C3 PROZESS- UND ANALYSENTECHNIK

COMPETENCE CREATES CONFIDENCE

MEASUREMENT TECHNIQUES AND INSTRUMENTATION FOR DETERMINING RELEVANT PARAMETERS IN THE CHARACTERIZATION AND EVALUATION OF ENERGY STORAGE SYSTEMS

Testing Specific Heat Capacity of Cylindrical, Button, and Pouch Batteries using the TPS systems and Hot Cell® sensors from Hot Disk AB

Hot Disk®

Hot Disk TPS System

Hot Cell® sensors for testing a button battery (left); a pouch battery (middle); and a cylindrical battery (right).

1

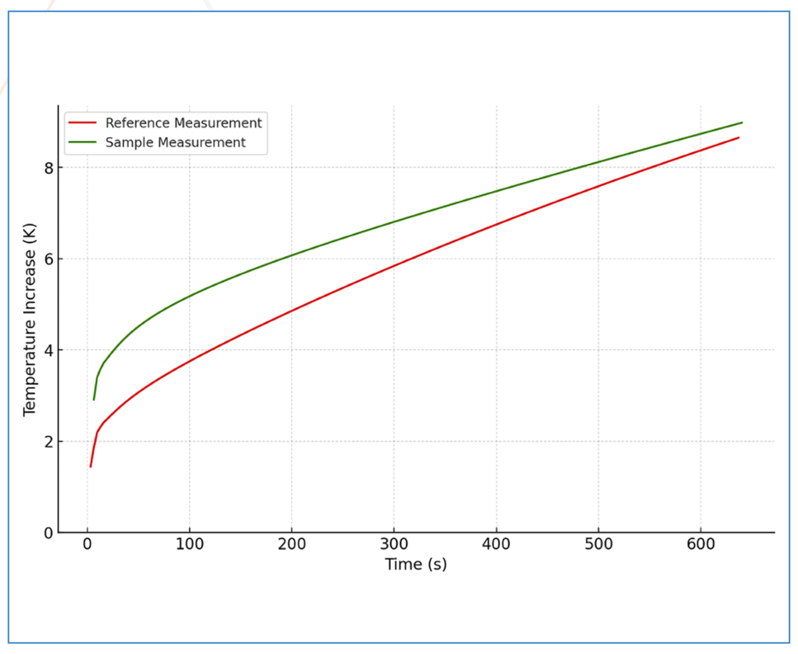
Hot Cell® sensors are used to directly, and very accurately, measure the Specific Heat Capacity (Cp) of samples of any complex structure or geometry. What makes the Hot Cell® method unique is that the sensors (Figure 1) can be scaled up in dimension to accommodate specific heat capacity testing of all geometries, including voluminous samples or components, such as decimeter-long and -wide pouch-cell batteries.

Battery performance, while not overheating, relies heavily on their effective thermal management. This in turn depends not only on their anisotropic thermal conductivity properties, but also on their specific heat capacity properties. A specific heat capacity measurement with our Hot Cell® sensors requires two transient temperature recordings. The first recording will be made without the sample inside the aluminum cell, while the second recording will include sample inside the aluminum cell (see figure 2).

Measurement Results

All testing reported here was performed using a Hot Disk TPS 2500 S instrument. The six (fully charged) Lithium battery samples were tested using the Hot Cell® sensors. Figure 3 lists the measurement conditions and the Cp results in units of J/kg/K, as this unit is more common in the literature for Lithium batteries. Overall, we find that the obtained Cp-values with the Hot Cell® sensors are trustworthy, well-aligned with available data in the literature.

The Hot Disk TPS technique is used for quickly and reliably testing Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity of any material type.



2 Example of a transient temperature recording using Hot Cell® sensor model AL-D50-H85, without (red curve) and with (green curve) battery sample.

Lithium battery sample and measurement parameters	Measured specific heat capacity using a Hot Cell sensor (J/kg/K)
Sample 1 (cylindrical cell) Meas. time: 640 s Meas. Power[1]: 0.45 (0.3) W	870
Sample 2 (cylindrical cell) Meas. time: 2560 s Meas. Power[1]: 0.48 (0.3) W	862
Sample 3 (button cell) Meas. time: 80 s Meas. Power[1]: 0.5 (0.25) W	785
Sample 4 (button cell) Meas. time: 80 s Meas. Power[1]: 2.0 (1.8) W	734
Sample 5 (pouch cell) Meas. time: 160 s Meas. Power[1]: 2.8 (2.2) W	820
Sample 6 (pouch cell) Meas. time: 640 s Meas. Power[1]: 6.5 (5.0) W	892

[1]Measurement power in parenthesis indicates the reference transient recording (i.e. without the battery sample inside the aluminum cell).

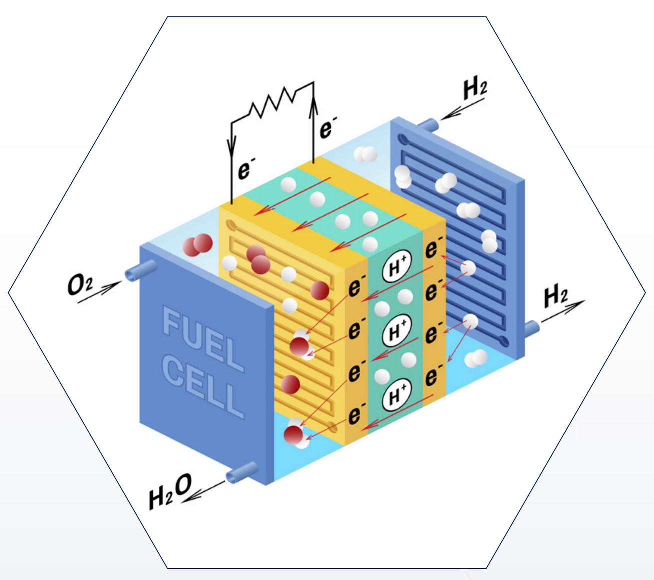
3 Measurement results of Cp tests on Lithium batteries using Hot Cell® sensors.

References

1. M. Gustavsson, N. S. Saxena, E. Karawacki and S. E. Gustafsson. "Specific Heat Measurements with the Hot Disk Thermal Constant Analyser", Thermal Conductivity 23 (1995)
2. Silas E. Gustafsson, "Transient Plane Source Techniques for Thermal Conductivity and Thermal Diffusivity Measurements of Solid Materials", Review of Scientific Instruments 62 (3), pp. 797 – 804 (1991).

GAMRY INSTRUMENTS

Electrochemical Measurement Techniques from Gamry Instruments in the field of Energy Storage



Application – Fuel Cell

Gamry Potentiostat/Galvanostat for electrochemical measurements

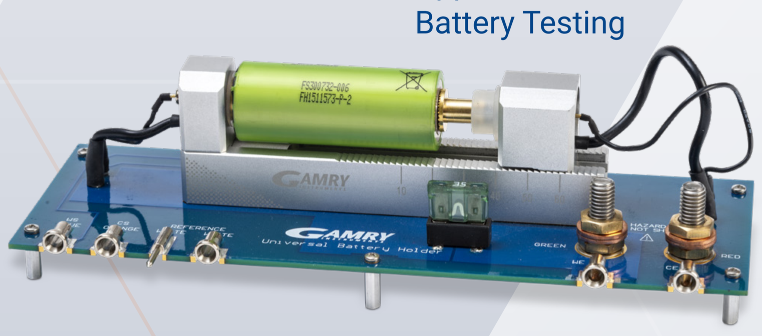
Instrumentation and Measurement Techniques

- Galvanostatic charging/discharging cycles
- Potentiostatic measurements
- Cyclovoltammetry (CV)
- Electrochemical Impedance Spectroscopy (EIS)

Measurable Parameters

- Capacitance
- Voltage and current
- Coulombic efficiency
- Impedance
- Resistive components
- Electrochemical reaction processes

Electrochemical impedance spectroscopy (EIS) is a powerful electrochemical technique that has enjoyed wide acceptance in the modern electrochemical laboratory. EIS is routinely used in battery development and fuel cell characterization.



Application – Battery Testing

Applications

- Battery cell characterization
- Aging studies
- Condition assessment
- Comparison of electrode materials
- Investigation of interfacial and transport processes

Pressure Reactors for Material Testing

büchiglasuster® switzerland Pilot Plant and Reactor Systems

Pressure reactors enable the study of materials and reactions under conditions relevant to hydrogen storage, thermochemical processes, and energy conversion.

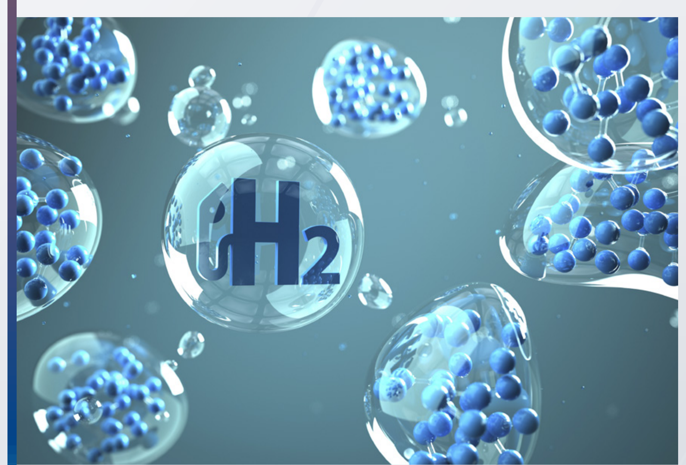
Controlled experiments under defined Temperature | Pressure | Gas conditions with Measured and controlled variables

- Temperature T
- Pressure p
- Stirrer speed
- Gas flow / Gas consumption
- Reaction progress
- Additional sensor signals

Applications

- Hydrogen storage
- Hydrogenation/dehydrogenation reactions
- Hydrogen carriers
- Catalyst research
- Thermochemical storage
- Material behavior under temperature and pressure

Büchi pressure reactors are available in volumes starting with some ml up to 500 liter with pressures up to 1000 bar and temperatures up to 600°C



Application – Hydrogen embrittlement

Standard Büchi Lab Pressure Reactor 200bar/300°C – „maxiclave"

GEFTA CONFERENCE, OCTOBER 2026
THERMAL ANALYSIS AND SAFETY OF ENERGY STORAGE SYSTEMS

www.c3-analysentechnik.de