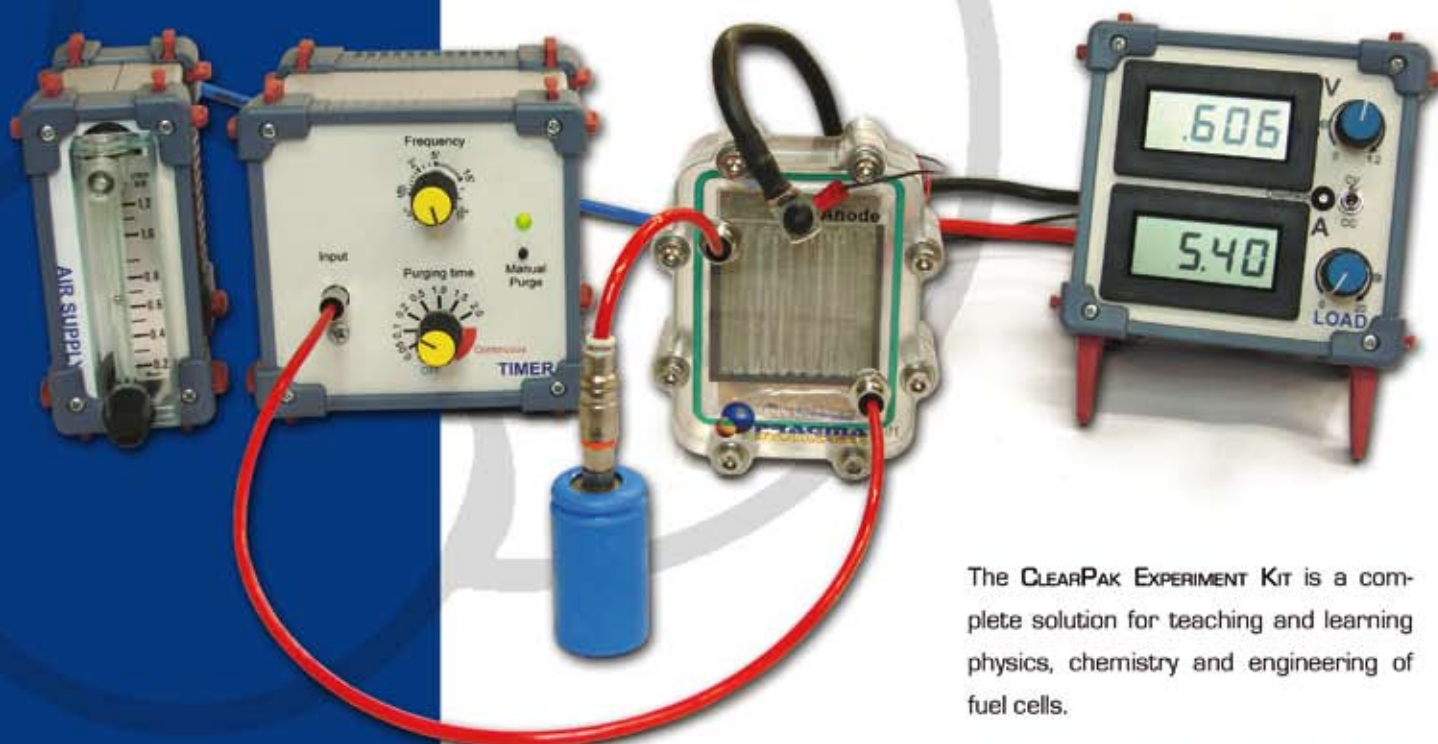


Complete hardware set to get an engineering insight of fuel cell design



**Complete solution**

**Robust design**

**High quality components**

**Practical and easy to operate**

**Large panel of experimentations**

CLEARPAK FUEL CELL is a 25cm<sup>2</sup> single cell with see-through design allowing observation of water behavior inside the cell. It gives to the user an incredible insight of the engineering of fuel cell stacks regarding performances and water management.

Delivering more than 10 amps of electrical current, ClearPak is a real fuel cell with true performances. Combined with the components of the experimentation kit, it addresses the beginner as well as the advanced user.

The CLEARPAK EXPERIMENT KIT is a complete solution for teaching and learning physics, chemistry and engineering of fuel cells.

The kit includes all the required components to operate and assess the performances of ClearPak: adjustable electronic load, air supply with adjustable flowmeter, hydrogen supply with chemical storage and automatic purge.

The components are designed to be robust, practical, easy-to-operate and to be representative to commercial fuel cell systems. Besides, ClearPak is a take-apart fuel cell that can be customized by the user with various flowfield designs or different Membrane-Electrodes Assemblies in order to expand the scope of experimentations.



ClearPak complete kit's features allow a wide range of experiments including :

- Plot characteristic polarization curves
- Energy conversion and efficiency calculations
- Study of air stoichiometry ratio effect upon performances
- Study of  $H_2$  purges effect upon voltage
- $H_2$  supply management through temporized purges
- Study of water balance/fuel cell hydration depending on gas flow
- Effect of MEA compression upon fuel cell performances

### ClearPak

Cell active area	25 cm <sup>2</sup>
Standard flowfield	Single serpentine
Maximum current	16 amps
Maximum power	7 watts
Maximum operating temperature	70°C
Maximum operating pressure	2 barg

### Electronic Load

Voltage range	0 - 1.2V
Voltage resolution	0.001V
Voltage accuracy	±0.65% of measure
Current range	0 - 20A
Current resolution	0.01A
Current accuracy	±1% of measure
Regulation modes	Constant voltage Constant current
Voltage probe	Separated from current mainstream
Power	24V power supply or 9V battery

### Hydrogen storage

Type	AB5 metal hydride
Capacity	10 standard liters
Max pressure @25°C	500mbarg
Connector type	quick coupling

### Hydrogen purge

Purge duration	Off, 0.05s, 0.1s, 0.2s, 0.5s, 1s, 1.5s, 2s, continuous
Purge frequency	10s - 30min
Power	24V power supply

### Air supply

Pump type	Eccentric diaphragm
Adjustable flowmeter	0.2 - 1.2 sL/min
Power	24V power supply



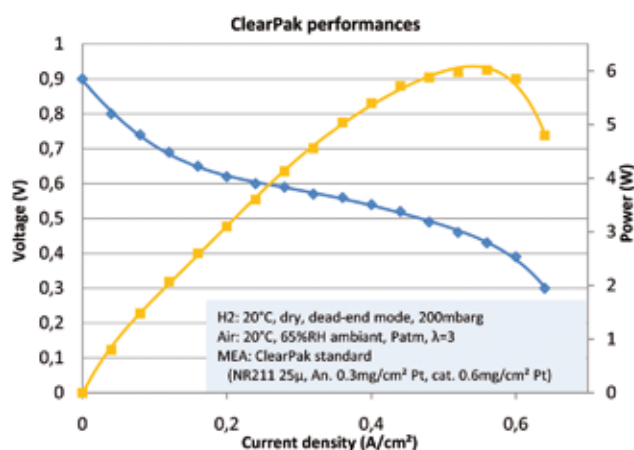
### Components

#### BASIC EXPERIMENTATION KIT

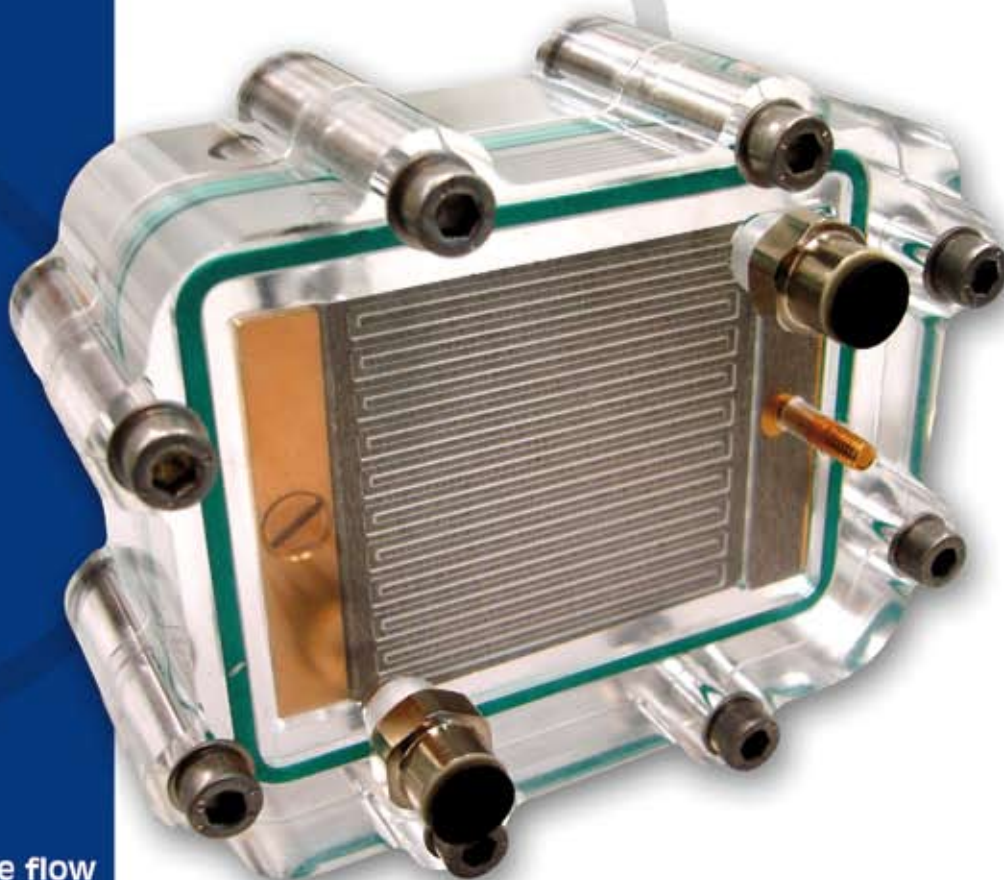
- ClearPak fuel cell
- One membrane-electrodes assembly
- Air pump with adjustable flowmeter
- 10sL metal hydride  $H_2$  storage
- $H_2$  programmable automatic purge
- Adjustable electronic loadbank
- 24V DC power supply
- Electric cables and connectors, gas tubes

#### PREMIUM EXPERIMENTATION KIT

- Basic kit content +
- Additional air-breathing cathode compression plate (free air convection for reaction supply)
- Clear compression plate with integrated temperature sensor and display electronics
- Preparation set (precision torque screw driver, T4 allen tip, flat wrench)
- Additional 10sL  $H_2$  tank
- 2 additional MEAs







**Clearly visible flow channels**

**Water management observation**

**Robust design**

**Forced gas flow**

**Easy and reliable setup**

ClearPak is a 25cm<sup>2</sup> single cell with see-through design allowing observation of water behavior inside the cell. It gives students an incredible insight of the engineering of fuel cell stacks regarding water management.

Delivering more than 10 amps of electrical current, ClearPak is a real fuel cell with true performances. With ClearPak, engineering students will address the following problems:

- how does water evacuate the cell,
- what is happening when the cell is flooded,
- where are the critical flowfield locations,
- what is the influence of gas flow on performances and water balance,
- what impact has the flowfield design on water management.

With ClearPak, a fuel cell is no longer a "black box". With hands-on operation, the user can observe and appreciate what is actually happening inside the cell during testing. Moreover, the large active surface will deliver realistic polarization curves.

ClearPak is available with various sets of compression plates with different flow field designs. ClearPak uses conventional 5x5cm MEA and GDLs. Electrical current is collected through gold plated copper bars. Mounting and dismounting the cell is an easy operation for students to prepare their testing.

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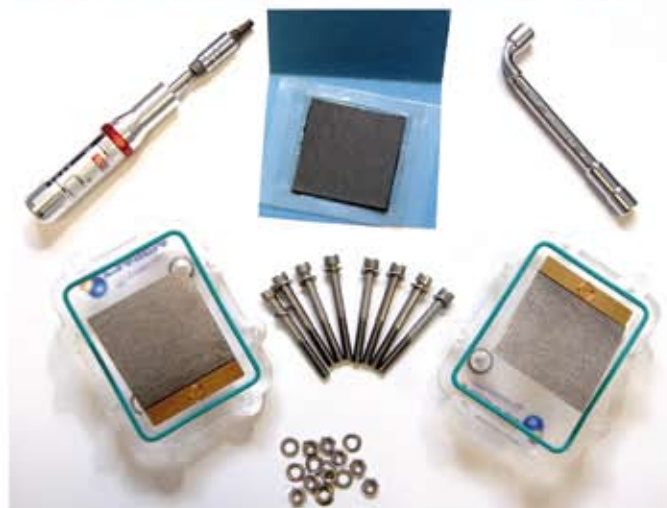
<http://www.pragma-industries.com>



ClearPak is delivered complete with:

- One set of MEA+GDLs
- One set of clear compression plates with selected flow fields
- O-ring gaskets
- Gold plated current collectors
- 6mm OD quick-connect gas ports
- Suitable screws, bolts and washers

Cell active area	25 cm <sup>2</sup>
Available flow field types	Single serpentine
	Multiple serpentine
	Parallel
	Interdigitated
Maximum current	16 amps
Maximum power	7 watts
Maximum operating temperature	70°C
Maximum operating pressure	2 barg
Gas supply	Forced flow air Forced flow H <sub>2</sub>
Dimensions	110x90x70 mm



ClearPak is ideally suited for:

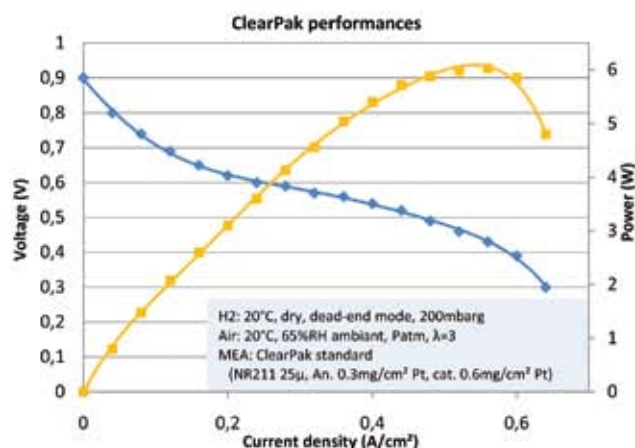
- Fuel cells engineering training course
- Fuel cells fundamentals teaching
- Fuel cells design research
- Fuel cells demonstration

ClearPak is compatible with:

- Hydrogen
- Reformate
- Methanol up to 5M

### Accessories

- Preparation set (torque screw driver, T4 allen tip, flat wrench)
- Spare parts (MEA, GDLs, gaskets, gas ports, current collectors)
- Air-breathing cathode compression plate (free air convection for reaction supply)
- Metal hydride H<sub>2</sub> storage + automatic purge
- Air pump with adjustable flowmeter
- Adjustable electronic loadbank
- Clear compression plate with integrated temperature sensor and electronics





## Cell Compression Unit

A complete unit to control compression force and temperature applied to a single PEM fuel cell during run test



**Stand-alone unit**

**Real-time compression control**

**Cell compression accuracy**

**Reproducibility**

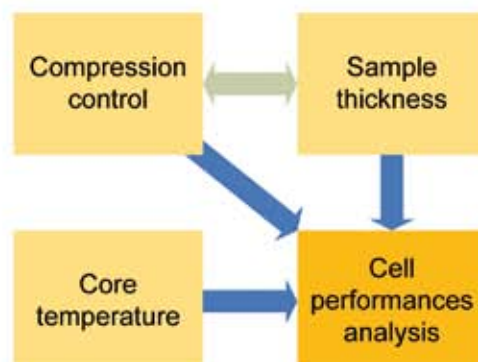
**Fast setup**

The compression force applied to the fuel cell core has a drastic influence on performances: it modifies the gas permeation, water management and electrical contact between interfaces. Thanks to the **Cell Compression Unit (CCU)**, you will now be able to precisely measure the influence of the compression over MEA, GDL and even gaskets.

Place your components in the single-cell hardware, the CCU will command and control the exact pressure you have set. With its precise electrical actuator, it can reach an impressive 10,000N compressive force. The CCU is fully autonomous, self-regulated unit, equipped with a force sensor and a graphical touch screen interface.

The cell design achieves gas tightness and compressive force with two separate actions, so the force is only applied to the active surface for perfect reproducibility and accuracy.

Optional equipment is available for the CCU according to your needs, so the CCU is the perfect tool for your research on fuel cell components.

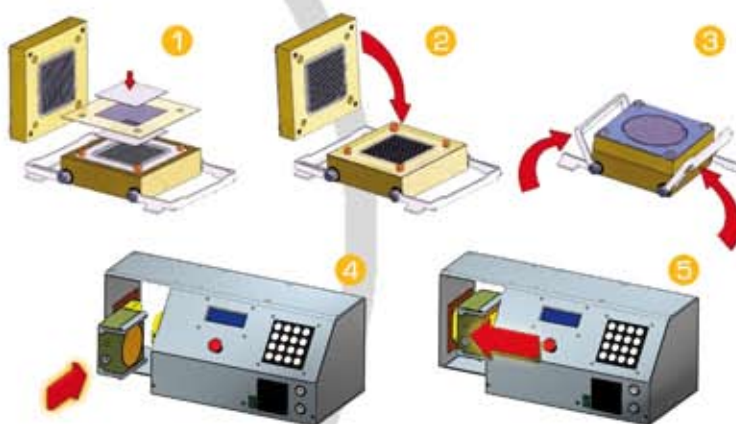




The Cell Compression Unit is ideal for:

- determining optimal contact force for maximum power density
- reproducing identical testing conditions for different MEA and GDL samples
- increasing your screening throughput

The QuickCell is easily mounted for testing without any tool. And it takes only seconds to set the MEA and GDLs inside the cell fixture precisely.



Compression force	500 to 10,000N
Force accuracy	2%FSR
Integrated cell heating	24V, 2x120W, 240°C max
Inputs/outputs	7" touch screen display Type K plug Emergency stop
Controls	<ul style="list-style-type: none"> <li>• Compression force</li> <li>• Sample thickness</li> <li>• Cell temperature</li> <li>• Programmable test sequence</li> <li>• Data logging</li> </ul>
Dimensions	510 x 230 x 194 cm [WxDxH]



Quickcell models	qFC5, LT or HT	qFC25, LT or HT	qFC50, LT or HT	qCF custom
Application	PEM, DMFC	PEM, DMFC	PEM, DMFC	PEM, DMFC
Fuel	H <sub>2</sub> , MeOH, reformat	H <sub>2</sub> , MeOH, reformat	H <sub>2</sub> , MeOH, reformat	H <sub>2</sub> , MeOH, reformat
Active cell area	5 cm <sup>2</sup>	25 cm <sup>2</sup>	50 cm <sup>2</sup>	Custom
Operating temperature	130°C for LT, 240°C for HT	130°C for LT, 240°C for HT	130°C for LT, 240°C for HT	130°C for LT, 240°C for HT
Standard flowfield design	Single serpentine	Single serpentine	5-fold serpentine	Custom
Flowfield material	Graphite compound	Graphite compound	Graphite compound	Custom

### Optional equipement

- Sample thickness sensor (measurement of specimen thickness variation)
- Gas pressure auto-balancing system
- Current distribution measurement device (current mapping)
- CCU integrated humidity sensor
- Liquid cooling element for compression frame
- Cell flowfield and dimensions customising
- High-power cables set and type-K thermocouple

