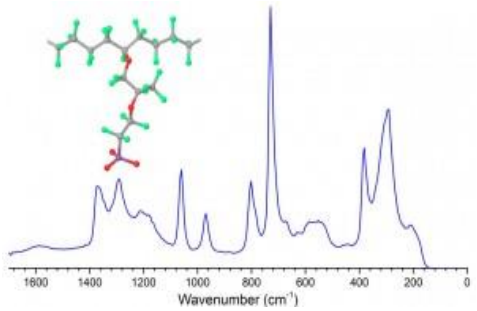
NuVant Systems Inc.
Pioneering Electrochemical Technologies

130 North West Street
Crown Point, IN 46307
www.nuvant.com

Operando vibrational spectroscopy fuel cell

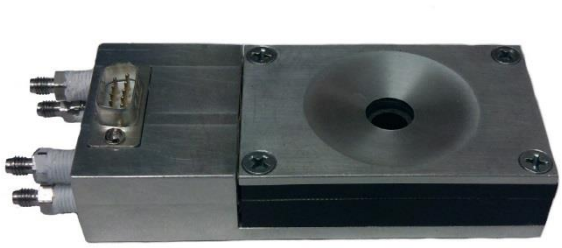
The IR and Raman fuel cells enable IR/Raman spectroscopy of membrane electrode assemblies under normal operating conditions. The spectroscopy cells have a 9-pin connector for interfacing to an EZstat potentiostat/galvanostat (sold separately). The EZstat controls the cell potential or current, and the temperature of the reactant transfer lines and humidifiers. Steel rule cutting dies are required for gasket cutting (two for Teflon gaskets and one for cutting of the gas diffusion layers).



Operando Raman spectrum of Pt/Nafion interface of an operating fuel cell

The Operando cell interfaces with a Pike DiffusIR™ diffuse reflection accessory: a slot on the underside of the cell ensures precise positioning of the cell. The cell features a pin-style upper flow field to optimize flow distribution around a CaF_2 window. Additional charge is required for adaptation to other diffuse reflectance devices.


Operando IR Fuel Cell


Operando Raman Fuel Cell

Specifications:

	H x L x W	Housing material	Flow field material	Temperature probe	Cell Heater	Window material	Inlet/outlet connections
IR fuel cell	1.52” x 7.48” x 2.00”	Aluminum	Graphite	Four-wire ceramic RTD	Two 15W heater cartridges	CaF_2	1/16” male NPT to 1/16” female swagelok
Raman fuel cell	0.91” x 4.52” x 2.00”	Aluminum	Graphite	Four-wire ceramic RTD	Two 15W heater cartridges	CaF_2	1/16” male NPT to 1/16” female swagelok

Pricing:

Operando IR Fuel Cell	$8000
Operando Raman Fuel Cell	$8000
Steel Rule Die Kit	$500
EZstat Pro	$7400


EZstat Pro potentiostat/galvanostat

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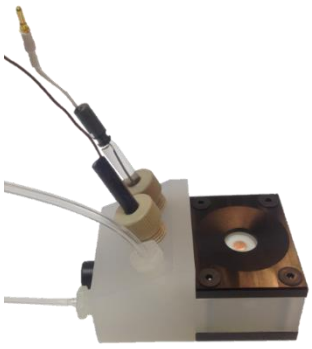
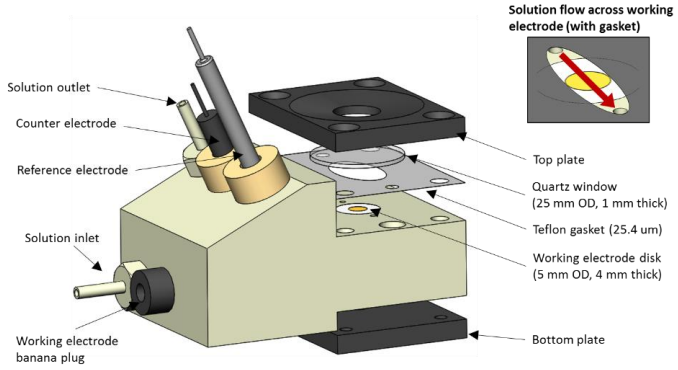
Operando solid electrode spectroscopy cell

The Raman spectroelectrochemical cell enables acquisition of infrared and Raman spectra of working electrode discs (variable sizes, up to 10 mm OD) under flowing solution. Working electrodes available include: Pt, Au, Ag, Cu, glassy carbon, etc. The cell uses a Pt-wire counter electrode and a Ag/AgCl reference electrode. For use with the EZpump peristaltic pump (flow rates from 0.008 to 7.8 ml/min). The EZstat Pro is recommended for cell operation and to control the EZpump. Adapts to the Harrick Praying Mantis™ Diffuse Reflection Accessory. Additional charge is required for adaptation to other diffuse reflectance devices. The cell can also be positioned below Raman microscope objectives.



Operando Solid Electrode Cell



Operando Solid Electrode Cell (exploded view)

Specifications:

	H x L x W	Housing material	Working electrode	Reference electrode	Counter electrode	Window material	Inlet/outlet connections
Raman solid electrode cell	1.60” x 3.00” x 2.00”	Kel-F	Pt, Au, Ag, Cu, glassy carbon, etc. (OD: 4 mm to 10 mm)	Ag/AgCl (7.5 cm length)	Pt (0.5 mm diameter, 23 cm length)	CaF_2	1/16” barbed, PP

Pricing:

Operando Solid Electrode Cell	$6800
Reference electrode:	
Ag/AgCl, aqueous	$125
Ag/AgCl, non-aqueous kit	$290
Working electrode:	
Gold	$950
Glassy carbon	$345
Counter electrode:	
Pt wire, 23 cm	$356
Steel Rule Die Kit	$500
EZstat Pro	$7400
EZPump	$1800

EZPump (flow rates from 0.008 to 7.8 ml/min)

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Operando Spectroscopy Publication List

1. Loupe N, Doan J, Cruse R, DiMarzio CA, Smotkin ES, Laser focal point sequestration for Raman micro-spectroscopy of thermally sensitive fuel cell catalytic layers. Electrochimica Acta. **2018**, 283, 1079-1086
2. Loupe, N., J. Doan, E.S. Smotkin. Twenty years of operando IR, X-ray absorption, and Raman spectroscopy: Direct methanol and hydrogen fuel cells, Catalysis Today. **2017**, 283, 11-26.
3. Kendrick I, Fore J, Doan J, Loupe N, Vong A, Dimakis N, Diem M, Smotkin ES. Operando Raman Micro-Spectroscopy of Polymer Electrolyte Fuel Cells. Journal of The Electrochemical Society. **2016** Jan 1;163(4):H3152-9.
4. Kendrick I, Smotkin ES. Operando infrared spectroscopy of the fuel cell membrane electrode assembly Nafion–platinum interface. International Journal of Hydrogen Energy. **2014** Feb 14;39(6):2751-5.
5. Evarts, S. E.; Kendrick, I.; Wallstrom, B. L.; Mion, T.; Abedi, M.; Dimakis, N.; Smotkin, E. S., "Ensemble Site Requirements for Oxidative Adsorption of Methanol and Ethanol on Pt Membrane Electrode Assemblies" ACS Catalysis. **2012**, 2, 701.
6. Lewis, E. A.; Kendrick, I.; Jia, Q.; Grice, C.; Segre, C. U.; Smotkin, E. S, "Operando X-ray absorption and infrared fuel cell spectroscopy", Electrochimica Acta. **2011**, 56, 8827.
7. Ian Kendrick, Dunesh Kumari, Adam Yakaboski, Nicholas Dimakis, and Eugene S. Smotkin, "Elucidating the Ionomer-Electrified Metal Interface", J. Am. Chem. Soc. **2010**, 132 (49), 17611–17616.