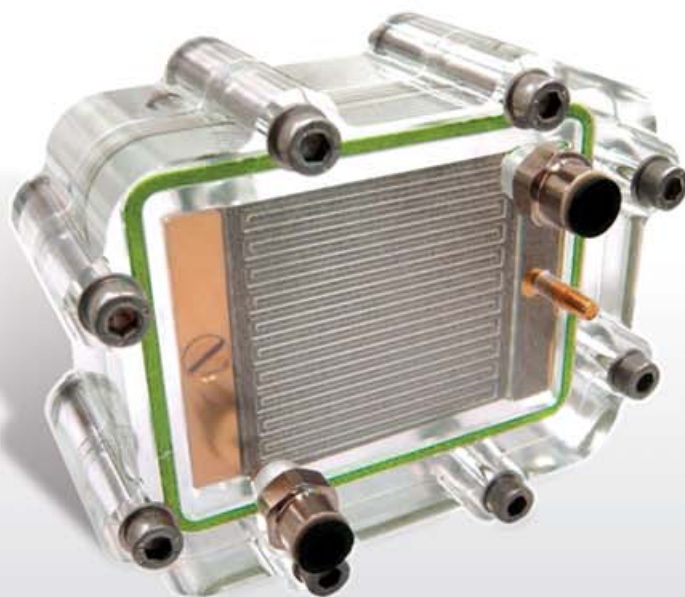


# EXPERIMENTAL TOOLBOX

## To Discover FUEL CELLS



EDUCATION ■■■  
DEMONSTRATION ■■■  
COMMUNICATION ■■■



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# SCIENCE PACK Item P101

- Large dismantable fuel cell
- Ideal for classroom and public demonstration
- Fully upgradable

Fields: general science and chemistry

Education grades: 7-12

Applications: classroom instruction, demonstration, communication, hands-on learning

The Fuel Cell Science Pack is designed to teach the principles of energy production with fuel cells. The teaching book included guides through various experiments to understand how a fuel cell works and how hydrogen can be efficiently converted into electricity.

The electric motor and fan can be used as a single device powered by the fuel cell for visual demonstration. The variable load can be used separately or in combination with the fan to investigate fuel cell performances and how devices can be power-controlled.



## Key features

- High power, large fuel cell
- See-through fuel cell to observe water by-product of reaction
- Sturdy design
- Perfect for practical demonstration of science behind fuel cells and hydrogen and initiation to electrochemistry
- Easy experiment setup

## Package content

- Take apart air breathing fuel cell
- Fuel cell core
- Load box with current and voltage measurement
- Rechargeable hydrogen canister (solid storage)
- Manual purge valve
- Fan and electric motor
- Set of three resistances
- Cables and tubing
- Fuel cells textbook and experiments guide



## List of experiments

- Building a fuel cell and a fuel cell circuit
- Plotting characteristic curves at various operating conditions
- Understanding energy conversion and efficiency calculation
- Determining the effect of air convection on FC performances
- Measuring the effect of catalyst loading on FC performances
- Measuring the effect of FC resistance

Choose amongst a large choice of accessories to extend experiment capabilities of the fuel cell packages:

Additional fuel cells  
Cells interconnection kit  
E-load for stack testing

Additional H<sub>2</sub> tanks  
Membrane-Electrodes Assemblies  
Spare parts

## P101 specifications

Fuel cell core	25cm <sup>2</sup> active area
Cell power	3.5W / 7A at 0.4V
Pt catalyst loading	0.2 mg/cm <sup>2</sup> @ anode 0.4 mg/cm <sup>2</sup> @ cathode
Fuel cell mode	air free/forced convection
H <sub>2</sub> storage type	AB <sub>5</sub> hydride alloy
H <sub>2</sub> storage capacity	10 normal liters
H <sub>2</sub> storage lifespan	> 2000 charge/discharge cycles
Fan and motor	250mW
Load cables	50cm each /16mm <sup>2</sup> cross section
e-load control modes	constant voltage (0.1 - 1.2V) constant current (0 - 20A)
e-load power	9V battery
Weight	5kg

# ENGINEERING PACK Item P102

- Realistic fuel cell and FC system
- High quality components
- Perfect for hands-on experimentation

Fields: general science and chemistry, FC Engineering

Education grades: 10-12, University

Applications: classroom instruction, hands-on learning, advanced classes, vocational training

Package suitable for a first level of engineering training on fuel cells and fuel cell systems with hands-on experimentation. The included ClearPak fuel cell delivers high current densities with a realistic thermal response. Water management inside the cell is clearly visible. The pack enables the control of fuel cell performances through the complete balance-of-plant system.



## List of experiments

- Building a fuel cell and a fuel cell circuit
- Understanding the fuel cell system and how it is controlled
- Plotting characteristic curves at various operating conditions
- Understanding energy conversion and efficiency calculation
- Measuring the effect of catalyst loading
- Measuring and analyzing the effect of fuel cell core compression
- Understanding the effect of H<sub>2</sub> purging on performances and fuel management
- Measuring the effect of air stoichiometry on FC behavior
- Observing the water production and evacuation in the flowfield
- Observing water liquid/vapor phase changing in the fuel cell and understanding dew point physics
- Controlling the fuel cell output in current and voltage
- Understanding fuel cell efficiency vs. system efficiency



## Key features

- High performance, large fuel cell
- See-through fuel cell to observe water by-product
- Realistic flow field design. The fuel cell behaves like a real industrial FC.
- Take apart fuel cell and system that can be assembled by student

## Package content

- Take apart forced flow fuel cell with serpentine flow field design
- Fuel cell core
- E-Load box with current and voltage measurement
- Rechargeable hydrogen canister (solid storage)
- Programmable purge valve
- Air pump with variable flowmeter
- Torque screwdriver and flat wrench
- Cables and tubing
- 24V power supply
- Fuel cells textbook and experiments guide
- Robust suitcase packaging

## P102 specifications

Fuel cell core	25cm <sup>2</sup> active area
Cell power	7W /15A at 0.4V
Pt catalyst loading	0.2 mg/cm <sup>2</sup> @ anode 0.4 mg/cm <sup>2</sup> @ cathode
Fuel cell mode	air forced flow
Fuel cell flowfield	single serpentine design
H <sub>2</sub> storage type	AB <sub>5</sub> hydride alloy
H <sub>2</sub> storage capacity	10 normal liters
H <sub>2</sub> storage lifespan	> 2000 charge/discharge cycles
Air pump	0.2-1.2 sL/min
Load cables	50cm each /16mm <sup>2</sup> cross section
e-load control modes	constant voltage (0.1 - 1,2V) constant current (0 - 20A)
e-load power	100-240V power supply
Torque screwdriver	0.8 - 2Nm
Weight	6kg

For more information and complete product range, please visit our website:  
[www.pragma-industries.com](http://www.pragma-industries.com)

# PROFESSIONAL PACK Item P103

- Complete package
- Extended range of experiments
- from basic to high level teaching

Fields: general science and chemistry, FC Engineering

Education grades: 10-12, University

Applications: classroom instruction, hands-on learning, advanced classes, vocational/professional training

Package suitable for a low and high level of engineering training on fuel cells and fuel cell systems with hands-on experimentation. The included ClearPak fuel cell delivers high current densities with a realistic thermal response. Water management inside the cell is clearly visible. Pack enables the control of fuel cell performances through the complete balance-of-plant system. Also possible to perform temperature-dependent and time-dependent testing as well as to compare efficiencies of various system configurations.



## List of experiments

- Building a fuel cell and a fuel cell circuit
- Understanding the fuel cell system and how it is controlled
- Plotting characteristic curves at various operating conditions
- Understanding energy conversion and efficiency calculation
- Measuring the effect of catalyst loading
- Measuring and analyzing the effect of fuel cell core compression
- Understanding the effect of H<sub>2</sub> purging on performances and fuel management
- Measuring the effect of air stoichiometry on FC behavior
- Observing the water production and evacuation in the flowfield
- Observing water liquid/vapor phase changing in the fuel cell and understanding dew point physics
- Understanding the coupling between power, temperature and performances of the fuel cell
- Measuring the effect of H<sub>2</sub> pressure on characteristic curves
- Comparing forced flow and free convection FC modes
- Controlling the fuel cell output in current and voltage
- Understanding fuel cell efficiency vs. system efficiency



## Package content

- Take apart forced flow fuel cell with serpentine flow field design
- Fuel cell core (x3)
- E-Load box with current and voltage measurement
- Rechargeable hydrogen canister (solid storage, x2)
- Programmable purge valve
- H<sub>2</sub> pressure reducer
- Air pump with variable flowmeter
- Cell-integrated temperature sensor with display electronics
- Free air convection compression plate ("air breathing" mode)
- Torque screwdriver and flat wrench
- Cables and tubing
- 24V power supply
- Fuel cells textbook and experiments guide
- Robust suitcase packaging

## P103 specifications

Fuel cell core	25cm <sup>2</sup> active area
Cell power	7W /15A at 0.4V
Pt catalyst loading	0.2 mg/cm <sup>2</sup> @ anode 0.4 mg/cm <sup>2</sup> @ cathode
Fuel cell mode	air forced flow
Fuel cell flowfield	single serpentine design
H <sub>2</sub> storage type	AB <sub>5</sub> hydride alloy
H <sub>2</sub> storage capacity	10 normal liters per tank
H <sub>2</sub> storage lifespan	> 2000 charge/discharge cycles
H <sub>2</sub> pressure reducer	0 - 3barg
Air pump	0.2-1.2 sl/min
Load cables	50cm each /16mm <sup>2</sup> cross section
e-load control modes	constant voltage (0.1 - 1,2V) constant current (0 - 20A)
e-load power	100-240V power supply
Temperature sensor	0 - 70°C e-load link for safety shutdown
Torque screwdriver	0.8 - 2Nm
Weight	7kg

# ACCESSORIES



## Fuel cells interconnection set

Item ref. T202

Set of parts used to interconnect up to three ClearPak cells. Used for experimenting on stacking individual cells together. Allows additional courses on series or parallel connections, power electronics, temperature distribution in stacks.

The set includes 12x elbow fittings for cells, 8x T fittings, 4x elbow fittings, 2x short power cables, 2x long power cables, 2x2 meters of PE tube (red/blue).



## High power e-load for stack testing

Item ref. L202

High capacity e-load for tests and measurements on ClearPak stacks

Current: 25A max

Voltage: 3.6V max



## Multiple serpentine ClearPak fuel cell

Item ref. F103

Complete fuel cell with multiple serpentine gas distribution channels. Delivered with current collectors, gaskets, two clear compression plates (multiple serpentine design), screws, bolts, washers, gas connectors.

MEA not included.



## Parallel ClearPak fuel cell

Item ref. F104

Complete fuel cell with parallel gas distribution channels. Delivered with current collectors, gaskets, two clear compression plates (multiple serpentine design), screws, bolts, washers, gas connectors.

MEA not included.



## Interdigitated ClearPak fuel cell

Item ref. F105

Complete fuel cell with interdigitated gas distribution channels. Delivered with current collectors, gaskets, two clear compression plates (multiple serpentine design), screws, bolts, washers, gas connectors.

MEA not included.



## Set of two 10NL hydrogen tanks

Item ref. H202

Storage capacity: 10 Normal Liters per tank

Charge/discharge cycles: 1000

Includes quick connector



## Set of two 20NL hydrogen tanks

Item ref. H203

Storage capacity: 20 Normal Liters per tank

Charge/discharge cycles: 1000

Includes quick connector



## Set of 3 Membrane-Electrodes Assemblies

Item ref. M201

Active area: 25cm<sup>2</sup>

Pt charge anode/cathode: 0.2/0.4mg/cm<sup>2</sup>

MEA individually sealed and tagged



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