

User Manual

Release 1.0

PAT-Core

Insulation sleeve with built-in separator and optional reference electrode and current collectors (plungers)



The information in this manual has been carefully checked and believed to be accurate; however, no responsibility is assumed for inaccuracies.

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1 Product description

The PAT-Core is the central part of all PAT series test cells. It is comprised of three components: the lower plunger, which serves as positive current collector, the upper plunger as negative current collector and the pre-assembled insulation sleeve with built-in separator and optional ring-shaped reference electrode for 3-electrode tests.

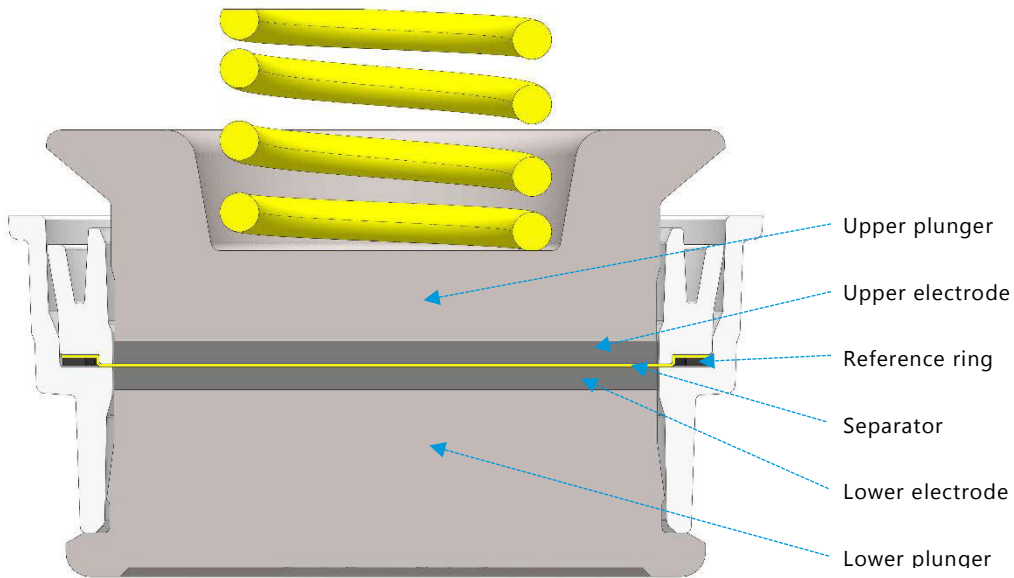


Features

- Single-use concept in order to lower lead time of experiments and to reduce the risk of cross-contamination
- Available with or without built-in reference electrode
- All battery grade construction materials: Al, Cu, PP
- Optionally re-usable current collectors made of stainless steel (316L)
- Compatible with all PAT series test cells and the ECC-PAT-Core test cell

2 Different test cases

The PAT-Core may be used for many different battery and capacitor types. The table below summarizes some of the most common test cases. In general, we recommend sleeves with built-in glass fiber separator rather than thin technical separators (such as Viledon or Celgard) when lithium metal is used as the negative electrode, and when measuring half cell impedances. Glass fiber is also the best choice, when wettability is a potential issue (e. g. when using ionic liquids).

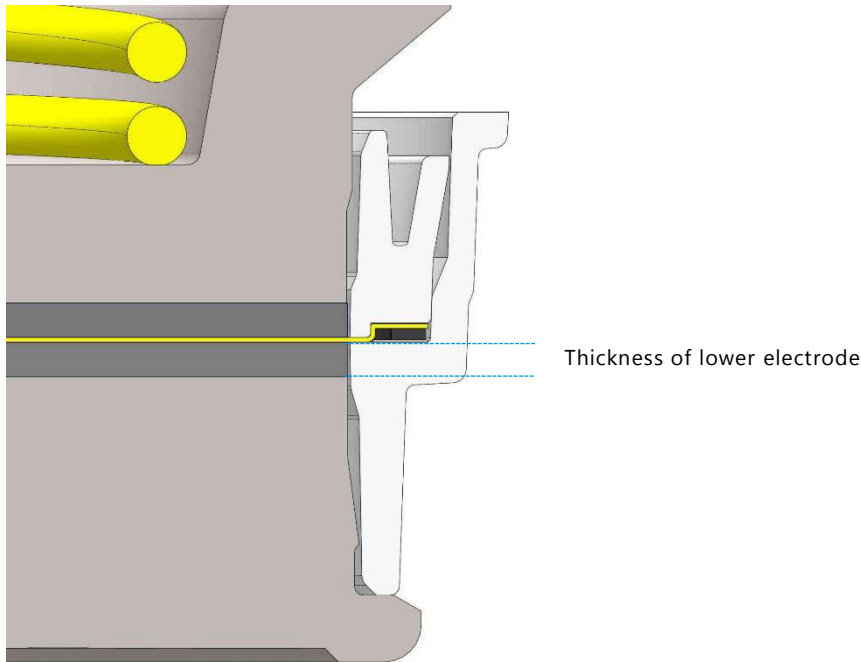


Battery Type	Lower electrode (+)	Upper electrode (-)	Lower plunger single-use/re-use	Upper plunger single-use/re-use	Separator
Li-metal	LCO, NCA, NCM or LFP	Li	Al/SS	Cu/SS	GF
Li-metal	Graphite or silicon	Li	Cu/SS	Cu/SS	GF
Li-metal	LTO	Li	Al or Cu/SS	Cu/SS	GF
Li-ion	LCO, NCA, NCM, or LFP	Graphite	Al/SS	Cu/SS	GF or thin
Li-ion	LFP	LTO	Al/SS	Al or Cu/SS	GF or thin
EDLC	AC	AC	Al/SS	Al/SS	GF or thin
Li-ion cap	AC	Lithiated graphite	Al/SS	Cu/SS	GF or thin

3 PAT-Core components

Lower plunger:

By default, the lower plunger serves as the positive current collector. It is available in different materials and in different "height numbers". The proper plunger height must be chosen to make sure that the pre-assembled separator is not excessively bent during assembly of the PAT-Core. The proper plunger height number depends on both the thickness of the lower electrode and the thickness of the built-in separator. The following rules apply:



For a separator thickness below 100 µm:

Height number = Thickness of lower electrode (in µm) + 50

For a separator thickness above 100 µm:

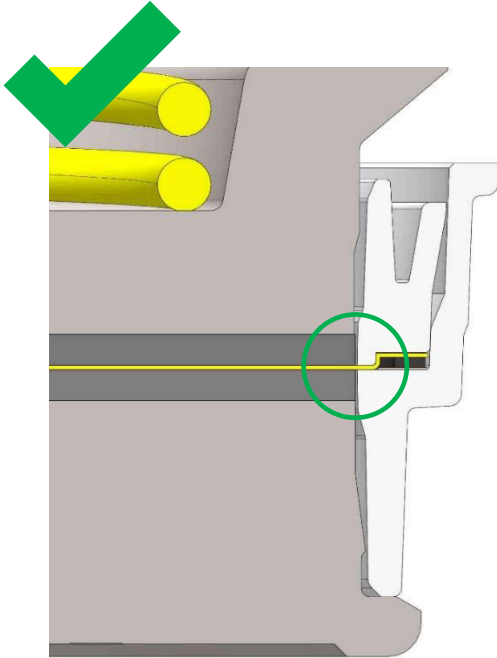
Height number = Thickness of lower electrode (in µm) + half of the separator thickness (in µm)

We supply lower plungers with height numbers between 0 and 800 in steps of 50.

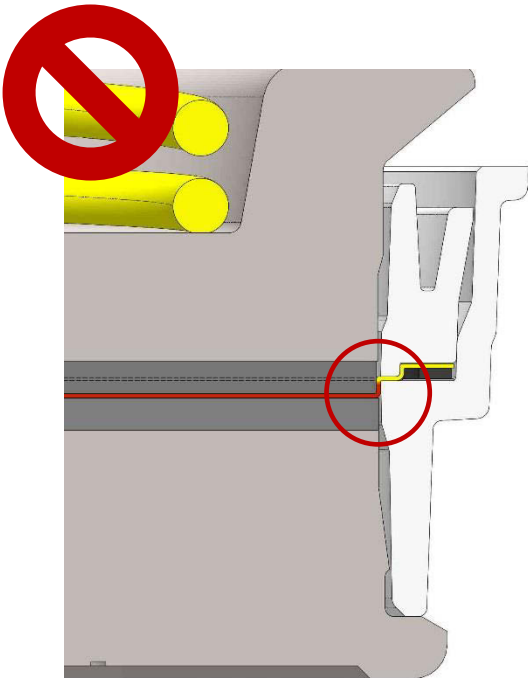
Example: You are using an insulation sleeve with 260 µm glass fiber together with a 90 µm thick LCO cathode. The above equation yields a height number of $90 + 260/2 = 220$. The closest available height number is 200.

Note: Any other height number ± 50 away from the calculated optimum is mostly good. The proper height number is most important when conducting half cell impedance measurements.

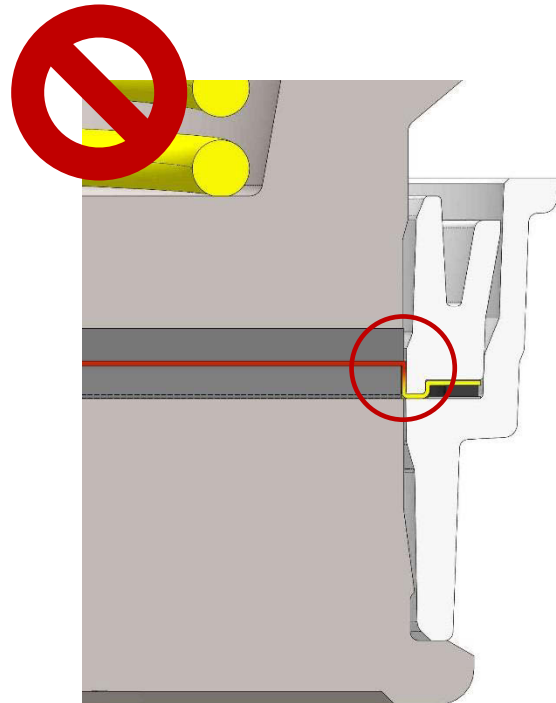
If you use a wrong plunger gap, you may get trouble with your battery test. The below figures illustrate this point.



Good case: No bending of built-in separator



Plunger height number too large:
Excessive downward bending of built-in separator



Plunger height number too small:
Excessive upward bending of built-in separator

Available lower plungers:

The lower plunger is available with gap sizes between 50 and 800 in steps of 50 µm. For ordering, just append the step size to the article code, see table below.

Gap of lower plunger (in µm)	50	100	150	200	..	800
Article code lower plunger (SS)	ECC1-01-0027-C_50	ECC1-01-0027-C_100	ECC1-01-0027-C_150	ECC1-01-0027-C_200		ECC1-01-0027-C_800
Article code lower plunger (Al)	ECC1-01-0027-A_50	ECC1-01-0027-A_100	ECC1-01-0027-A_150	ECC1-01-0027-A_200		ECC1-01-0027-A_800
Article code lower plunger (Cu)	ECC1-01-0027-B_50	ECC1-01-0027-B_100	ECC1-01-0027-B_150	ECC1-01-0027-B_500		ECC1-01-0027-B_800

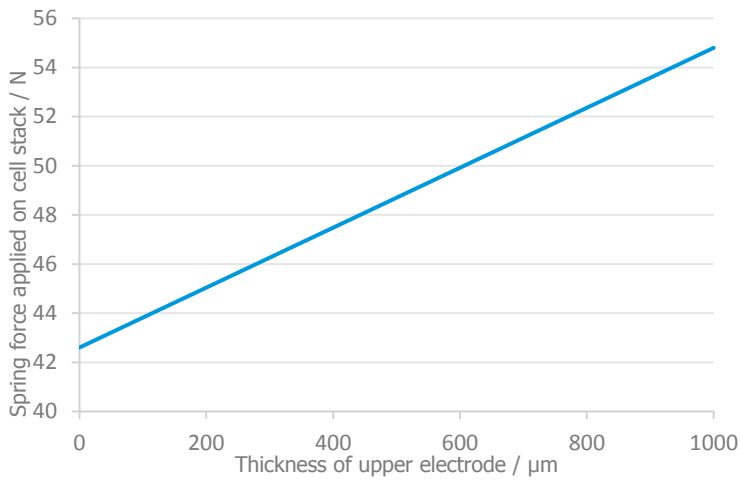
Upper plunger:

By default, the upper plunger serves as the negative current collector. Only one height is available which fits for any thickness of the upper electrode up to 800 µm. The upper plunger is available in different materials: Stainless steel 1.4404, Al 99.5% and Cu 99.9%.

	type of utilization (single-use vs. reusable)	article no. upper plunger
copper Cu 99.9 (E-CU 58)	single-use	ECC1-01-0026-A
aluminium Al 99.5 (EN-AW- 1050)	single-use	ECC1-01-0026-B
stainless steel 316L (1.4404)	reusable	ECC1-01-0026-C

Spring force in relation to the thickness of the upper electrode:

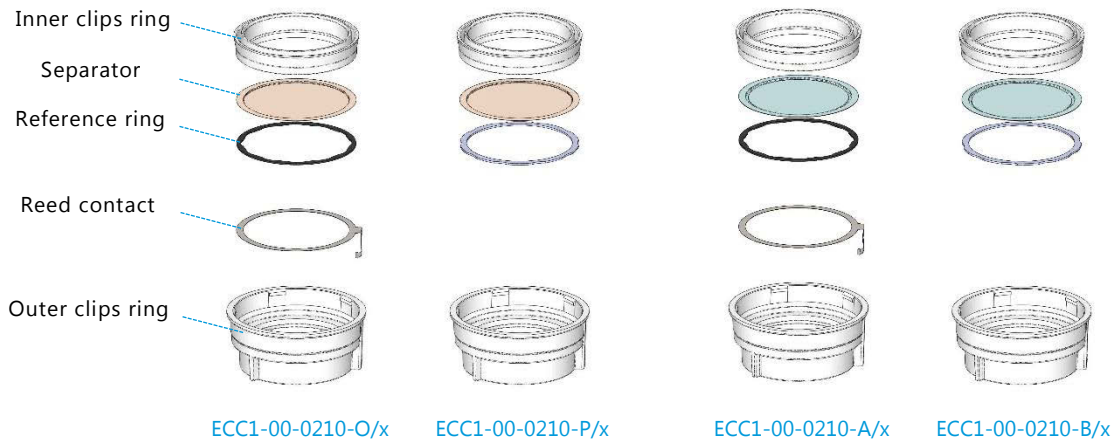
Please note that the height of the upper electrode has an impact on the spring on the cell stack. Different springs are available as spare parts for the PAT series test cells, please refer to the respective manual.



Insulation sleeve:

The insulation sleeve is available with and without a ring-shaped lithium metal reference ring, and with two different types of separator: borosilicate glass fiber separator (Whatman GF/A) having a thickness of 260 μm , and nonwoven polyester pasted with Al_2O_3 (Freudenberg Viledon FS 3005-25) having a thickness of 25 μm . Other separators and customized solutions are available on request. Furthermore, the sleeve is available in the disassembled state, either with or without the lithium reference ring. The table below comprises the four standard versions only.

	article no.	type of testing (2 or 3 electrodes)
Insulation sleeve with lithium metal ring reference, with glass fiber separator (260 μm)	ECC1-00-0210-O/x	3 electrodes
Insulation sleeve with lithium metal ring reference, with Viledon separator (25 μm)	ECC1-00-0210-A/x	
Insulation sleeve with glass fiber separator (260 μm)	ECC1-00-0210-P/x	2 electrodes
Insulation sleeve with Viledon separator (25 μm)	ECC1-00-0210-B/x	



4 PAT-Core assembly

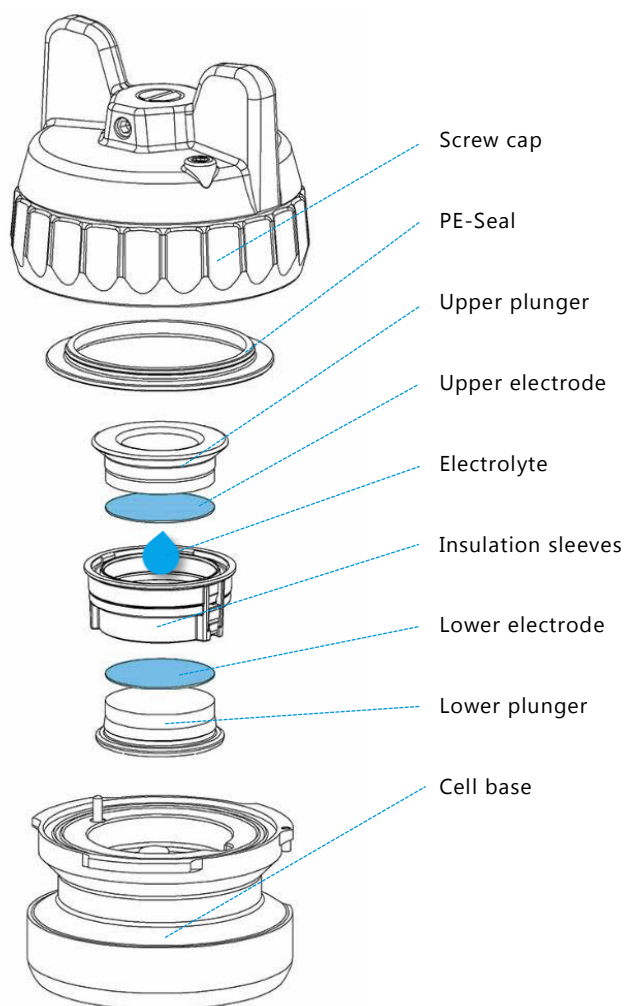
This section describes how the PAT-Core in combination with the compatible test cells has to be assembled in order to conduct proper battery tests.

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

4.1 Safety precautions

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

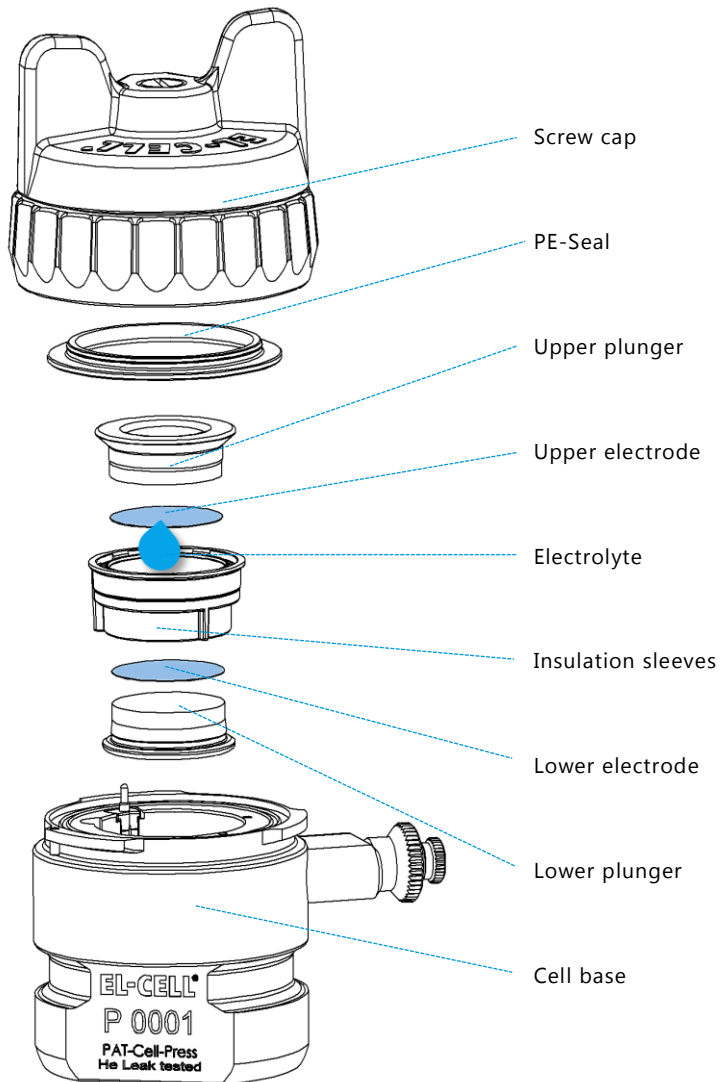
4.2 PAT-Core assembly using a PAT-Cell



1. Put the **insulation sleeve** onto the worktop with the smaller side pointing upwards.
2. Insert the **lower electrode** into the sleeve with the active layer facing downwards.
3. Attach the **lower plunger**.
4. Turn the assembly upside down.
5. Align the contact spring of the sleeve with the horizontal contact 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.

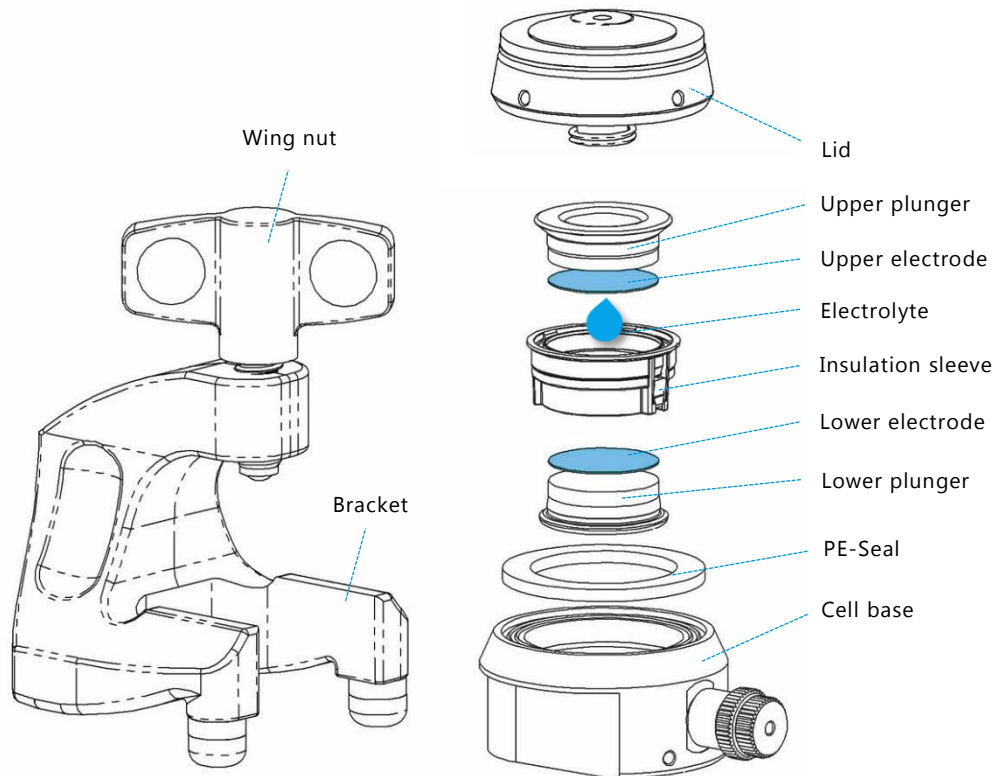
8. Attach the **upper plunger**.
9. Attach the **screw cap** to the cell base with the wing nut fully released.
10. Tighten the wing nut clockwise in order to seal the cell.

4.3 PAT-Core assembly with a PAT-Cell-Press



See procedures for the PAT-Cell in section 3.2

4.4 PAT-Core assembly using a ECC-PAT-Core



1. Put the **insulation sleeve** onto the worktop with the smaller side pointing upwards.
2. Insert the **lower electrode** into the sleeve with the active layer facing downwards.
3. Attach the **lower plunger**
4. Turn the assembly upside down.
5. Align the contact spring of the sleeve with the horizontal contact 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. Mount the **PE-Seal** on the cell.
10. Put the **lid** (with integrated spring) on top.

11. Hold the lid down and push the cell into the **bracket**.
12. Turn the **wing nut** to close the cell.

5 Disassembly and cleaning

After disassembly, dispose all single-use PAT-Core components and electrodes properly. If the cell base of the test cell has got contaminated with electrolyte, clean it with plenty of water and dry with compressed air. Use less electrolyte for subsequent tests. Plungers made of stainless steel have to be cleaned with plenty of water. If necessary, remove persistent dirt with aqueous nitric acid (20%, 2 hours at room temperature). All other cell components are for immediate re-use without cleaning.

6 Consumables

Plunger (single-use):

- Upper plunger (Al) [ECC1-01-0026-B](#)
- Upper plunger (Cu) [ECC1-01-0026-A](#)
- Lower plunger (Al), height number x = 50 to 800 [ECC1-01-0027-A_x](#)
- Lower plunger (Cu), height number x = 50 to 800 [ECC1-01-0027-B_x](#)

Insulation sleeves (single-use):

- Insulation sleeve with Li-reference ring and Viledon separator
[ECC1-00-0210-A/x](#)
- Insulation sleeve with Viledon separator only
[ECC1-00-0210-B/x](#)
- Insulation sleeve with Li-reference ring and glass fiber separator
[ECC1-00-0210-O/x](#)
- Insulation sleeve with glass fiber separator only
[ECC1-00-0210-P/x](#)

Seals (single-use):

- Sealing ring (lid) [ECC1-00-0232-A](#)

7 Technical support

Technical support for this product is exclusively provided by EL-CELL GmbH.

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8 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.