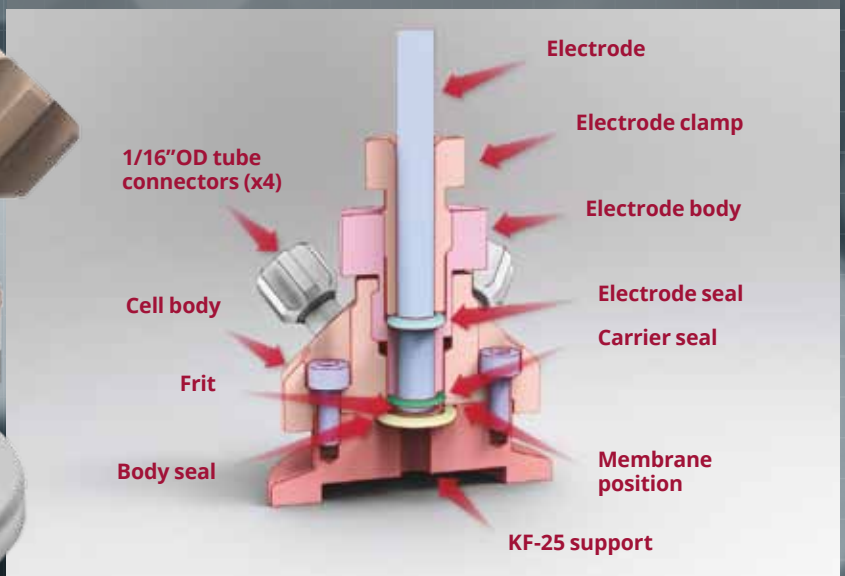
Differential Electrochemical Mass Spectrometry (DEMS)

SOLUTIONS FOR DISSOLVED GAS ANALYSIS AND OFF-GAS ANALYSIS IN ELECTROCHEMISTRY

Hiden Analytical DEMS Cell

Key Features

- Differential Electrochemical Mass Spectrometry (DEMS) is an analytical technique that combines electrochemical half-cell experimentation with mass spectrometry
- It allows in situ mass resolved determination of gaseous or volatile electrochemical reactants, reaction intermediates and products in real time
- Hiden Analytical offer a range of DEMS cells with electrolyte/nanoporous sampling interface to the Hiden HPR-40 DSA Mass Spectrometer



Vitreous Carbon – User coatable working electrode	Replaceable nanoporous membrane
4 Ports for additional electrodes	Interface to the Hiden HPR-40 DSA

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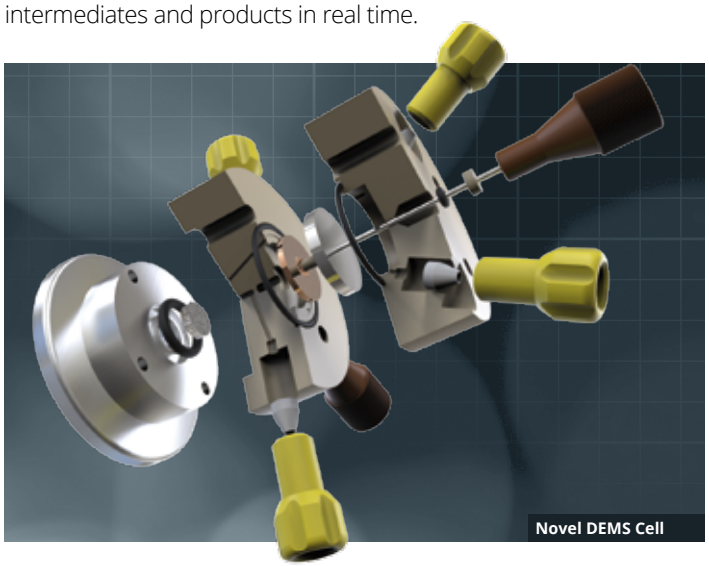
Novel DEMS Cell

Hiden Analytical have a new license agreement with The University of California, Berkeley Lab. Under the terms of the agreement Hiden Analytical will commercialize a novel differential electrochemical mass spectrometry (DEMS) cell for integration with the Hiden Analytical range of membrane inlet mass spectrometer systems. The new cell, developed by Ezra L. Clark and Prof. Alexis T. Bell, coupled with Hiden's differentially pumped mass spectrometer system provides for in-situ mass resolved determination of gaseous or volatile electrochemical reaction intermediates and products in real time.



A novel differential electrochemical mass spectrometry (DEMS) cell for integration with the Hiden Analytical HPR-40 DSA membrane inlet mass spectrometer systems. The new cell, developed by Ezra L. Clark and Prof. Alexis T. Bell of The University of California, Berkeley Lab, coupled with Hiden's differentially pumped mass spectrometer system provides for in-situ mass resolved determination of gaseous or volatile electrochemical reaction intermediates and products in real-time.

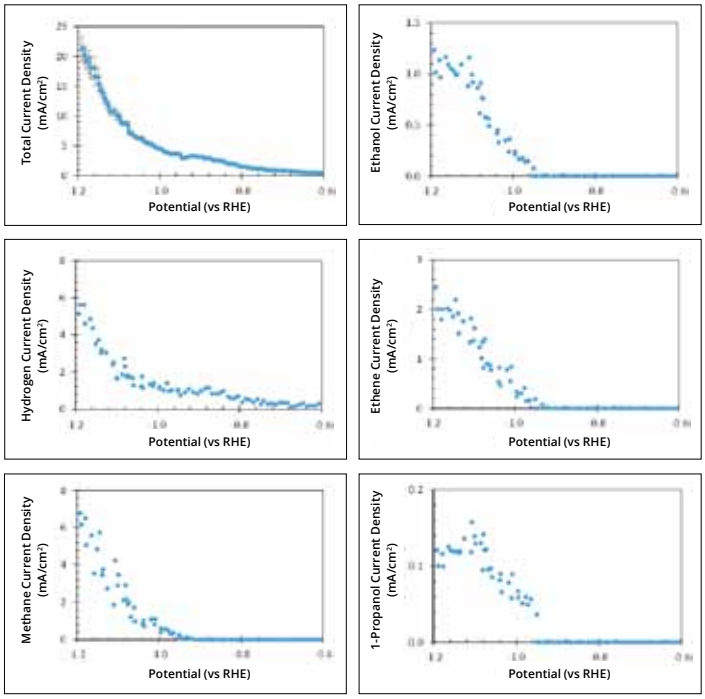


Figure 1. DEMS results obtained for CO_2-sparged 0.05 M K_2CO_3 electrolyte (pH = 6.8) with an electrolyte flow rate of 1 mL/min and a scan rate of 0.2 mV/s. Further details are included in the ACS publication.

QIC series gas analysers with optimised sampling for real-time off-gas analysis

Hiden's QIC series gas analysers provide for multi-component, wide dynamic range real-time analysis of the key species involved in electrochemistry, hydrogen, oxygen, carbon dioxide and reaction products; ethanol for example.

A recent publication in Nature includes data from the Hiden MS: Jun Lu et al. (2016) *"A lithium–oxygen battery based on lithium superoxide"* Nature **378** (529), 377–382.

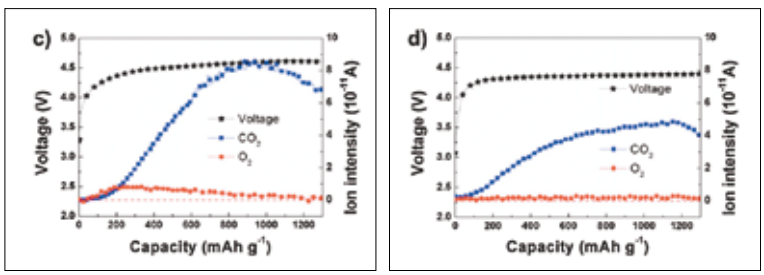


Figure 2. Gas evolution results of Li-O_2 cells c) without a catalyst and d) with a catalyst while charging as measured by DEMS.

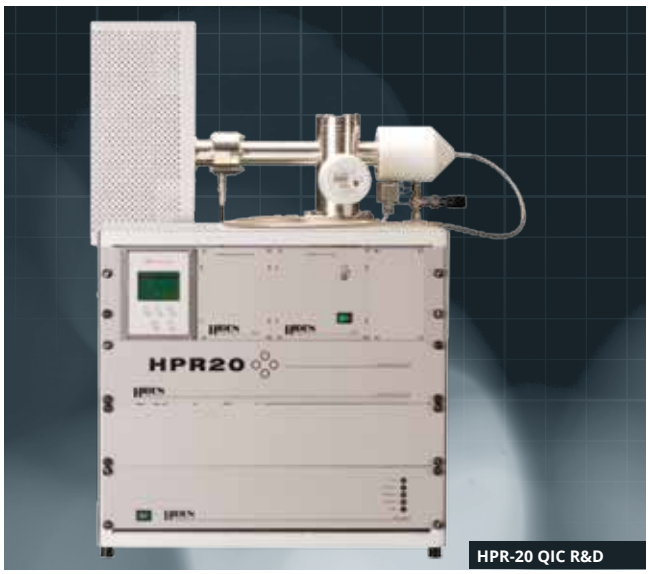


Figure 1: E. L. Clark, M. R. Singh, Y. Kwon, and A. T. Bell (2015) *"Differential Electrochemical Mass Spectrometer Cell Design for Online Quantification of Products Produced during Electrochemical Reduction of CO_2"* Anal. Chem., **87** (15), 8013–8020

Figure 2: K. Kang et al. (2013) *"Mechanism of Co_3O_4/graphene catalytic activity in Li-O_2 batteries using carbonate based electrolytes"* Electrochimica Acta **90**, 63-70