EL-CELL®
electrochemical test equipment

User Manual

Release 1.61

PAT-Cell-Gas

Electrochemical test cell for in-situ gas analysis in a flow-through set-up



© 2026 EL-Cell GmbH

Disclaimer

EL-Cell GmbH makes no assurances or warranties with respect to this manual and, to the extent permitted by law, limits its liability for violation of any implied warranty to the substitution of this manual for another. In addition, EL-Cell GmbH reserves the right to revise this publication at any time without notice to anyone.

The information provided in this documentation includes general descriptions and/or technical characteristics regarding the performance of the equipment described herein. This documentation cannot serve as a proper evaluation of the suitability or reliability of the equipment for any specific application by any user and should not be relied upon as a substitute for such evaluation. Each user or installer is responsible for conducting an appropriate and complete risk assessment, evaluation, and testing of the equipment for their specific application. EL-Cell GmbH cannot be held responsible or liable for any misuse of the information contained herein.

Always comply with all relevant state, regional, and local safety regulations when installing and using this device. For safety reasons and to ensure compliance with the documented system data, only the manufacturer is authorised to perform repairs on components.

Disregarding this information may result in injury or damage to the equipment.

All rights reserved. No part of this publication may be reproduced, processed, or transmitted in any form, including photocopying, recording, or any other electronic or mechanical process, without the written permission of the publisher. Requests for permission must be made in writing to the publisher at the address written below.

Manufacturer and Customer Service

EL-Cell GmbH

Tempowerkring 8

21079 Hamburg – Germany

Telephone: +49 40 79012-734

Email: info@el-cell.com

Website: el-cell.com

Technical Support

Telephone: +49 40 79012-734

Email: support@el-cell.com

Website: el-cell.com/support/technical-support/

Please always quote the serial number on the nameplate when making customer service inquiries.

Shipping Address for Repairs

EL-Cell GmbH

Tempowerkring 8

21079 Hamburg - Germany

Please contact our customer service department before making a return. We will not open or process shipments without a completed decontamination report or RMA.

Content

1 Preamble 6

1.1 Purpose and Target Audience 6

1.2 Usage Instructions 6

1.3 Obtaining Documents and Information 7

2 Product Description 8

3 Variants 10

4 Technical Data 12

4.1 Dead Volume 12

4.2 Spring Force in Relation to the Thickness of the Upper Electrode: 12

5 Compatible Devices 13

5.1 Compatible Docking Stations 13

5.2 Compatible Potentiostats/Battery Testers 13

6 Safety Precautions 14

7 Assembly of the PAT-Cell-Gas 15

7.1 Using Metal Sealing Rings 17

7.2 Using the Quick Connect Tube Fittings 19

8 Working Modes of the PAT-Cell-Gas 21

8.1 Air Mode 21

8.2 OEMS Mode 22

9 Disassembly and Cleaning 23

10 Sample Valve with Septum Port 24

10.1 How to Draw Gas Samples 24

11 Changing the Lid Spring 25

12 Unpacking 27

13 Consumables 28

14 Accessories 29

15 Spare Parts 31

16 Troubleshooting 36

17 Warranty 37

1 Preamble

1.1 Purpose and Target Audience

This manual covers the structure, function, operation, and maintenance of the device described. It is intended for end users. An end user can be defined as any person who interacts directly with the device. The term "end user" usually includes laboratory personnel who have been specifically trained to operate this instrument and are familiar with all the precautions required to work in the laboratory.

Only an authorized and properly qualified and experienced person 18 years of age or older may use the device, who:

- has read and understood these installation and operating instructions
- is familiar with the installation and operation of this or a similar device
- is aware of all possible dangers and acts accordingly

1.2 Usage Instructions

Make sure you have read and understood the complete instructions and all safety information before using this product. Failure to follow these instructions may result in minor or serious injury.

Follow all instructions. This will prevent accidents that could result in property damage or injury. Keep all safety information and instructions for future reference and pass them on to subsequent users of the product.

The manufacturer is not liable for property damage or injuries resulting from incorrect handling or failure to comply with the safety instructions. In such cases, the warranty becomes void.

1.3 Obtaining Documents and Information

A current version of the documentation is available on the following website:

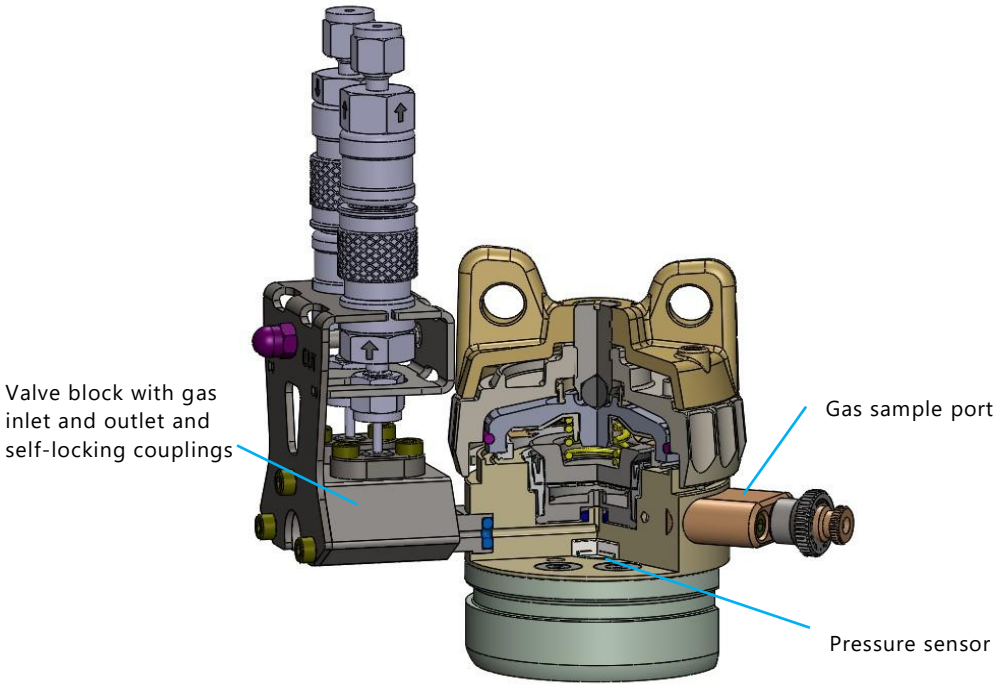
https://el-cell.com/support/manuals/

Alternatively, you can scan this QR code,
to access the website:



2 Product Description

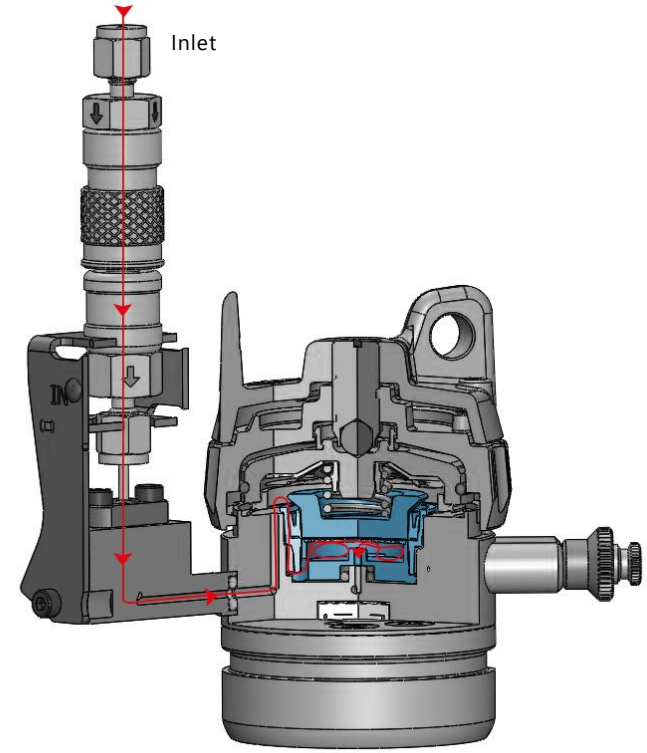
The PAT-Cell-Gas is a test cell dedicated to in-situ gas analysis of battery materials in a flow-through set-up. For this purpose, the test cell features a gas inlet and outlet, and optionally, a built-in pressure sensor and a valve port for drawing gas samples using a syringe. The test cell is typically connected to peripheral equipment for gas supply and gas analysis. This manual covers the test cell only.

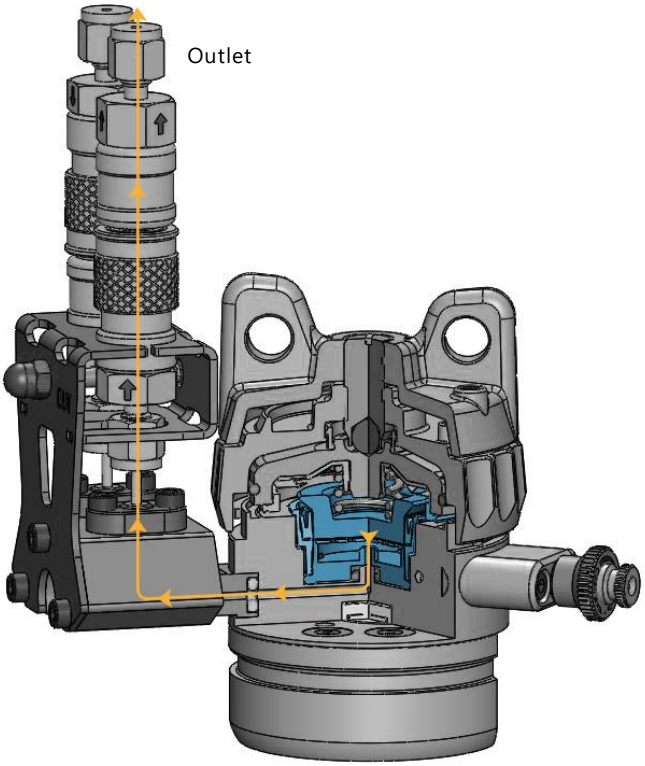


Features

- PAT series test cell with gas inlet and outlet, compatible with 1/16 inch Swagelok Tube Fitting
- The inside PAT-Core (cell stack) is comprised of a lower gas-permeable electrode, a separator, and the upper (counter) electrode.
- The cell can be operated with or without a reference electrode
- The gas-permeable electrode is seated on a special lower plunger for current and gas feed.
- Two different lower plungers are available: with a perforated plate (for minimum pressure drop) or with a flow field (for optimized plug flow)
- The incoming gas is directed to the lower electrode of the cell stack and leaves the cell through the central bore in the lower plunger.
- Option P and SP: Gas pressure sensor, 0 to 3 bar abs. These options are only operable in combination with the PAT-Tester-x potentiostat for full sensor support.
- Option S and SP: Gas sample port

Schematic View: Gas Inlet and Outlet





3 Variants

PAT-Cell-Gas



Features

- Gas inlet and outlet

PAT-Cell-Gas S



Features

- Gas inlet and outlet
- Gas sample port

PAT-Cell-Gas II P



Features

- Gas inlet and outlet
- Gas pressure sensor, 0 to 3 bar abs
- Temperature sensor, -20°C to +80°C

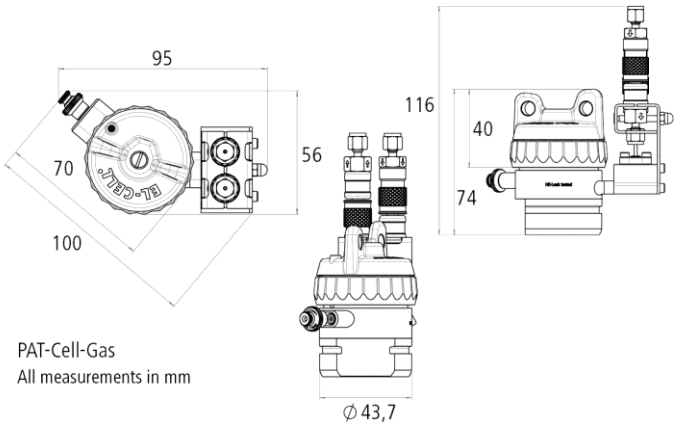
PAT-Cell-Gas II SP



Features

- Gas inlet and outlet
- Gas sample port
- Gas pressure sensor, 0 to 3 bar abs
- Temperature sensor, -20°C to +80°C

4 Technical Data



- Length: **95 mm**
- Width: **43.7 mm**
- Height: **116 mm**
- Weight: **0.7 kg**
- Gas connection:

  1/16 inch Swagelok Tube Fitting
- Electrode diameter: **18 mm**
- Temperature resistance **-20 to +80 °C**

4.1 Dead Volume

PAT-Cell-Gas with metal lid seal:

- PAT-Cell-Gas without PAT-Core: **8.275 ml**
- PAT-Cell-Gas with PAT-Core (Lower plunger AIR): **4.638 ml**
- PAT-Cell-Gas with PAT-Core (Lower plunger flow field): **3.915 ml**

4.2 Spring Force in Relation to the Thickness of the Upper Electrode:

Lid Spring	Force applied to the cell stack*
FED9028 (default)	40 N ± 10%
FED9079	105 N ±10% if used with an aluminum lid seal 115 N ±10% if used with a PE lid seal
FED9052	7 N ± 30%

- * These values apply to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

5 Compatible Devices

5.1 Compatible Docking Stations

Device	Charge/Discharge/ EIS	Read Sensor Data (Pressure, Temperature)
PAT-Clamp-1	Yes	Yes
PAT-Stand-1	Yes	Yes
PAT-Stand-1 U	Yes	Not supported
PAT-Stand-4	Yes	Not supported
PAT-Stand-16	Yes	Yes
PAT-Chamber-16	Yes	Not supported
PAT-Heater-4	Not supported	Not supported

5.2 Compatible Potentiostats/Battery Testers

Device	Charge/Discharge/ EIS	Read Sensor Data (Pressure, Temperature)
PAT-Tester-x-8	Yes	Yes
PAT-Tester-i-16	Yes	Yes
Third-party Potentiostats	Yes	Not supported

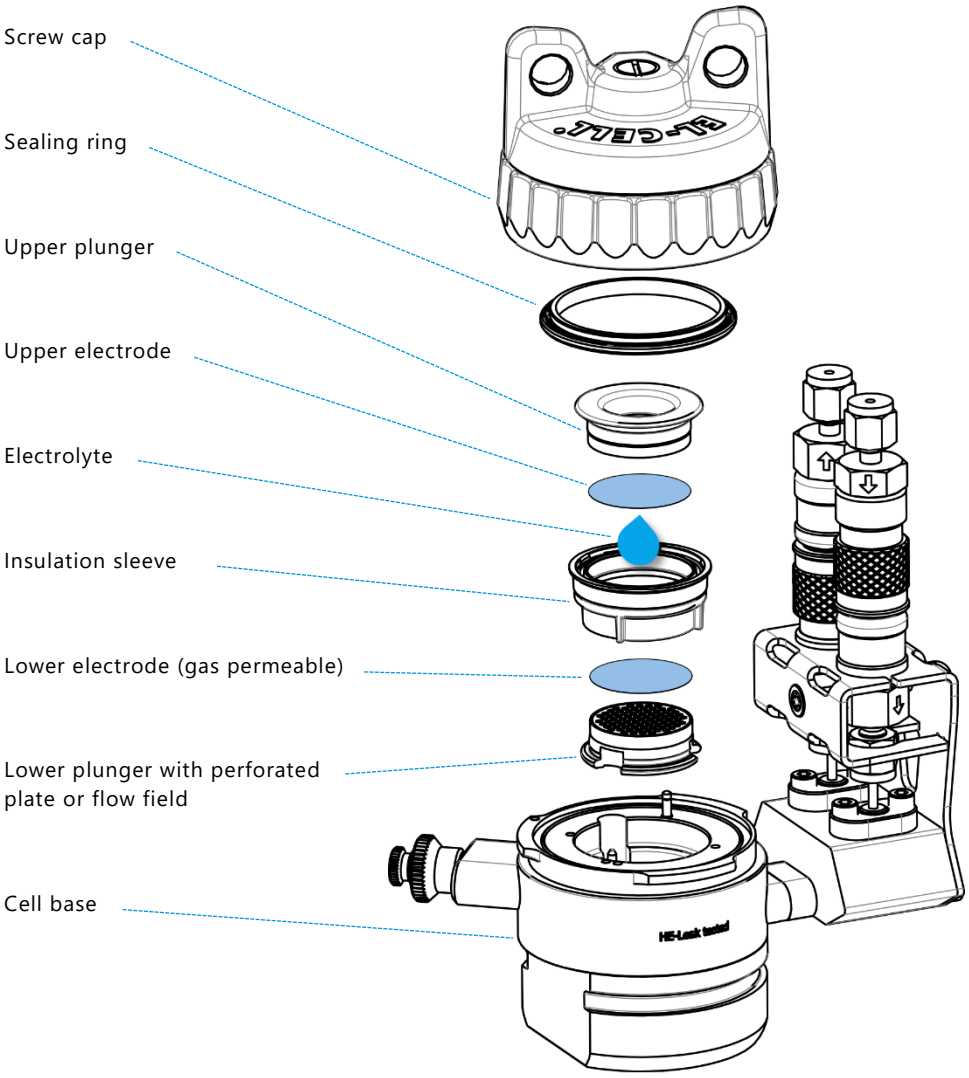
6 Safety Precautions

Use proper safety precautions when using hazardous electrode materials and electrolytes. Wear protective glasses and gloves to protect yourself against electrolytes that may accidentally spill out during disassembly. Upon cell disassembly, dispose of all materials properly. Metallic lithium and some insertion compounds may decompose heavily in contact with water and other solvents, and can cause fire.

7 Assembly of the PAT-Cell-Gas

This section describes how to assemble the PAT-Cell-Gas test cell. A more detailed description of the PAT-Core is in a separate manual.

Note: The assembly has to take place under a protective atmosphere in a glove box.



1. Put the special lower plunger onto the worktop with the perforated plate/flow field pointing upwards. Make sure that the O-ring seal at the bottom of the plunger is in place. Make sure that the perforated plate is inserted correctly on top of the plunger (only when using the two-piece perforated version of the lower plunger)

2. Put the **insulation sleeve** onto the worktop with the smaller side pointing upwards.

3. Insert the **lower gas-permeable electrode** into the sleeve with the active layer facing downwards.

4. Push the **lower plunger** into the insulation sleeve.

5. Align the contact spring of the sleeve with the reference pin inside the **cell base**. Then insert the assembly into the cell base.

6. Evenly dispense approx. 100 µL of **electrolyte** on top of the separator with a pipette. Note: The optimum amount of electrolyte will depend on the thickness and porosity of the separator and the electrodes used.

7. Insert the **upper electrode** into the insulation sleeve with the active layer facing downwards.

8. Attach the **upper plunger**.

9. Attach the cell lid and tighten the wing nut to seal the cell. NOTE: Replace the lid seal after each experiment. Insert it into the screw cap or place it on the cell base (flat metal sealings only). You can choose between different sealing materials: PE, PTFE, and Al. PE has lower water permeability than PEEK, but significantly higher air permeability. PE should not be used above 50°C. Al seals show the best overall performance.

10. The cell can now be removed from the glovebox and connected to the peripheral equipment, such as gas supply and mass spectrometer.

7.1 Using Metal Sealing Rings

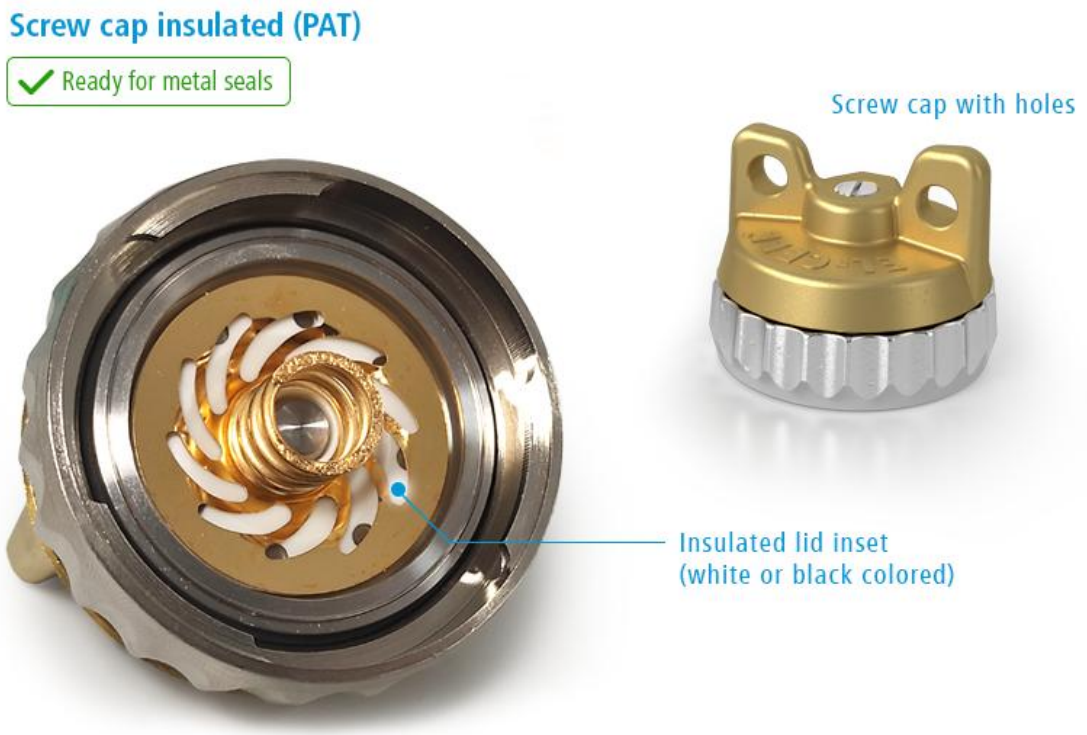
NOTICE

Please note when using metal sealing rings:

Make sure that a compatible lid for metal seals is installed. It can be recognized by the following two features.

- It has two holes on the top.
- It features a white or black inset made of PPS in the lid.

As the two holes can also be found on older cell lids without insulation, you should always check whether the inset is present. Non-compatible cell lids have no inset at all. The use of a non-compatible screw cap can result in a short circuit.



7.1.1 Installing metal sealing rings

When fitting the metal sealing ring, please note the differences between the available products.Whilst the aluminium sealing ring ECC1-00-0232-G is pressed into the lid, the flat metal seals ECC1-00-0232-M (Cu) and ECC1-00-0232-N (Al) are fitted differently.



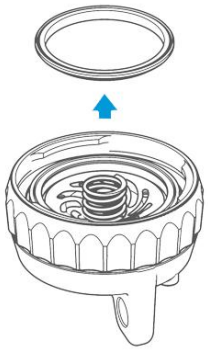
ECC1-00-0232-G: Insertion into the lid



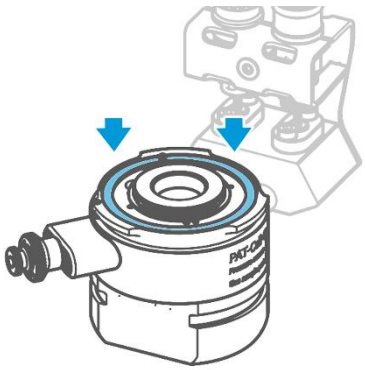


Flat sealing rings ECC1-00-0232-M (left) and ECC1-00-0232-N (right): Placing on the cell base

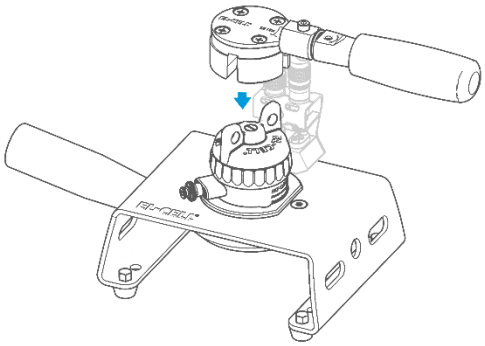
For assembly, follow the steps below when installing the cell inside the glovebox:



1. If present, first remove the sealing ring from the cell lid.



2. Place the new flat sealing ring on top of the cell base.

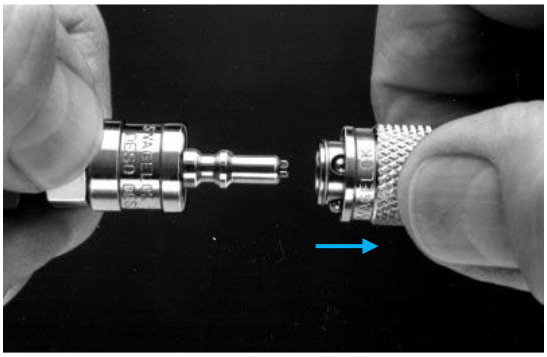


1. Place the cell lid on top and tighten the cell using the torque wrench from the Metal Seal Mounting Kit. We recommend inserting the cell into the assembly block.

7.2 Using the Quick Connect Tube Fittings

Couple:

1. Align the plug and the body with each other. Pull back the body sleeve.



2. Insert the plug into the body as far as it will go. Release the sleeve. Ensure that the sleeve returns to its original position.

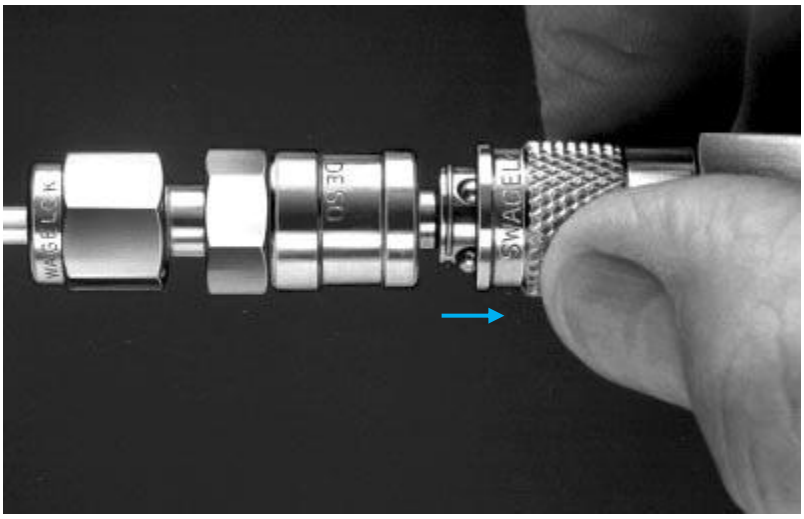


NOTICE

Please note that the gas channels of the PAT-Cell-Gas are open when the quick-connect couplings are fitted. Decouple them to close the cell

Decouple:

Pull back the body sleeve. Pull the plug out of the body.



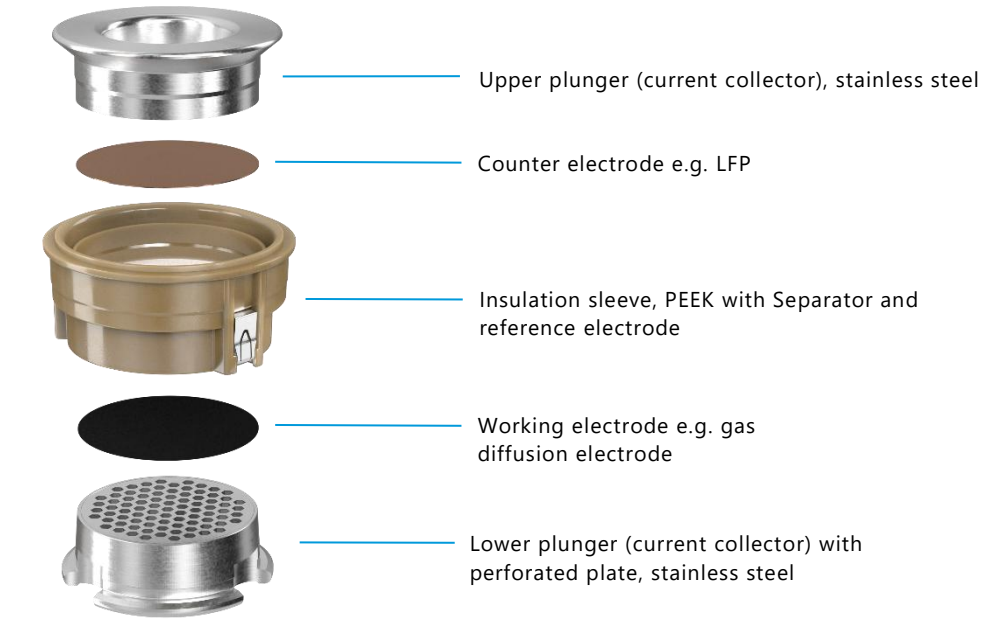
8 Working Modes of the PAT-Cell-Gas

There are two dedicated lower plungers available for the PAT-Cell-Gas for different testing purposes.

8.1 Air Mode

The lower plunger with perforated plate allows for electrochemical characterization of gas diffusion electrodes used for instance in Li-air batteries. The lower electrode is contacted by and "breathes" through the perforated stainless steel current collector supporting it. During operation, the pressure gradient building up between cell headroom and the gas volume below the perforated plate effectively prevents back-mixing. The relatively large volume below the perforated is at the expense of time resolution, but makes this solution robust against clogging of the gas path.

PAT-Core configuration example



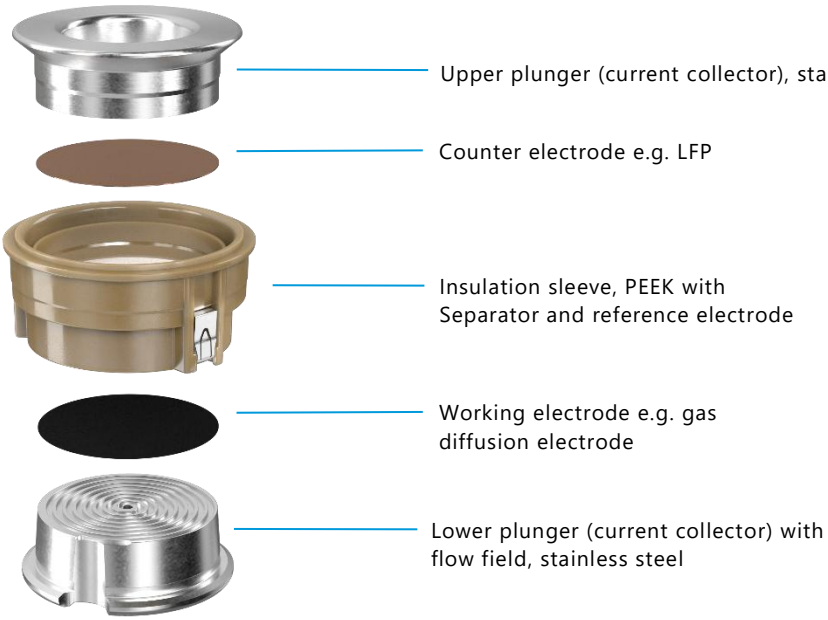


Gas flow inside the Lower Plunger (perf. Plate)

8.2 OEMS Mode

The PAT-Core setup, utilizing a lower plunger with a flow field, provides nearly perfect plug-flow of the purge gas, which is essential for quantitative, time-resolved analysis. Gases evolved or consumed at the working electrode may be analysed through the composition change of the gas stream that is to be passed along the spiral-type flow field below the working electrode. The composition of the outgoing gas can be analyzed by, e.g., mass spectrometry. The pressure gradient between cell headroom and spiral-type flow field effectively prevents back-mixing. This, combined with the tiny gas volume of the flow field, ensures the best possible time resolution.

PAT-Core configuration example





Lower Plunger (flow field): Gas flow along the flow field

9 Disassembly and Cleaning

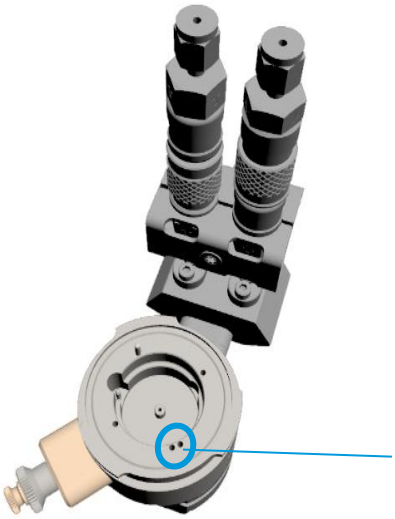
When working with aprotic, moisture-sensitive electrolytes such as $LiPF_6$, it is best to always leave the cell base and cell lid in the glove box and only expose the PAT core components to room air for cleaning or disposal.

Note that excess electrolyte may leak from the PAT-Core and cause contamination in the cell base and on the contact pins. For standard electrodes and standard separators, use 100 µl electrolyte.

If the cell base or lid has been in contact with ambient air or if they are being used for the first time, they must be dried in a vacuum at 80°C for at least 12 hours before use.

Stainless steel plungers can be cleaned with water, acetone, or ethanol. If necessary, persistent stains can be removed from the plungers with aqueous nitric acid (20%, 2 hours at room temperature). Insulating sleeves made of PP are intended for single use. Insulating sleeves made of PEEK or PPS can be cleaned with water, acetone, or ethanol and are reusable after careful drying (120°C, vacuum, >12 hours).

Never immerse the cell base in liquid. In particular, avoid contact of the electronic components on the bottom of the cell base with liquid.



Holes towards the stainless steel membrane of the laser welded pressure sensor (options P and SP). For all other options, these holes are dead-ended. **Avoid contact with electrolyte or other liquids!**

For the cell variants with a pressure sensor (options P and SP), the two adjacent holes at the top of the cell base (circled in the picture below) make a connection to the laser-welded pressure sensor located inside the lower part of the cell base. In order to avoid corrosion, no liquids must enter these holes during cell assembly, cell operation, and cleaning. Refer to the troubleshooting section for help if liquid did get into one of the holes.

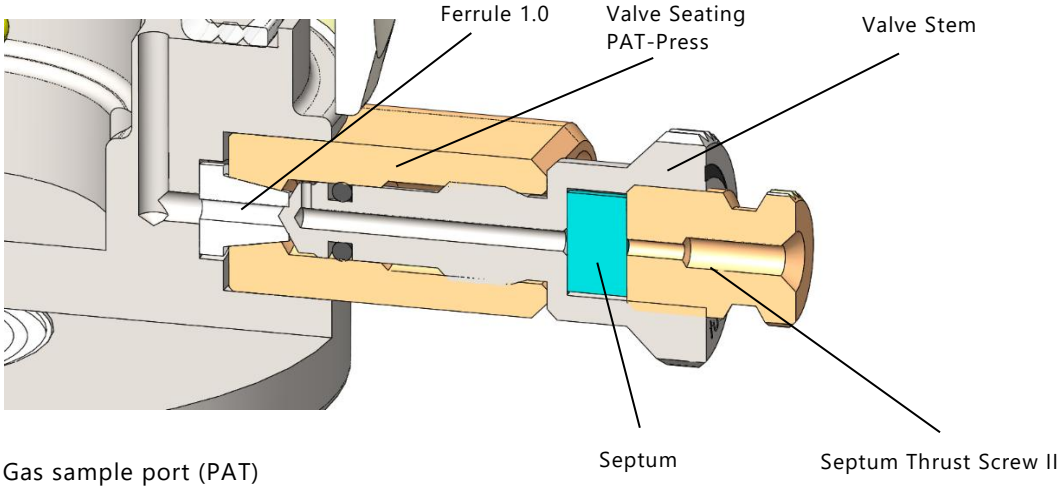
For the cell variants without a pressure sensor, the two adjacent holes are dead-ended. Still, avoid contamination with electrolyte and other liquids.

Notes:

- Protect yourself against chemical hazards. Electrolytes may spill out during cleaning. Electrode materials and electrolytes may react with the ambient atmosphere or solvents used for cleaning. Wear appropriate protective equipment, goggles, and gloves.
- Clean all cell parts right after disassembly. Leaving cell parts in contact with the ambient atmosphere while still being wetted with electrolytes may result in severe corrosion.

10 Sample Valve with Septum Port

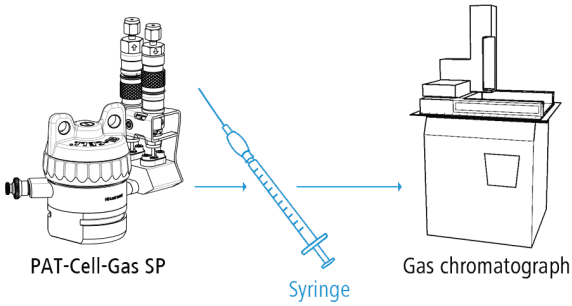
The gas sample valve (available with PAT-Cell-Gas S and SP) serves to draw gas samples for further characterization from the headspace of the test cell.



Gas sample port (PAT)
ECC1-00-0155-C

In the closed state, the valve spindle is seated on the PTFE ferrule and thus prevents any bleeding through the pierced septum.

10.1 How to Draw Gas Samples



1. Pierce the septum with a sample syringe appropriate for the subsequent gas analysis, with e.g., a gas chromatograph. We recommend using a syringe with a pencil-point needle to prevent clogging when the septum of the sample port is pierced. A 1 ml syringe (LAB0024) and a pencil-point needle (LAB0039) are provided with the equipment.

2. Open the valve by turning the valve handle counter-clockwise approximately. 90 degrees

3. Fill the syringe by drawing back the syringe piston.

4. Close the valve by turning the valve handle clockwise till finger-tight, and remove the syringe.

Note: Do not connect the sample port directly or permanently to an external device.

11 Changing the Lid Spring

The lid spring can be changed to allow different forces to be applied to the cell stack. Other springs are available; see Chapter 11 for more information.



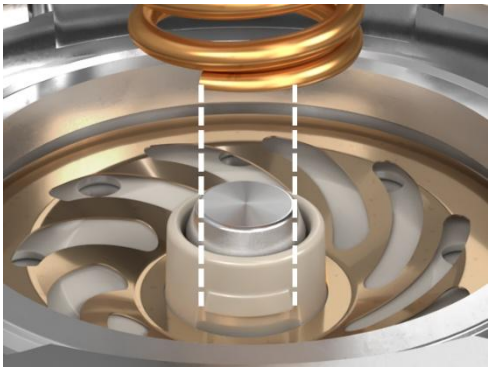
Follow these steps to change the spring in the Screw Cap Insulated (PAT).



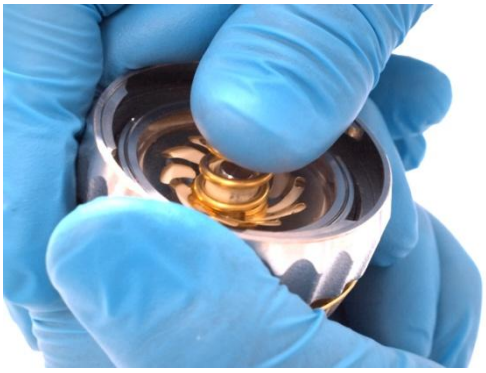
Remove the installed spring with a suitable tool (e.g., the back end of tweezers or a screwdriver). Be careful not to damage the PEEK part at the pin.



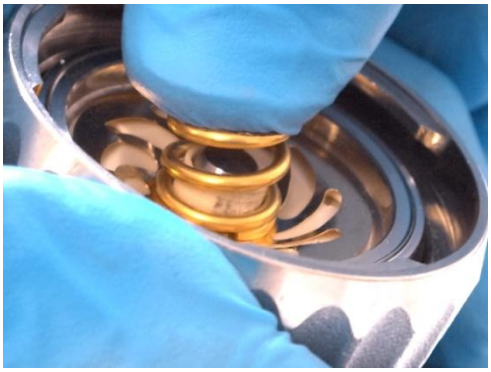
Note: There is a high and a low lug on the pin used to attach the spring.



Position the new spring aligned with the high lug as shown in the image.



Now press the spring onto the pin until it touches the disc spring.



Check that the spring is seated correctly by bending it slightly in all directions.

12 Unpacking

Check the contents of the packages against the list given below to verify that you have received all of the required components. Contact EL-CELL if anything is missing or damaged.

NOTE: Damaged shipments must remain within the original packaging for freight company inspection.

List of Components

PAT-Cell-Gas / PAT-Cell Gas P:

- PAT-Cell-Gas test cell without PAT-Core*
- Sealing ring PE (10x) ECC1-00-0232-A/X

PAT-Cell-Gas S / PAT-Cell-Gas SP:

- PAT-Cell-Gas test cell without PAT-Core*
- Septum (10x) ECC1-00-0097-B/X
- Syringe 1ml (w/o Luerlock) LAB0024
- Spinal needle pencil-point (27g) LAB0039
- Sealing ring PE (10x) ECC1-00-0232-A/X
- Ferrule 1.0 (2x) ECC1-00-0029-B/2

* **Note:** The components of the PAT-Core (insulation sleeves and plungers) must be purchased separately.

13 Consumables

- Sealing ring PTFE (10x) ECC1-00-0232-B/X
- Sealing ring PE (100x) ECC1-00-0232-A/C
- Sealing ring, Al, 10 pcs, ECC1-00-0232-G/X
- Sealing ring, Al (washer) (10 pcs) ECC1-00-0232-N/X
- Sealing ring, Cu (washer) (10 pcs) ECC1-00-0232-M/X
- Lower Plunger (perf. Plate), stainless steel ECC1-01-0081-C_x
  (x = height number 50 to 800)
- Lower Plunger (flow field), stainless steel ECC1-01-0038-C_x
  (x = height number 50 to 800)

You can find a list of all available consumables on el-cell.com.

14 Accessories

Valve body plug



The Valve body plug is an optional accessory for the PAT-Cell-Gas. It enables the cell to be operated without a valve block and connected gas circuit.

Order no.: ECC1-00-0391-E

Compression spring (Au), FED9079



- This optional lid spring applies the following force to the cell stack:
- 105 N ±10% if used with an aluminum lid seal
- 115 N ±10% if used with PE lid seal.

These values apply to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

- Compression spring 1,6x11, 6x8, L: 11,33 (Au, 5 pcs), Order no.: FED9079/V

Compression spring (Au), FED9052



This optional lid spring applies a force of 7 N ± 30% to the cell stack:

This value applies to an upper electrode thickness ranging from 0 to 0.8 mm. Within this range, the electrode thickness has no significant influence on the force.

- Compression spring 0.85x9.25x12.5x2.31 (Au) (5pcs) Order no.: FED9052/V

Metal seal mounting kit

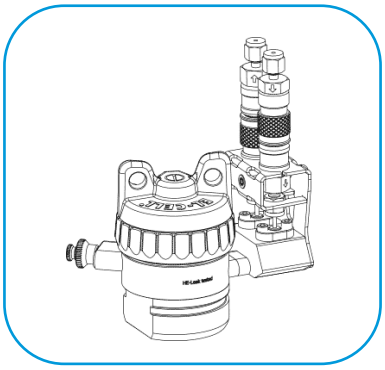


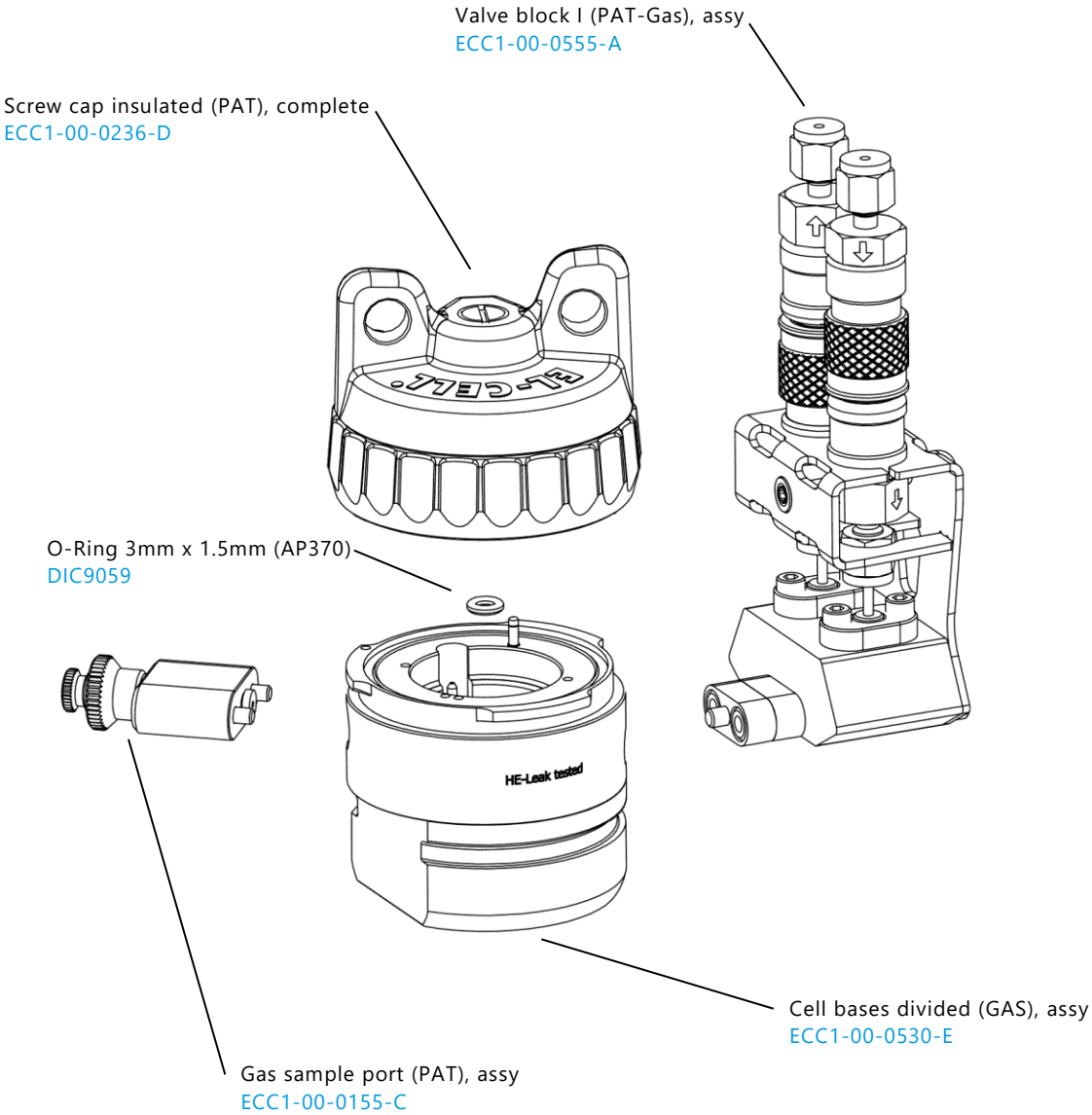
This toolkit is designed to ensure the correct installation when using metal lid seals. The assembly block holds the cell in place, while the torque wrench enables you to secure the cell lid with the recommended torque.

- Metal seal mounting kit, order no.: ECC1-02-0040-A

15 Spare Parts

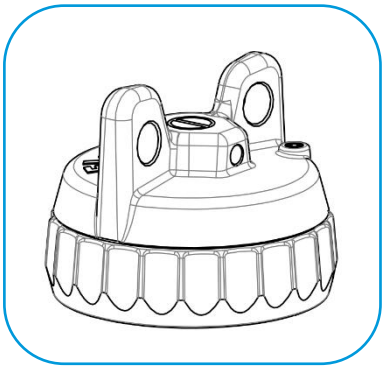
PAT-Cell-Gas SP, complete

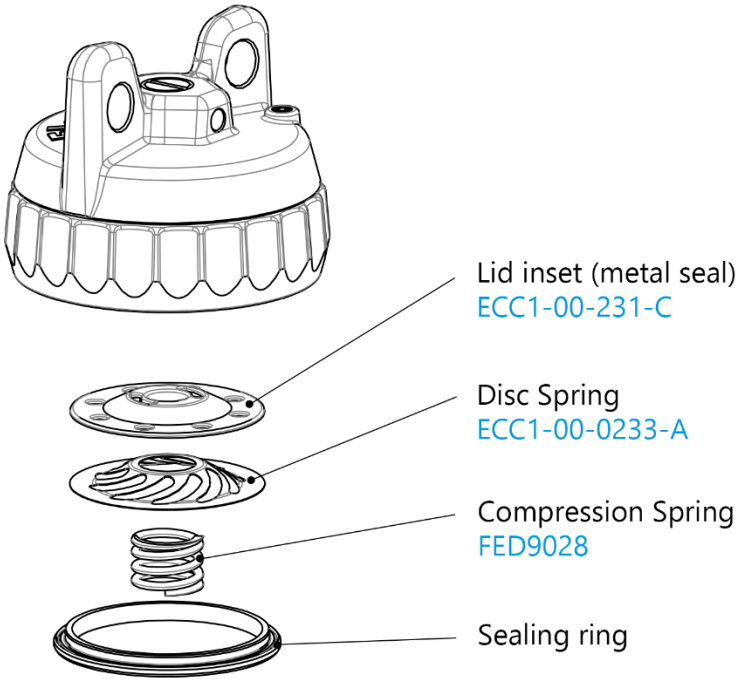




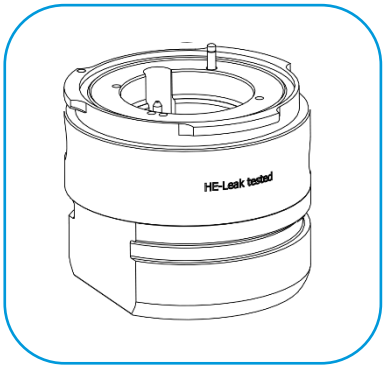
Screw cap insulated (PAT), complete

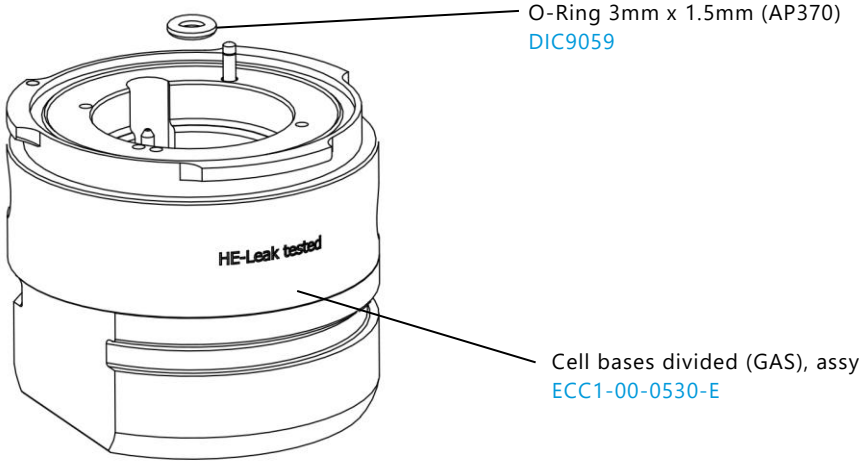
ECC1-00-0236-D





Cell base divided (GAS), assy
ECC1-00-0530-E



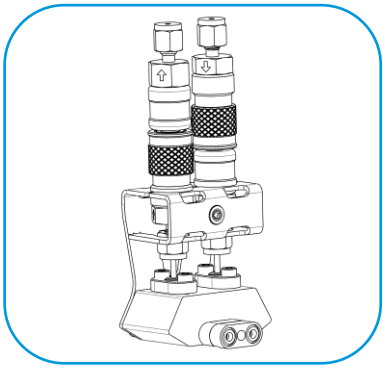


O-Ring 3mm x 1.5mm (AP370)
DIC9059

Cell bases divided (GAS), assy
ECC1-00-0530-E

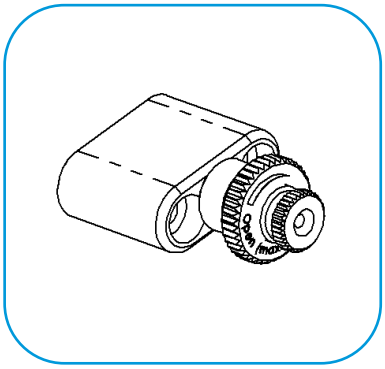
Valve block I (PAT-Gas), assy

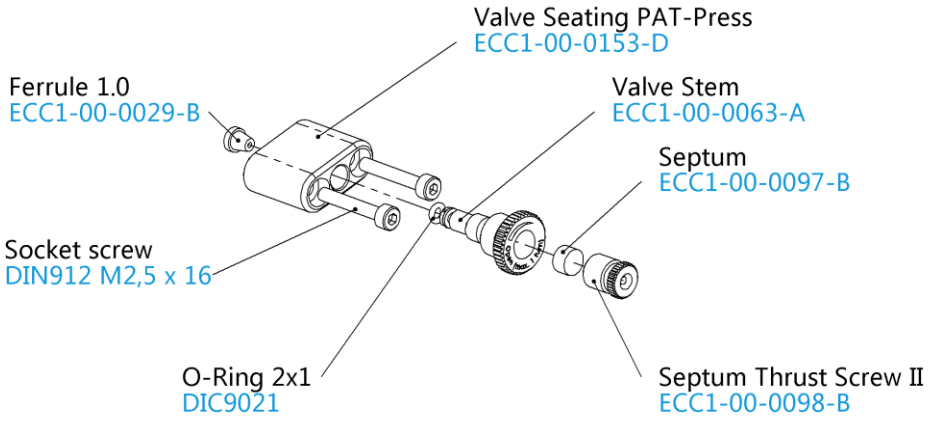
ECC1-00-0555-A



Gas sample port (PAT), assy

ECC1-00-0155-C





16 Troubleshooting

What can I do if electrolyte has entered one of the holes in the cell base?

Please only attempt this in an emergency, as there is a risk of damaging the cell: Flush the holes with an appropriate solvent (e.g., distilled water) applying low pressure. Afterwards, the cell base should be dried out overnight at 80° C to remove liquid residues.

17 Warranty

For a period of one year from the date of shipment, EL-Cell GmbH (hereinafter Seller) warrants the goods to be free from defect in material and workmanship to the original purchaser. During the warranty period, Seller agrees to repair or replace defective and/or nonconforming goods or parts without charge for material or labor, or, at the Seller's option, demand return of the goods and tender repayment of the price. Buyer's exclusive remedy is repair or replacement of defective and nonconforming goods, or, at Seller's option, the repayment of the price.

Seller excludes and disclaims any liability for lost profits, personal injury, interruption of service, or for consequential incidental or special damages arising out of, resulting from, or relating in any manner to these goods.

This Limited Warranty does not cover defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, modification, or the attachment of improper devices to the goods. This Limited Warranty does not cover expendable items. This warranty is void when repairs are performed by a non-authorized person or service center. At Seller's option, repairs or replacements will be made on site or at the factory. If repairs or replacements are to be made at the factory, Buyer shall return the goods prepaid and bear all the risks of loss until delivered to the factory. If Seller returns the goods, they will be delivered prepaid and Seller will bear all risks of loss until delivery to Buyer. Buyer and Seller agree that this Limited Warranty shall be governed by and construed in accordance with the laws of Germany.

The warranties contained in this agreement are in lieu of all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

This Limited Warranty supersedes all prior proposals or representations oral or written and constitutes the entire understanding regarding the warranties made by Seller to Buyer. This Limited Warranty may not be expanded or modified except in writing signed by the parties hereto.