Sphere

# ASC Product Catalog

Summer 2023

**Highlight:**

Explore the **latest additions** to our portfolio:

- ASC-C
- ASC-P (testing service)

to **scale up** your research!


## Next generation battery testing.

# Sphere Energy's products

## ASC Portfolio

**ASC-T**
Temperature control

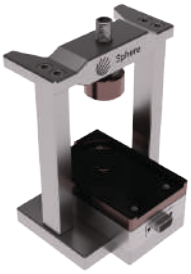
**ASC-AD**
Pressure balancing

**ASC-A**
Airtight screening

**ASC-Gas**
In-operando gas analysis

**ASC-C**
Coin cell tests


**ASC-P *(service only!)***
Pouch cell tests



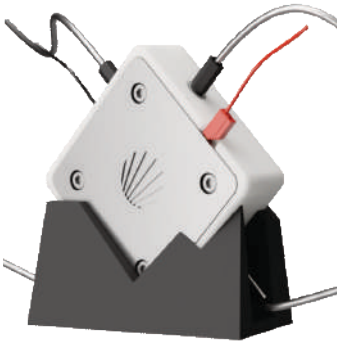
**Pressure frame**
Pressure control & monitoring

**Thickness option**
Volume change monitoring


**Control Unit**
Temperature & pressure control

**Further products:**

## FLC Cell



**Test cell for flowing electrolyte systems**

## UVC Cell

**UV-Vis test cell**

ASC

FLC

UVC

# Table of Content



## Our Mission

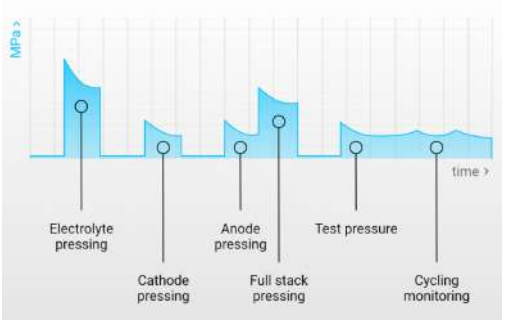
The world is imminently moving towards sustainable, innovative energy storage solutions and thrives for the reduction of $CO_2$ in the atmosphere. Here, the global R&D community is playing an essential role in enabling a more sustainable future. The mission is to discover new materials and designs that ultimately enable the industrialization of the next generation of green-energy technologies. But one of the biggest challenges in research is the lack of specified testing equipment. New materials often demand for a new testing-approach, or simply need data that cannot be captured with state-of-the-art test-cells, such as e.g.: stacking pressure for next-generation batteries. To combat this fundamental challenge, Sphere Energy has decided to dedicate all efforts to satisfy the needs for test equipment coming from R&D - to enable researchers to focus again on creative experimental design, execution and analysis. Within our portfolio, the ASC line is focused on the promising field of next-generation batteries such as e.g. solid-state batteries. The ASC equipment allows the researchers to investigate electrochemical performance of solid-state batteries and their components, by combining classical cycling and conductivity tests with the option to monitor and tune stacking pressure, cell temperature and obtain in-operando insights on the sample thickness changes or released gasses.

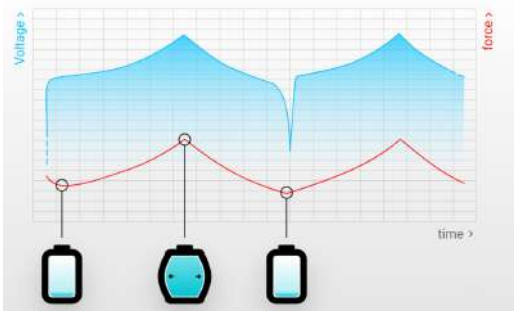
„**The goal of our equipment is to enable researchers around the world to obtain standardized data that is reproducible, can be easily compared and bridges the gap between academic and industrial research. We believe this is key to accelarate the commercialization of promising energy storage technologies.“**

# Challenges in ASSB testing (1/2)

## Precise pressure control + monitoring

With our pressure frame (including highly precise sensors), a static mechanical pressure can be applied onto your battery material and can be controlled precisely. This assures that the very eminent parameter of pressure is monitored throughout the whole process - starting already during the sample preparation. By live-monitoring the pressure during your experiments, a better understanding of the „breathing“ of your materials can be obtained.

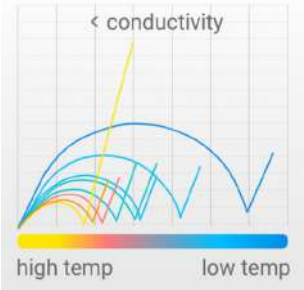



*>>> page 4 (pressure frame + sensor)*

## Adaptive temperature control up to 200 °C

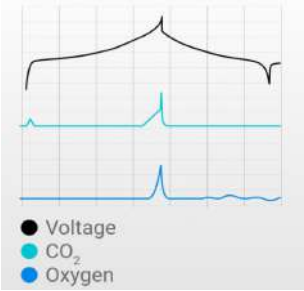
With an internal heating element, the ASC-T enables the control and application of high temperatures without the need for a climate chamber and long waiting periods for acclimation. The heating is not only made for electrochemical measurements of your battery material (e.g. conductivity measurements, see right) but can also support the battery sample preparation phase.




*>>> page 5 (ASC-T)*

## In-situ gas analysis

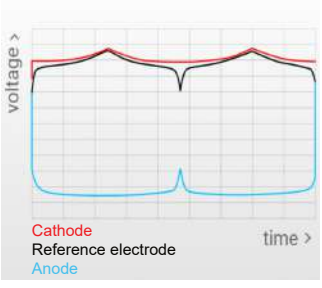
With our equipment, gasses that might form during electrochemical processes can be analyzed in real-time. With separated gas flow channels for the anode and cathode, the ASC-Gas allows you to precisely understand all reactions and monitor potential safety risks of your new battery materials.




*>>> page 8 (ASC-Gas)*

## Reference electrodes

In our ASC-T cell, you have the possibility to separately analyze the reactions, which occur at the anode and cathode respectively. For this, a reference electrode of desired material is placed directly in the center of the test cell.




*>>> page 5 (ASC-T)*

# Challenges in ASSB testing (2/2)

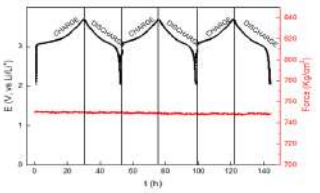
## Hermetically sealed testing cells

Whenever you work with air-sensitive and/or toxic materials, the glove-box is inevitable. Within our ASC portfolio we deliver solutions to test these materials outside of the glove-box for easier operation and efficient handling within limited space.

*>>> page 6 (ASC-A)*

## Dynamic pressure balancing

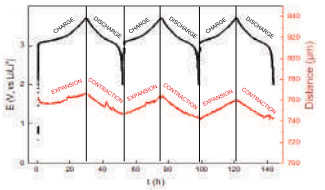
Thanks to our dynamic pressure balancing system, the initially set testing pressure can be kept constant during your experiments. This spring-based system enables a constant pressure application (see right) and is perfectly suited for long-term cycling tests.



*>>> page 7 (ASC-AD)*

## In-situ thickness monitoring

An additional thickness option enables the precise determination of your material thicknesses. Further, you can directly monitor any volume changes during testing (see right).



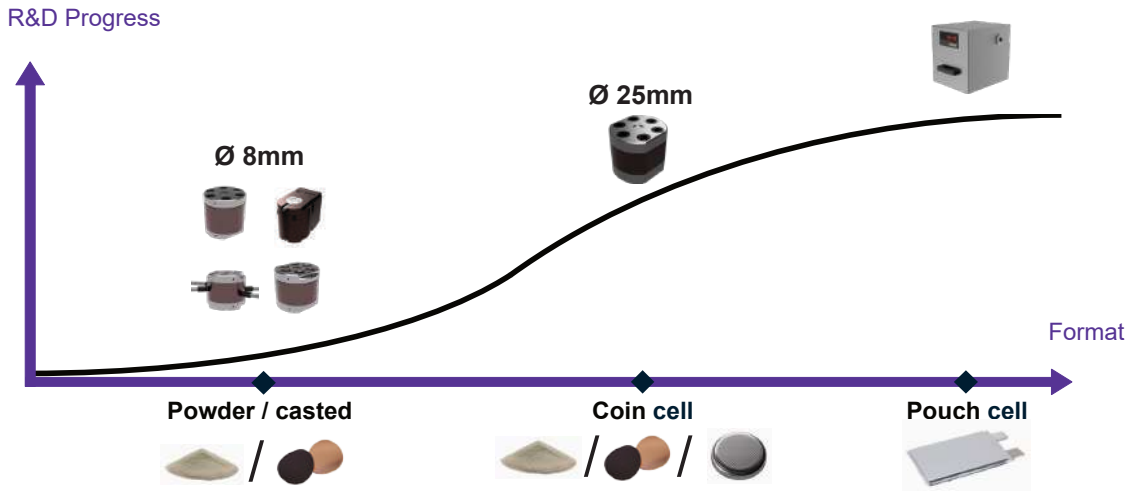
*>>> page 9 (thickness option)*

## Scale up to pilot/large-scale production

Analogous to any common battery research laboratory, we started with test cells that were capable of measuring small samples. Along our journey we constantly adapted our test cell portfolio to the growing needs of bigger sample sizes, while keeping our attention to details and thoughtful product design - always with the goal of simplifying your research and ensuring an extraordinary data quality.

*>>> page 11 / 12 (ASC-C / ASC-P)*

**We accompany you along the entire battery development cycle - from powder testing to pouch cells!**



# Research made simple

## Compact design

- Product dimensions designed for optimal use under lab conditions
- Perfectly suitable for glove-box handlings & transfers

## Simple usability under difficult conditions

- Reproducible results by monitoring all important parameters during testing and preparation steps
- Prepare your battery materials where they will be measured (no cross-contamination or cracking of pellets)
- Broad range of features covering any eventualities (airtight cells, dynamic pressure, gas analysis, etc.)
- Simplified material (powder/casted) loading thanks to the symmetric design of our test cells
- Long-lasting design thanks to high-end materials and replaceable wear parts
- Time-saving mechanisms paving you the way to high throughput battery testing

## Modular approach

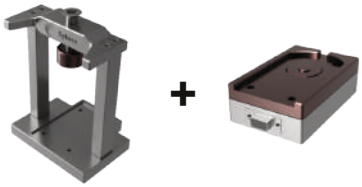
- The ASC family is made from intercompatible products - so you can easily enlarge your testing possibilities and capacities whenever needed

# Pressure frame + sensor

**Two options:**

i) High pressure range (ideal for up to 4 ton/cm²)

ii) Low pressure range (ideal for up to 0.5 ton/cm²)

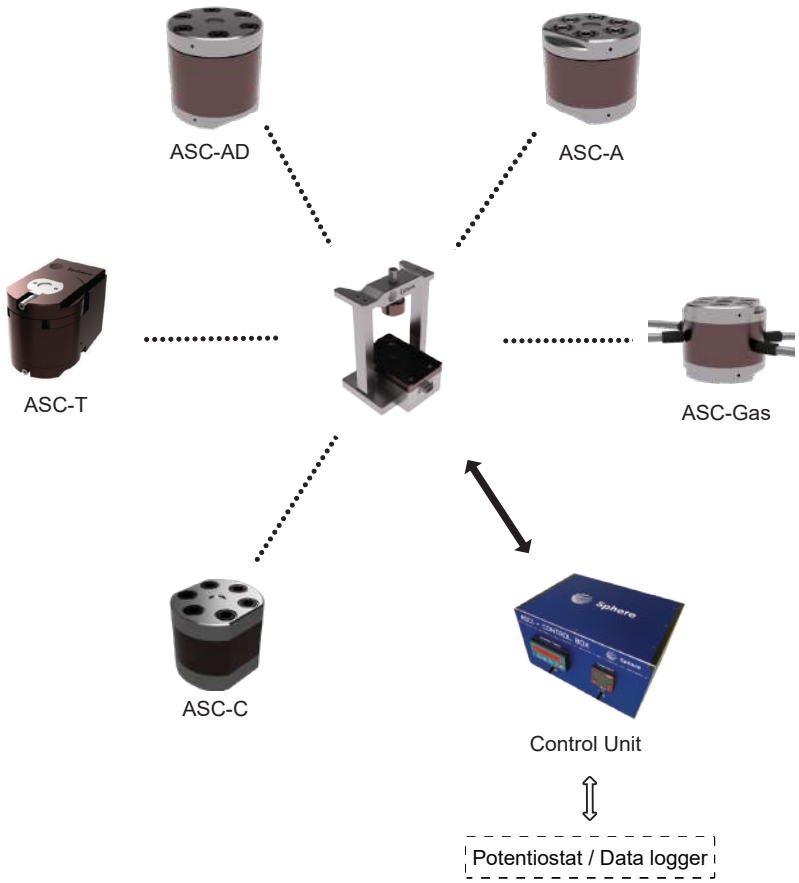


## Key Features

- Apply and live monitor mechanical pressure
- High-quality sensor (accuracy of 20 - 200 g/cm²)
- Smart design to assure correct placement of your cell

## Intercompatibility of our cells:

The following test cells are designed to be perfectly compatible with our pressure frame to assure a simple testing process combined with maximum flexibility within your laboratory. The pressure value is given via an analogical output and can be displayed and monitored via our control unit and is synchronized with your potentiostat/cycler.

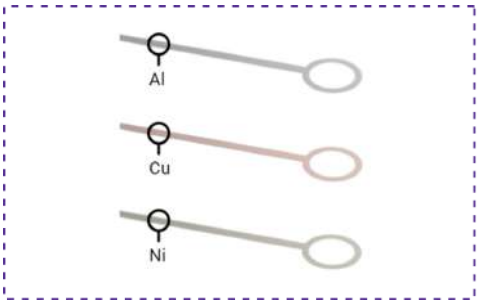


# ASC-T: For optimal temperature control

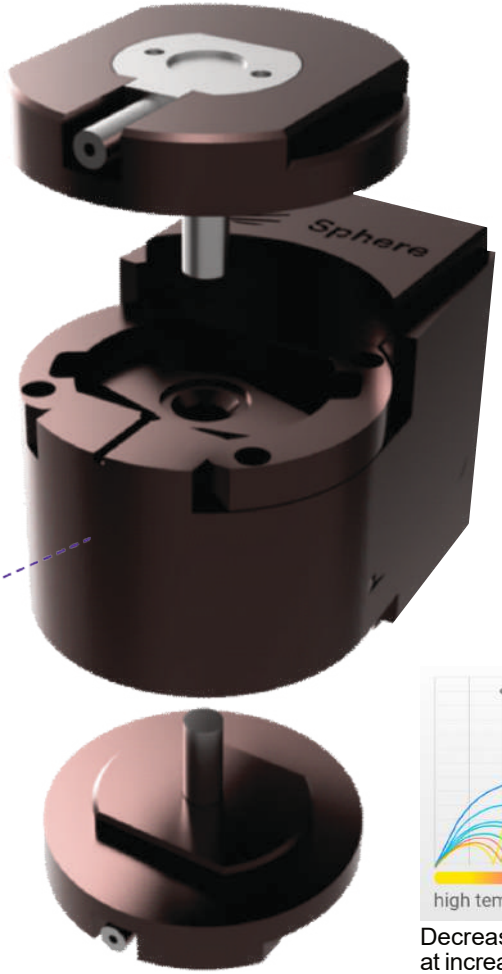
## How does your chemistry perform under various temperatures?

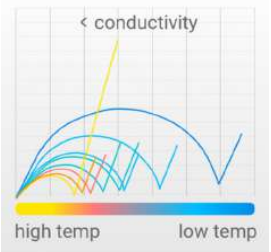
A question that can be answered with the ASC-T. It is designed to heat your sample from room temperature up to 200 °C. Of course it is compatible with the pressure frame – to control and monitor the pressure during assembly and electrochemical testing. The internal sleeve made from $Al_2O_3$ even allows external sintering of the material stack. Therin, the pellet can be placed in an oven and withstand temperatures of up to 1200°C. The ASC-T is also compatible with a third reference-electode.

| | |
|---|---|
| **Sample dimension** | ⌀ 8 mm |
| **Max. temperature** | 200 °C (accuracy: ± 2 °C) |
| **Max. pressure** | 4 ton/cm² |
| **Material** | Stainless steel, PEI & $Al_2O_3$ |
| **Optional reference electrode** | |




To optimally identify the reactions at the anode and cathode separately, we included the option of adding a reference electrode in the center of your battery stack - in a variety of metals, that can be also coated with active materials. Choose a suitable one from our selection.




Decrease of impedance at increased temperature.

### Customer Quote

„The ASC-T highly simplified the handling of air-sensitive compounds since we don't have to remove them out of the glove-box anymore for our temperature treatment step. At the same time, it helped us gathering precise information about the conductance of our materials at various temperatures.“

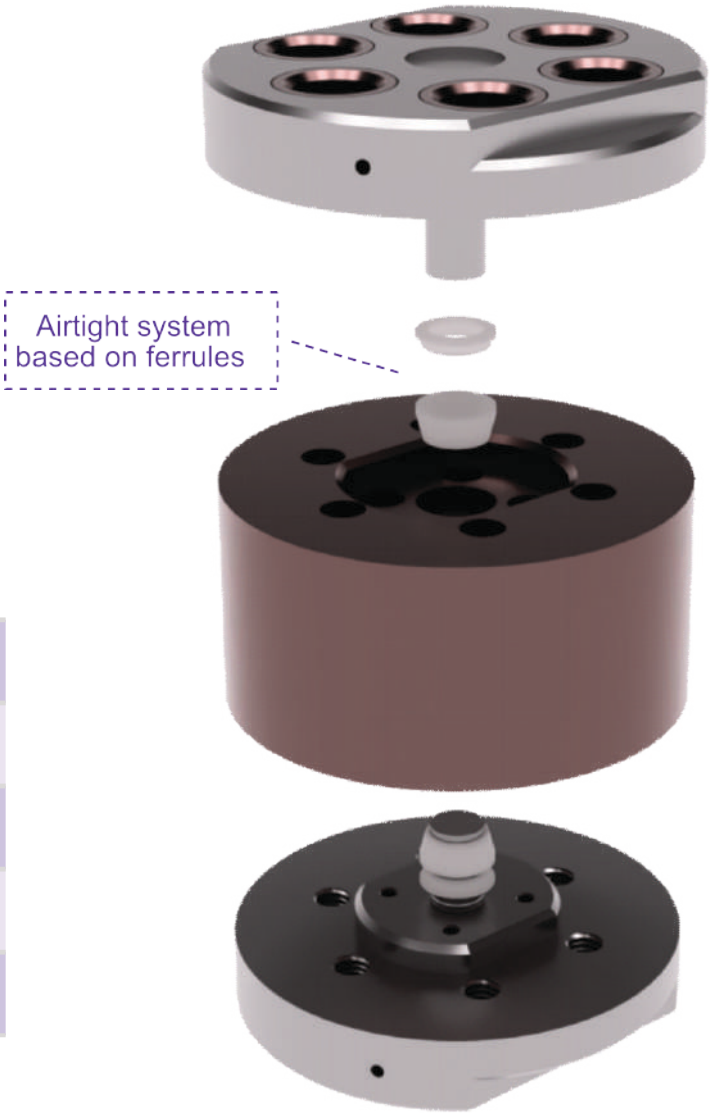
*- Group leader in a R&D facility of an automotive OEM.*

# ASC-A: The airtight cell for outside screening

## Do you have limited space in your glove-box or would you like to place the testing cells inside a climate chamber?

The ASC-Airtight (ASC-A) is made to test air-sensitive materials outside of the glove-box under mechanical compression. The pressure can be applied via torque screwdriver or via our precise pressure frame - in this case live pressure monitoring is possible.


The ASC-A placed inside of the pressure frame.




| | |
|---|---|
| **Sample dimension** | ⌀ 8 mm |
| **Hermetically sealed cell** | |
| **Max. pressure** | 4 ton/cm² |
| **Fixed elecectrode distance** | |
| **Material** | Stainless steel & PEI |

### Customer Quote

„Combined with a pressure frame, these cells perfectly suit our needs to screen newly developed battery materials on our numerous testing channels, while keeping track of the most important variables. The ASC set gave us a good inital overview of the variety of ASC cells and helped shaping our internal process.“

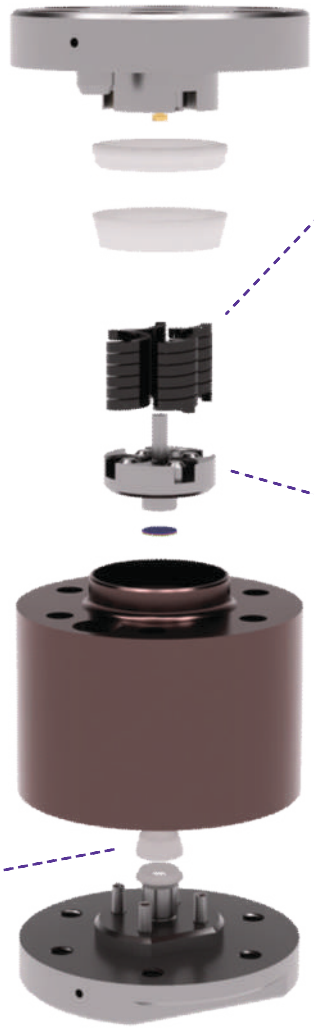
*- Next generation battery research head of a European battery manufacturer*

# ASC-AD: For long-term cycling at fixed pressure

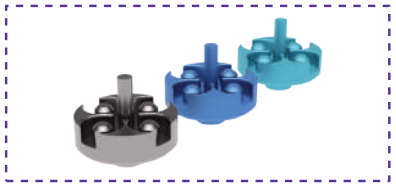
## Have you ever wondered how your battery would perform under constant pressure?

In addition to the functionalities of the ASC-A, the ASC-Airtight Dynamic (ASC-AD) offers an active pressure balancing system. With this system, we ensure that the initially set stacking pressure is kept constant during the expansion or contraction of the tested materials. This is key for optimal results in long-term electrochemical cycling. In combination with the pressure frame, pressure monitoring can be done (only inside the glove-box).

| | |
|---|---|
| **Sample dimension** | ⌀ 8 mm |
| **Hermetically sealed cell** | |
| **Max. pressure** | 4 ton/cm² |
| **Dynamic pressure balancing** (up to 1 ton/cm²) | |
| **Material** | Stainless steel & PEI |



The dynamic pressure applied can be perfectly customized with a variety of plungers and selection of springs having different spring coefficients.



Airtight system based on ferrules

**Perfectly suited for long-term cycling!**

### Customer Quote

„The ASC-AD is our preferred option to cycle battery cell prototypes for several weeks/months under realistic conditions. This is how we work in our industry collaborations.

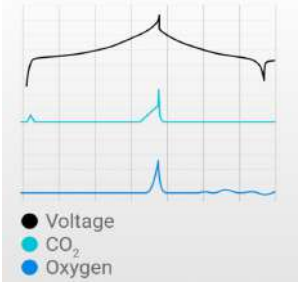
*- Academic researcher of a leading American university*

# ASC-Gas: Perfect for in-operando gas analysis

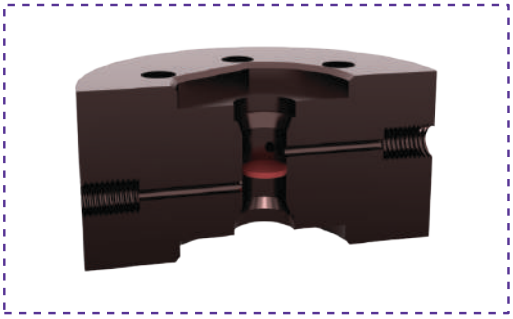
## Do you know which gasses form during cycling of your battery?

A question that can be answered with the ASC-Gas. In addition to the functionalities of the ASC-A, the ASC-Gas can be connected to a mass spectrometer via gas in- and outlet. This enables a real-time analysis of gasses released during your electrochemical measurements. With separated gas flow channels for the anode and cathode, the ASC-Gas allows you to fully understand the chemical reactions taking place and safety risks of your individual materials.

| | |
|---|---|
| **Sample dimension** | ⌀ 8 mm |
| **In-situ gas analysis** | |
| **Max. pressure** | 4 ton/cm² |
| **Hermetically sealed cell** | |
| **Material** | Stainless steel & PEI |




A charge-discharge curve (black) and the respective gasses formed (green, blue) at various stages of cycling.



The gas inlet injects the carrier gas, which flows around the lower piston and eventually reaches the gas outlet, next to the upper piston. The small gap between the pistons and the internal wall of the cell, as well as the porosity of the sample, allow the gas to flow through the cell and sample and collect any gasses formed.

### Customer Quote

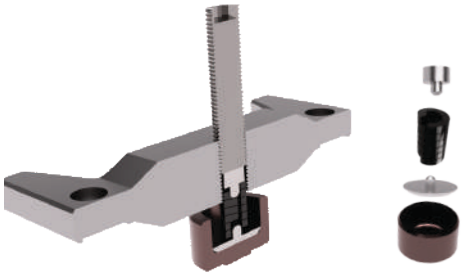
"The ASC-Gas cell of Sphere enabled us to identify the gaseous decomposition products that we observed. This led to the crucial understanding of the inner working of our Na-ion batteries."

*- Na-ion research group of a leading European university*

# Thickness option: Measure & monitor thickness

## Accurately determine thickness & volume changes of your materials

Our thickness option allows you to measure your sample thickness precisely in all ASC cells. Further, the material expansions and contractions are no longer a secret. Combined with an ASC-AD, or ASC-T (here you need the modified frame top, see below), the pressure can be kept constant during experiments and changes in thickness can be live-monitored. The thickness option includes a high-precision comparator which can be firmly mounted onto our pressure frame - this delivers a resolution of 0.001 mm with a precision of 0.003 mm.



It is also possible to explore electrochemical measurements under constant values of pressure with your ASC-T. For this, you need to adapt the pressure-frame with a spring in order to compensate for the thickness variation obtained during testing, e.g. electrochemical cycling.

The thickness changes can be monitored in-operando and recorded via cable or wireless connection.

**In-operando sample thickness**

**Monitor “breathing“**

**Precision of up to 0.003 mm**

**Recording via cable or wirelessly**

### Customer Quote

"Understanding the correlation between the performance of our materials and their expansion and contraction during cycling helped us to improve the performance of our silicone anode."

*- Researcher of a French battery material producer*

# ASC-Set: Your perfect starter kit for 8mm cells

## Are you looking for an all-in-one setup for your laboratory?

A question that can be answered with the ASC-Set. It contains the ASC-T, the ASC-A and the ASC-AD. With this starter kit you are all set to kickstart your research and find out what cells and processes suit best your work.

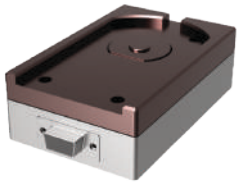
**What is included:**

**ASC-T**

**ASC-AD**

**ASC-A**

**Pressure frame**



**Pressure sensor**


**Control Unit**

## Key Features

- Universal test equipment set for next generation battery laboratories
- Start with this kit and continuously enlarge your portfolio along the way
- Cells for heating, pressure monitoring outside the glove-box & long-term cycling

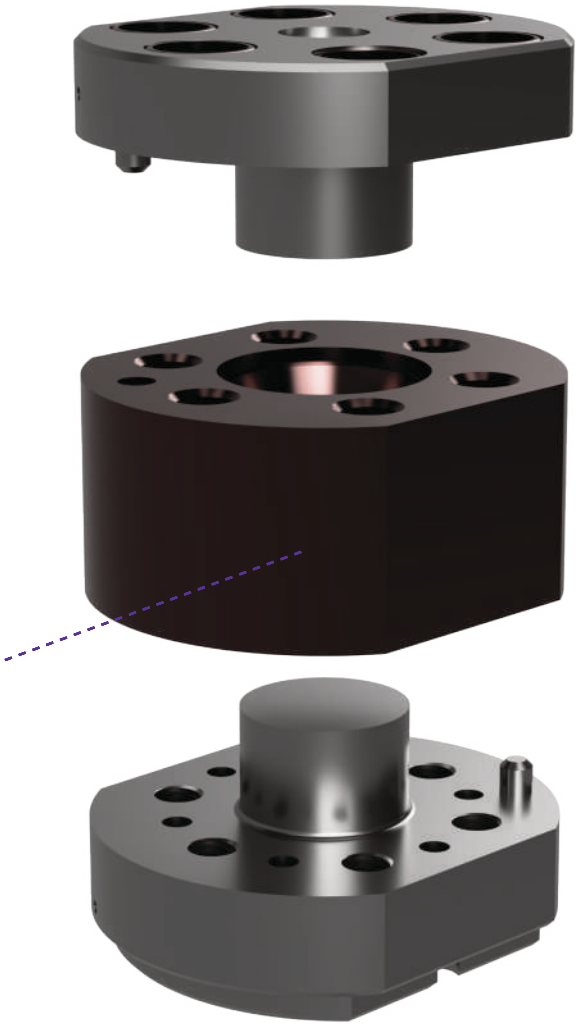
# ASC-C

## Are you looking for testing equipment of bigger sized cells?

Benefit from a proven cell design and seamless intercompatibility with all ASC parts thanks to a similar design approach - but now with a 10 x bigger electrode surface! Test your coin cell batteres as well as powder/casted materials in larger samples under airtight conditions and with full control of the stacking pressure.

| | |
|---|---|
| **Sample dimension** | ⌀ 25.2 mm |
| **Hermetically sealed cell** | |
| **Max. pressure** | 4 ton/cm² |
| **Fixed electrode distance** | |
| **Material** | Stainless steel & PEI |

Test your full assembled coin cells or assembly your battery samples consisting of powder/casted materials directly inside the cell body.



### Customer Quote

"My group is used to Sphere's testing equipment and with the ASC-C we can apply the same testing principles for development projects with a higher TRL level, requiring a larger diameter of the cell."

*- Group leader of a electrochemistry group of a British university*

# ASC-P (via in-house testing service only)

## Are you looking for testing equipment suited for pouch cells?

Sphere Energy has you covered. With the latest addition to our ASC family, we can precisely control and track the external pressure on your pouch cell battery. Further, its design allows you to monitor the swelling of the pouch cells.

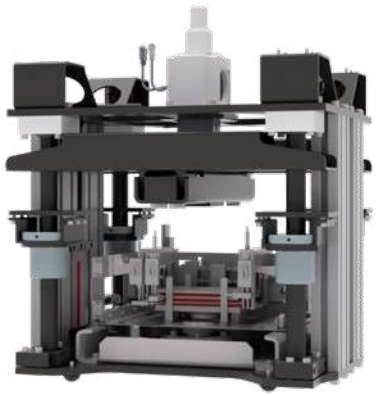
**Understand the pressure behaviour of your pouch cells**

i) Stack up to three pouch cells

ii) Include pressure/thermal pads

iii) Pressure/temperature correlation

iv) Measure force changes or swelling



***Service available now!***

| | |
|---|---|
| **Max. cell dimension** | 200x126x20 mm |
| **All-in-one design** | |
| **Max. force** | 80 kN |
| **Active pressure balancing** | |
| **Testing service** | Flexible setup |

Test your pouch cell batteries - whether it is a first prototype or a commericalized product - under various scenarios: pressure monitoring, constant pressure or volume expansion monitoring.

# Overview & combinations

| ASC Portfolio | ASC-A | ASC-AD | ASC-T | ASC-Gas | Thickness Option | ASC-C | ASC-P |
|---|---|---|---|---|---|---|---|
| Temperature control | | | ● | | | | |
| Reference electrode | | | ● | | | | |
| Airtight setup | ● | ●* | | ● | | ● | |
| Pressure balancing | | ● | ● | | | | ● |
| Thickness measurement | | | | | ●** | | |
| Expansion monitoring | | | | | ●*** | | |
| Gas analysis | | | | ● | | | |
| 8mm diameter | ● | ● | ● | ● | | | |
| 25,2mm diameter | | | | | | ● | |
| 200x126x20mm | | | | | | | ● |

*No pressure monitoring outside of the glove-box

**Pressure frame required

***only with ASC-AD/-T (pressure frame required) & ASC-P

## ASC Combinations

**Choose your battery sample size:**

**Select suitable cells:**

**Additions:**

**⌀ 8 mm** →

+

**Coin cell ⌀ 25.2 mm** →

+

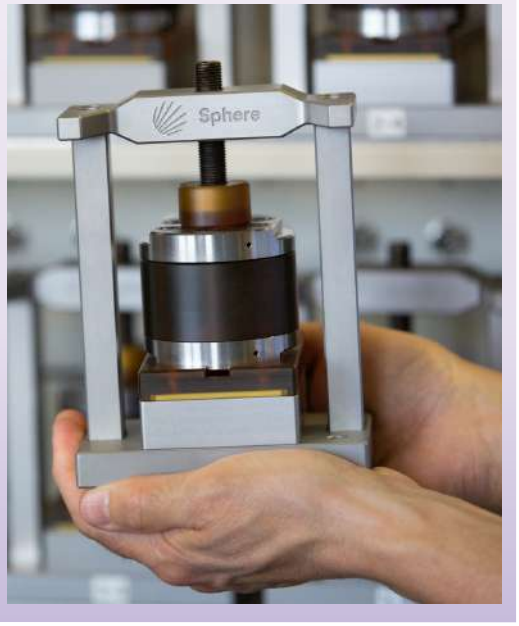
**Pouch cell 200x126x20 mm** → **ASC-P testing service**

# Individual solutions

## Tailored offerings for every R&D team

We help you find the optimal process for your lab:

- Goal setting (e.g. High throughput, precision)
- TRL level (power R&D or casted protoyping)
- Battery sizes (8 mm / 25 mm / pouch cell)
- Preferred pressure range
- Pressure monitoring
- Thickness measurements
- Other individual desires




Contact us via *info@sphere-energy.eu* or visit *www.sphere-energy.eu* to schedule a call.

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