MARKUS KOLLER[12] // Markus.Koller@ait.ac.at // **JOHANNA UNTERKOFLER**[3] **// GREGOR GLANZ**[1]
DANIEL LAGER[2] // **ALEXANDER BERGMANN**[3] // **HARTMUT POPP**[1]
1 AIT Austrian Institute of Technology GmbH, Center for Low-Emission Transport, Giefinggasse 4, 1210 Vienna, Austria.
2 AIT Austrian Institute of Technology GmbH, Center for Energy, Giefinggasse 4, 1210 Vienna, Austria.
3 Graz University of Technology, Institute of Electrical Measurement and Sensor Systems, Graz, Austria.

RADIAL THERMAL CONDUCTIVITY MEASUREMENTS OF CYLINDRICAL LITHIUM-ION BATTERIES - AN UNCERTAINTY STUDY OF THE PIPE METHOD

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

OVERVIEW

- Safe and efficient design of LIB system requires knowledge about thermal properties of the cell
- This study determines the radial thermal conductivity values by different measurement methods
- Lack of equipment on the market for cylindrical cells
- Uncertainties and problems inherent in the pipe method for cylindrical cells were shown in a FEM simulation

EXPERIMENTAL METHOD

Two different methods are used, first the **pipe method** and second a combination of the **laser flash method** (LFA) and **differential scanning calorimetry** (DSC).

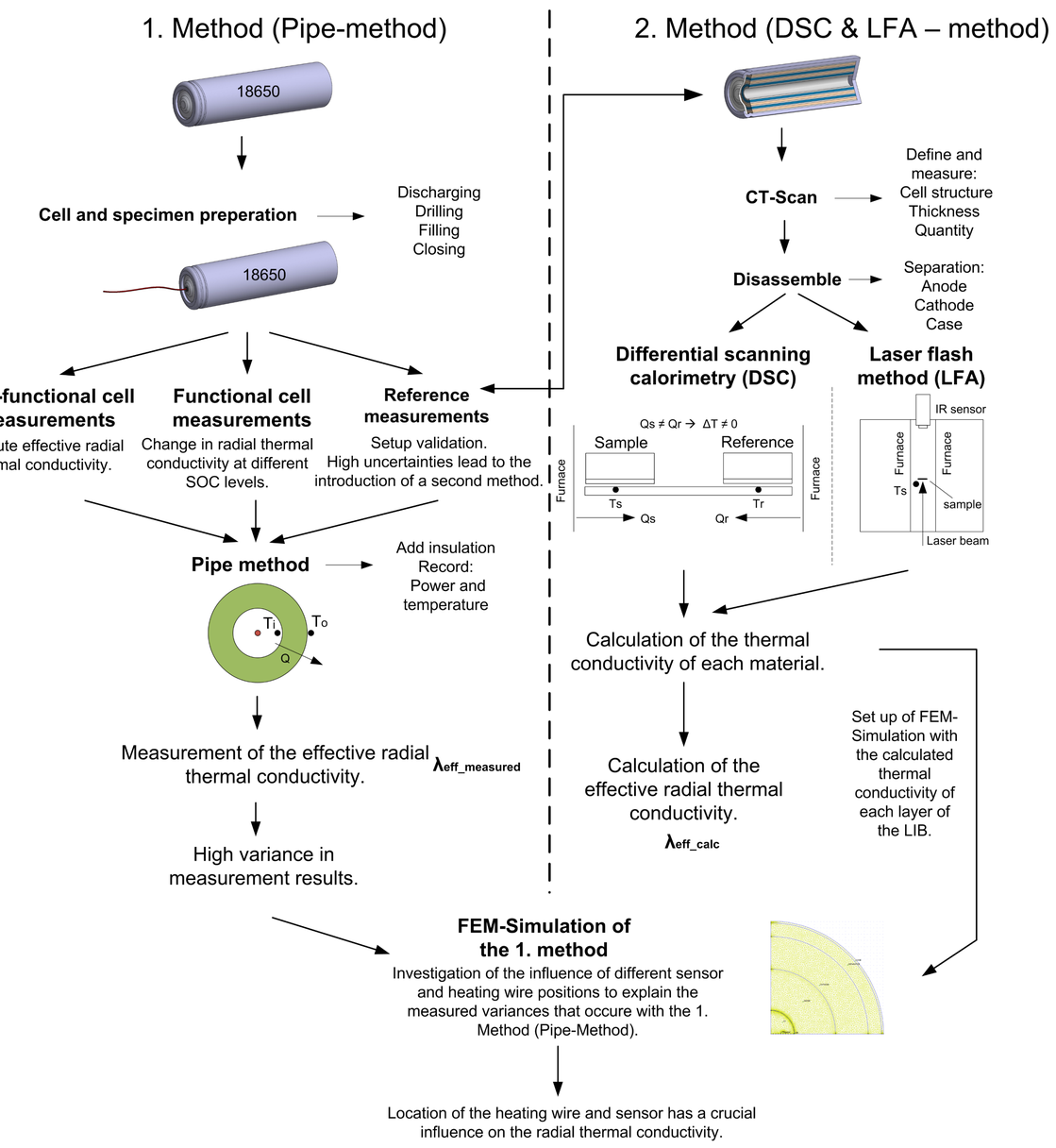

Fig.1: Flowchart of the methods used, including a description of the performed steps.

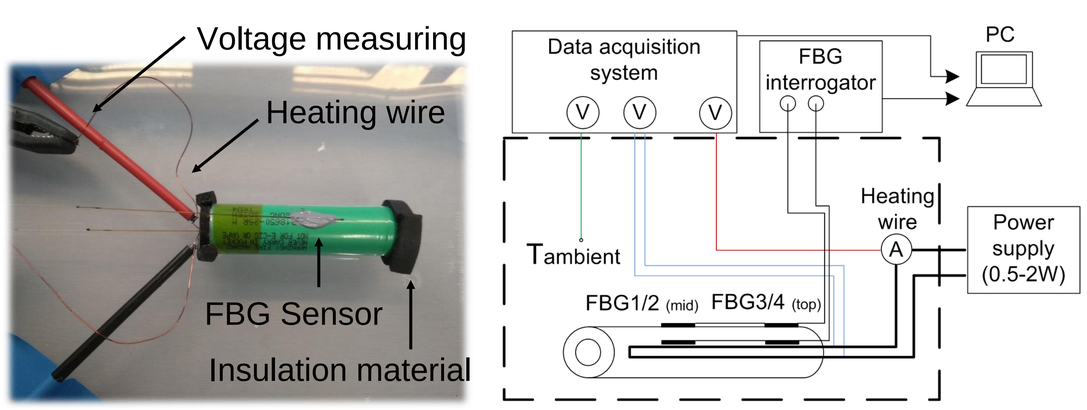

Fig.2: Prepared cell (left) and FBG-based measurement setup (right).

Seven Samsung INR18650-25R cells with lithium nickel cobalt aluminum oxide (NCA) as cathode material and graphite as anode material were prepared for the measurements. FBG based temperature sensors were used to determine whether the thermal conductivity can be measured more precisely. The accuracies of the used sensors are ±1.5 °C and ± 0.8 °C for the thermocouples and FBGs, respectively.

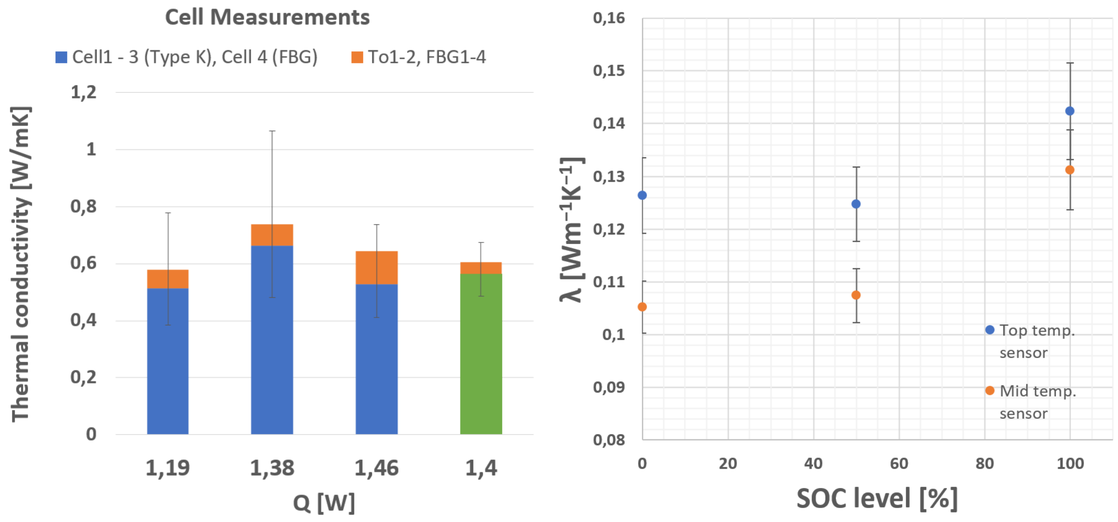

Fig.3: Cell measurements, blue: Type-K based measurements; green: FBG based measurements (left), SOC dependency of the effective thermal conductivity (right)

SIMULATION

For better understanding of the influence of sensor position and diameter tolerance a simulation model of an 18650 cell was created. The inner structure of the cell was determined with the help of a **CT scan**. The number of anode and cathode layers as well as the number of separator layers can be counted and summed up. Depending on the distance to the inner surface the thermal conductivity can vary up to ~25%.

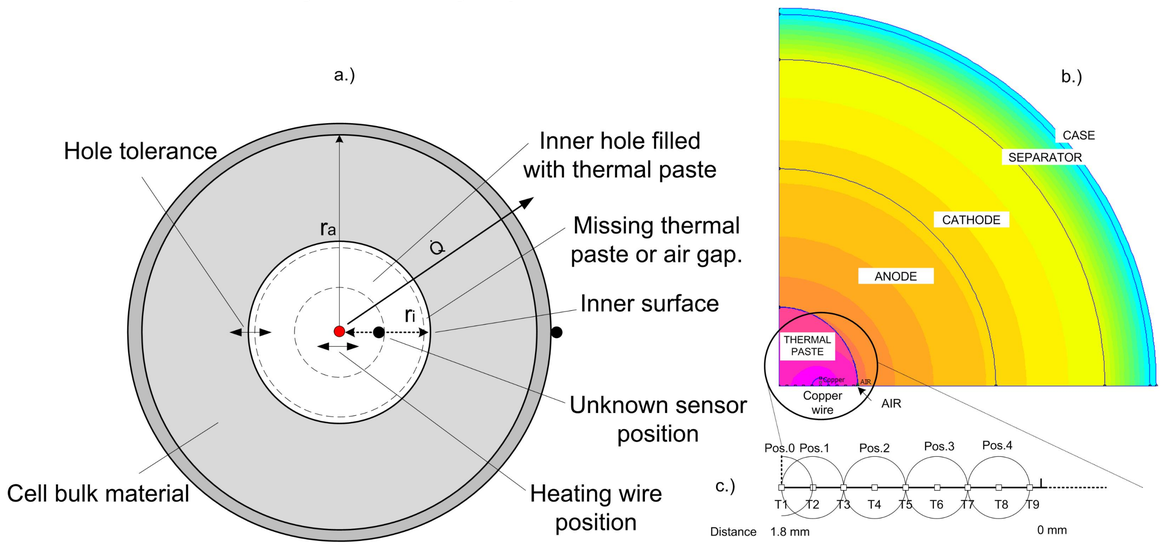

Fig.4: Cross section of the cell (a) showing possible uncertainties that can influence the measurement results of the radial thermal conductivity. The simulation model (b) with virtual temperature sensors (T1-T9) and different positions (Pos.0-Pos.4) of the heating wire (c).

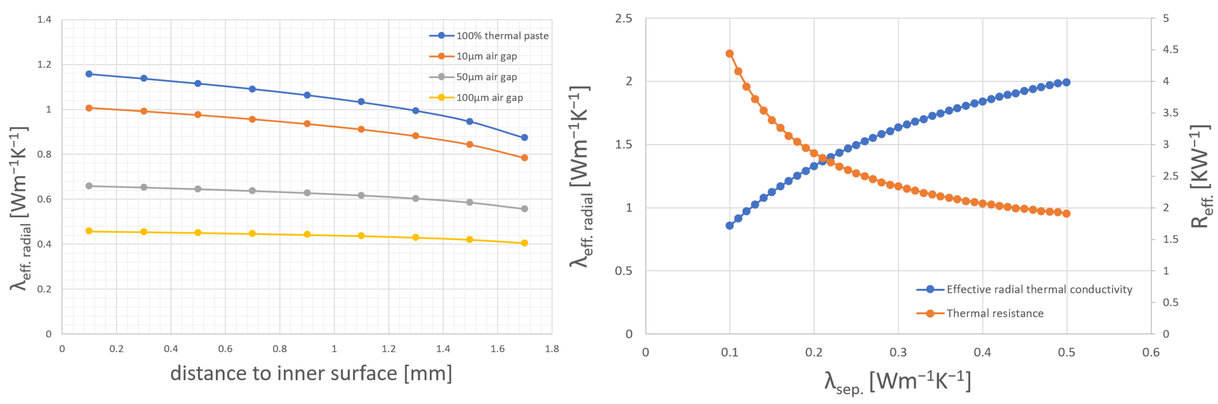

Fig.5: Simulation results of different temperature sensor positions and missing thermal paste leading to wrong calculations (left). Influence in varying thermal conductivity values of separator material on the effective thermal conductivity of a 18650 cylindrical cell (right).

CONCLUSION

Method leads to high variations. Simulation and calculation suggest these variations result from:

- Difficulties in sensor placement within the cell.
- Influences such as strain and humidity can decrease the accuracy of the FBGs.
- Inhomogeneous shape of bulk material.
- Pipe method can be heavily influenced by an unknown position of the temperature sensor and the heating wire.

The research leading to these results has received funding from the Austrian Research Promotion Agency (FFG) within the collaborative project MOGLI (Grant Agreement No. 879610).

FFG Promoting Innovation.