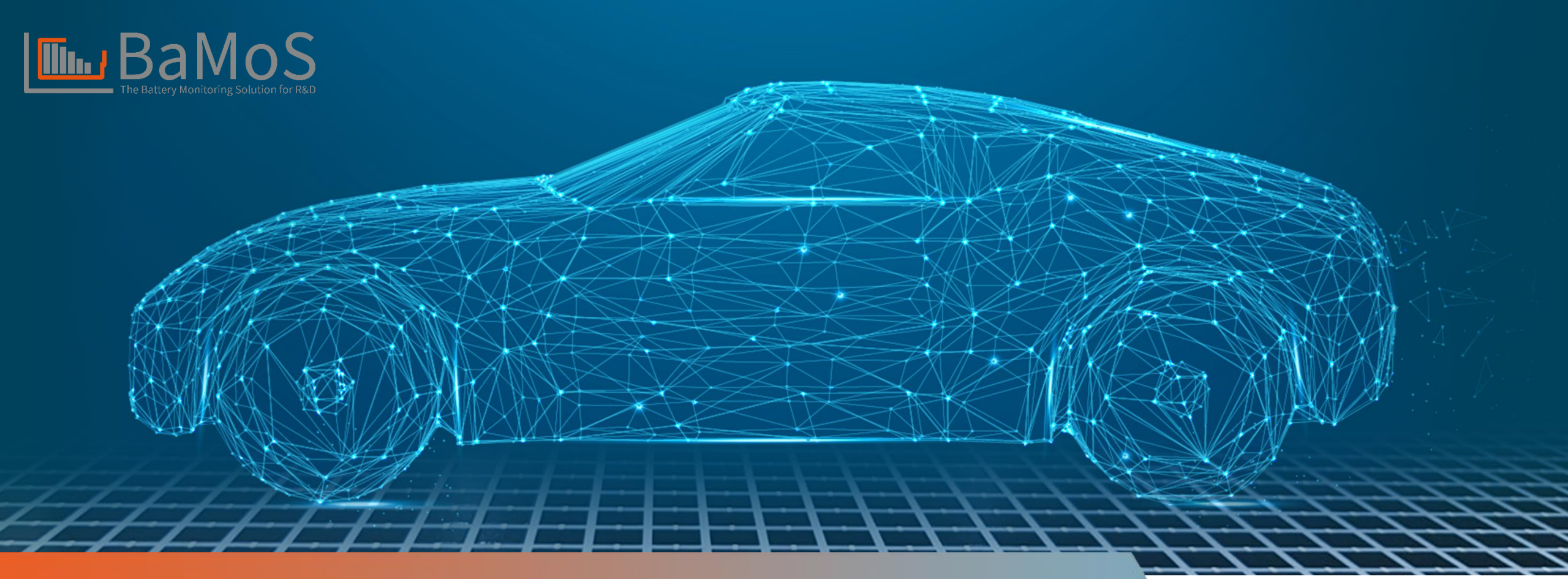
BaMoS
The Battery Monitoring Solution for R&D



BaMoS – The Battery Monitoring Solution by InnovationLab

A novel way to understand your battery

30.03.2023

INNOVATION LAB
thinking works

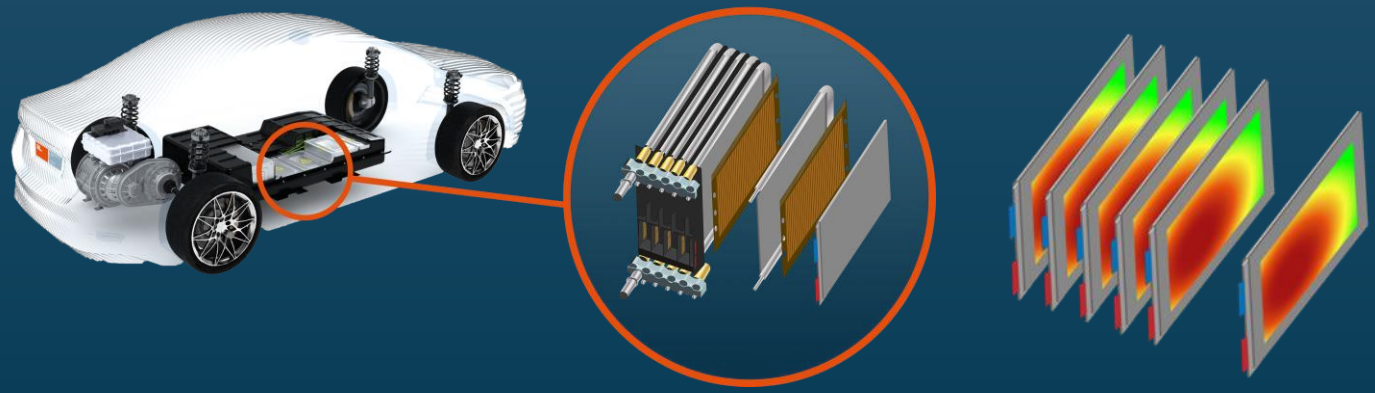
BASF We create chemistry
HEIDELBERG
SAP
KIT Karlsruhe Institute of Technology
UNIVERSITÄT HEIDELBERG ZUKUNFT SEIT 1386

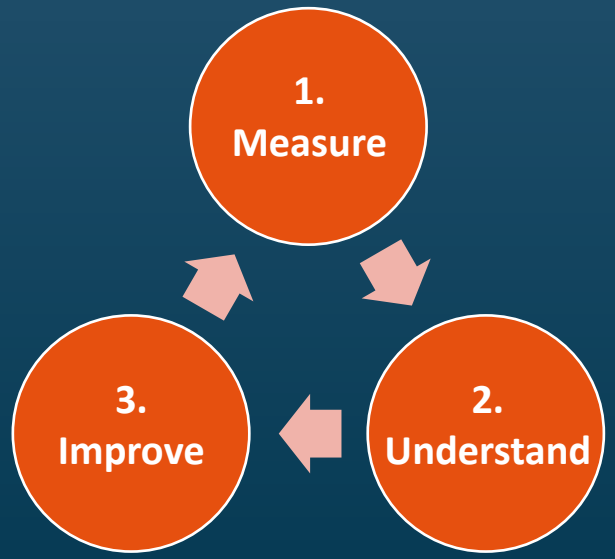
The Importance of Data

Being able to capture significant data is the first step for improvement. However, often it is not possible to get data from exactly where you want.

This is the case for rechargeable batteries. No one really knows yet what is happening within a battery system during the charging cycle and stress tests in terms of temperature and pressure.

How can a measure for improvement be defined without properly understanding the system?





How to Measure Inside a Battery System

Foil Sensors

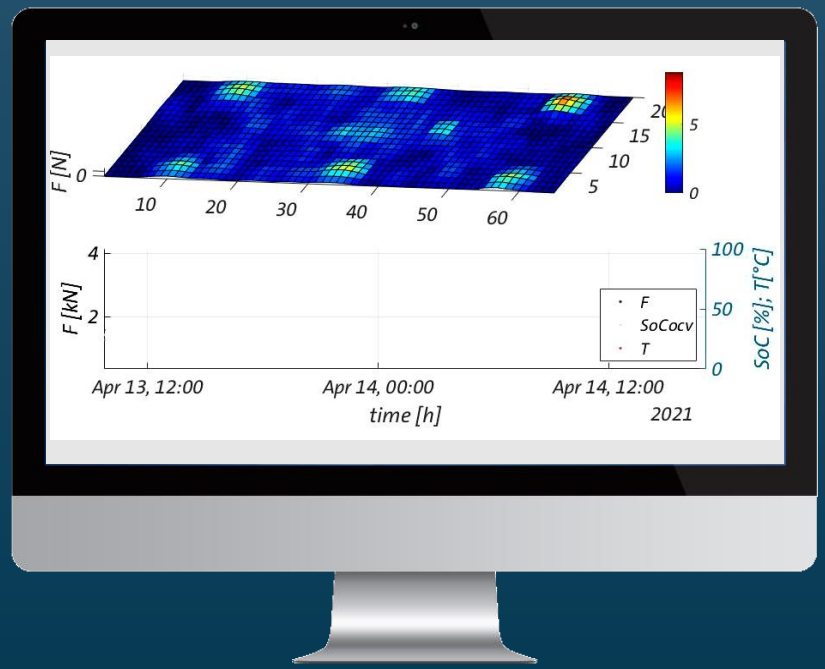
Thin foil sensors can be placed between the cells and thus solve this issue.

<u>An example</u>:

During the charge/discharge cycle, batteries undergo continuous volume changes. These volume changes translate into changes of pressure, which can be captured by foil sensors.

This allows to…

- ✓ measure the state of charge (SoC) directly,
- ✓ implement preload and cell balancing measures,
- ✓ detect irregular behavior,
- ✓ prevent overcharging,
- ✓ and gain information on state of health (SoH).



Foil sensors enable getting data from inside of the battery system.
Both spatially & temporally resolved.

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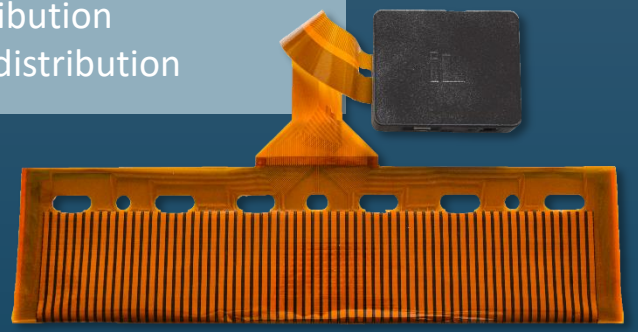
Overview

1. Sensor Foils:

a. Pressure distribution
b. Temperature distribution

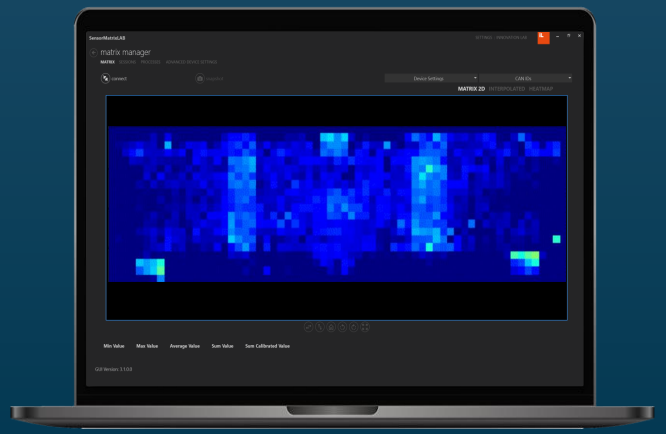


2. Read-out Electronics:

- State-of-the-art with reduced cross-talk
- 12-bit resolution
- Low noise
- Several communication interfaces

3. Software:

- Live visualization, storage and analysis of the data
- Data filtering
- Real-time streaming via API



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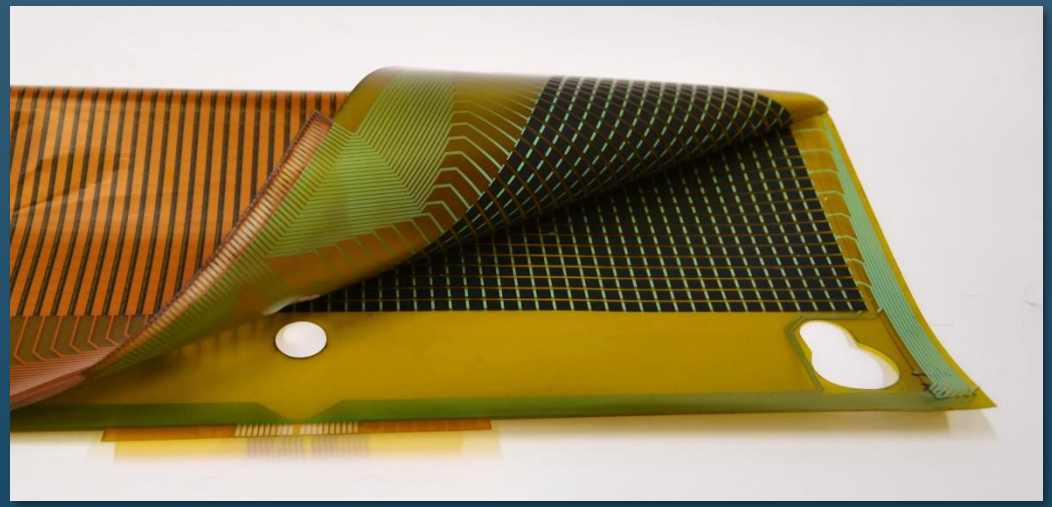
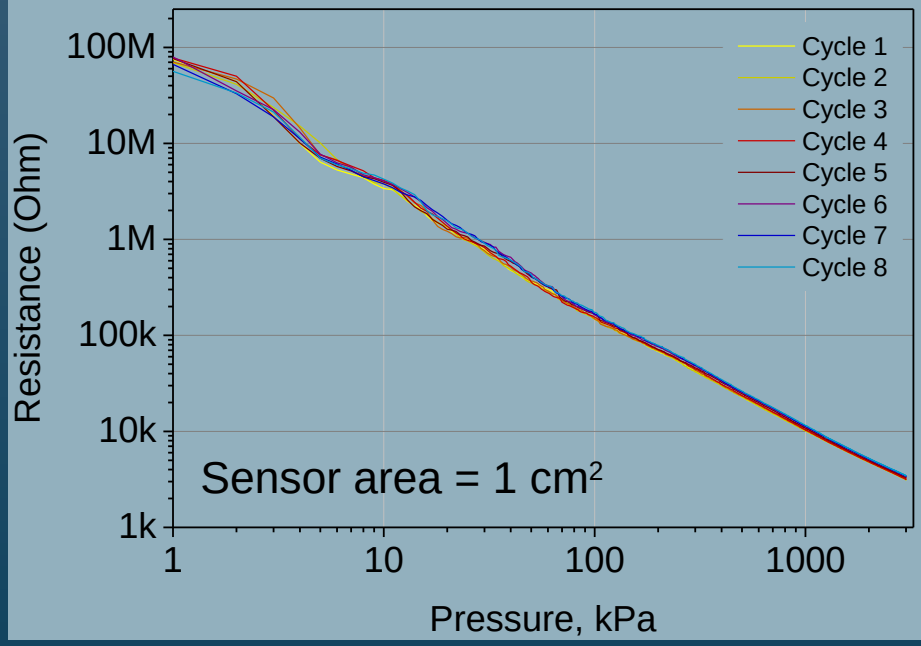
Sensor foils for measuring the pressure distribution



Matrix of printed piezoresistive pixels on extremely thin substrate.

Typical performance:



Strong performance:

- ✓ Huge measurement range: 0.5 – 500 N/cm²
- ✓ High repeatability: < 7 %
- ✓ High durability: < 5 % loss after 1 Mio. Cycles of 150 N/cm² load
- ✓ Overall thickness: < 120 µm
- ✓ Operating Temperature: -20°C – 100°C

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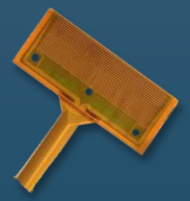
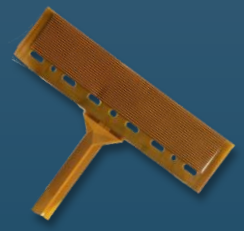
Sensor foils for measuring the pressure distribution

Portfolio:

	Type 1	Type 2	Type 3	Type 4	Custom
					
Measurement Mode	Thru	Thru	Thru	Shunt	
Resolution (# of pixels)	29 x 17	65 x 20	65 x 20	32 x 10	up to 96 × 96
Active area (cm^2)	15 x 9	33 x 10	53 x 11	32 x 10	up to 40 × 60
Pixel size (cm^2)	0.32 × 0.32	0.30 × 0.30	0.50 x 0.32	0.62 x 0.57	down to 0.01 (Thru) down to 0.2 (Shunt)
Foil material	PI (2 x 50 µm)	PI (2 x 50 µm)	PI (2 x 50 µm)	PEN (2 x 125 µm)	PI, PET, PEN,…
Suitability for • low pressure • high pressure	 + +	 + / - + / ++	 + +	 ++ -	

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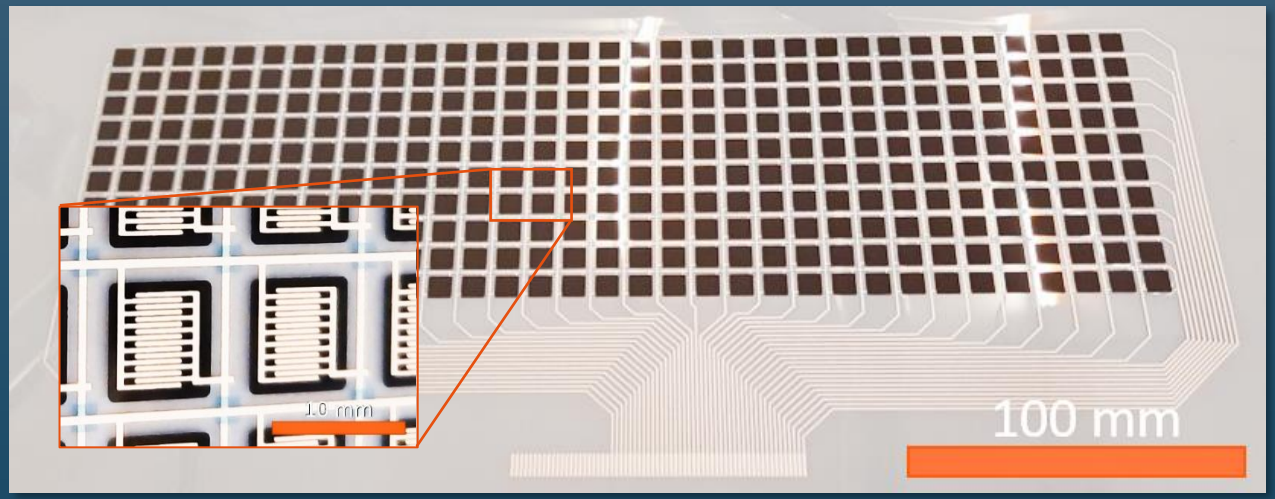
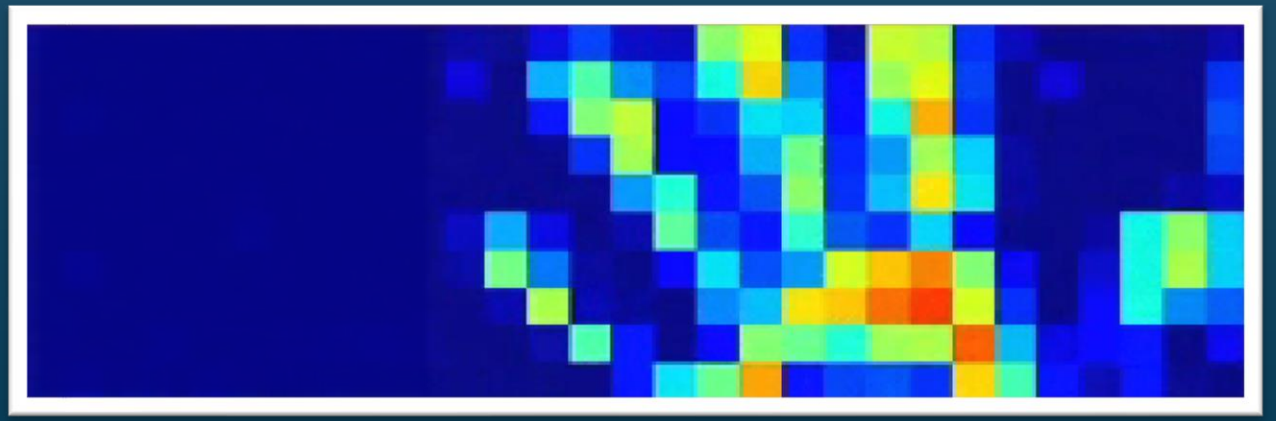
Sensor foils for measuring the temperature distribution



Temperature-sensitive resistors printed on interdigitated electrode structures enable **spatially resolved temperature measurements** on very thin foils (< 80 µm).



Color-coded image of the temperature distribution induced by a hand.

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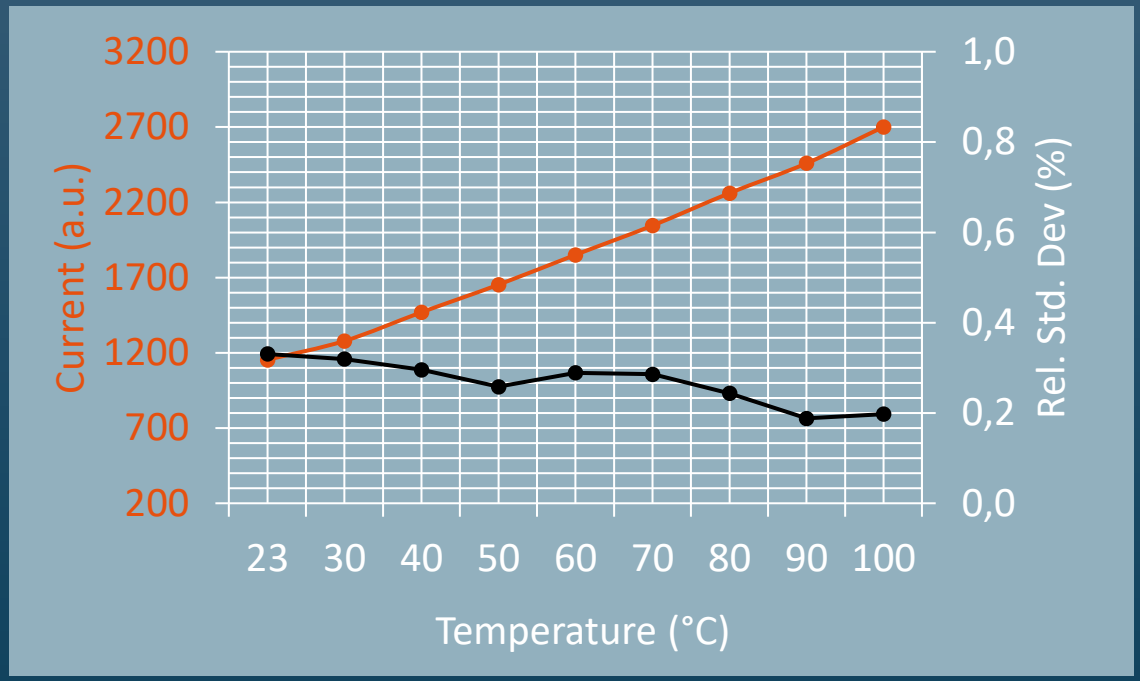
Sensor foils for measuring the temperature distribution

Portfolio:

	Standard	Custom
Resolution (# of pixels)	32 x 10	up to 96 x 96
Active Area (cm^2)	32 x 10	up to 35 x 55
Pixel size (cm^2)	0.6 x 0.6	down to 0.2
Foil material	PEN	PI, PET, PEN



Dependency of the measured current on the temperature.
A clear linear behavior is observed.

Typical performance:

- ✓ Highly linear behavior
- ✓ Accuracy: < 1 $°C^{-1}$
- ✓ Range: 10 - 100 °C and beyond
- ✓ Pressure independent

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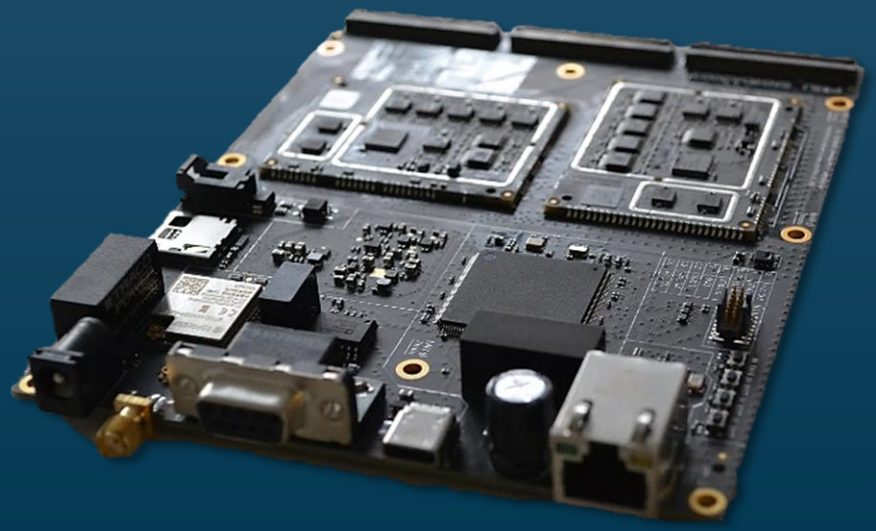
Read-out electronics

- High-resolution for matrices with up to 96x96 sensor pixels
- Low noise 12-bit ADC signal
- Strongly reduced crosstalk between pixels
- Typical read-out frequencies of 14 fps.
- Usable for force- and/or temperature-sensitive matrices
- Communication via serial USB, CAN or Ethernet



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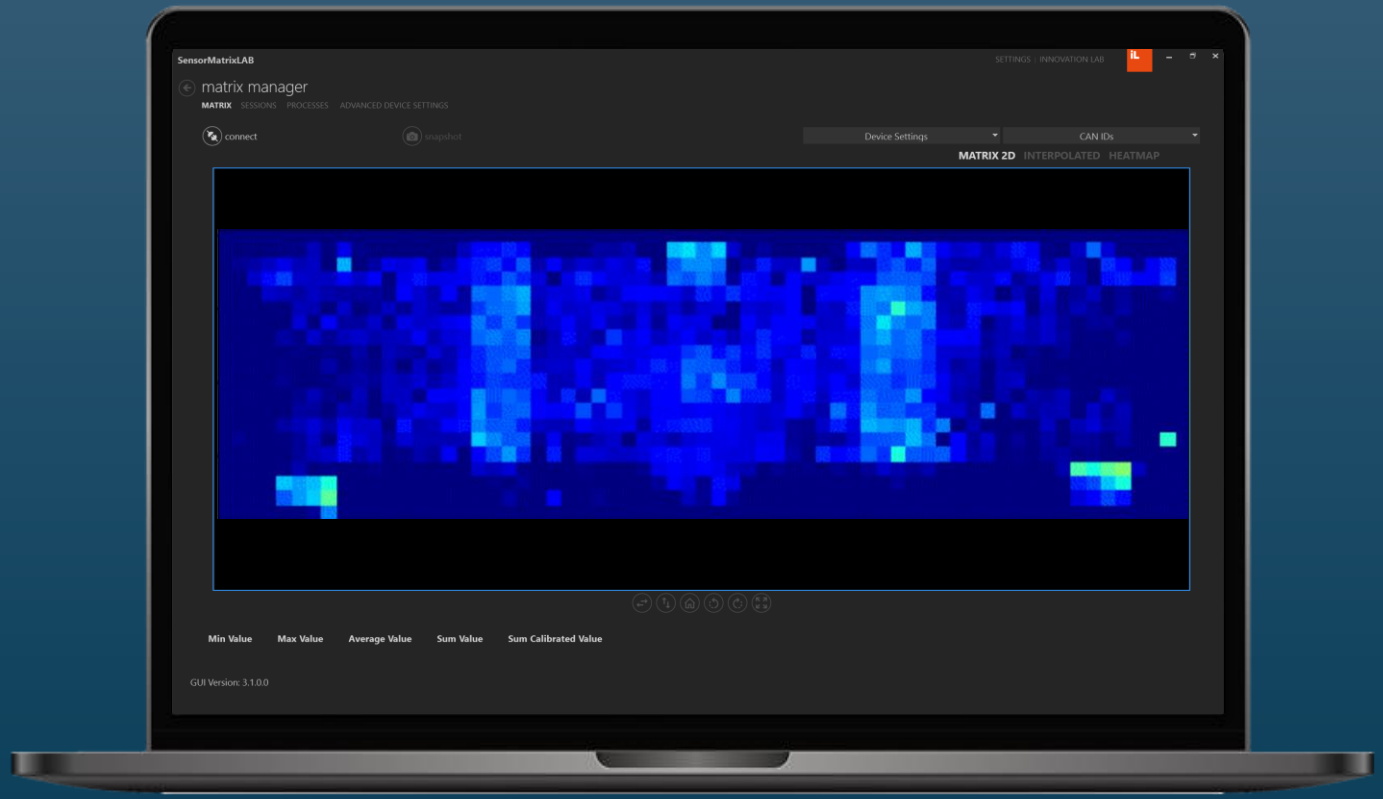
Software: SensorMatrixLAB v4.0



- Advanced data visualization
- Data recording and replaying
- Real-time streaming via API
- Supports different communication Interfaces
- Configuration of read-out electronics settings
- Support of customized printed sensor matrixes
- Adjustment of measuring range via V_{ref}
- Advanced signal processing

More information at: www.innovationlab.de/en/products/sensormatrixlab/

Who we are

InnovationLab – The One-Stop Shop for Printed and Organic Electronics

- **Highly-skilled engineers and scientists**
- **Unique R&D, upscaling and production infrastructure**
- **Connected to internationally acclaimed Universities, research institutes and material provider**
- **Innovation partner of world-leading companies in Automotive, Healthcare, Logistics and Retail industries**

Shareholders:

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We create chemistry

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Summary

Our **Battery Monitoring solution** in your **R&D test stands** supports you to…

- ✓ harvest **spatially resolved** live data on **cell level**
- ✓ adjust charge-discharge cycles and increase battery health
- ✓ drive the battery **at the optimum conditions**
- ✓ make your battery research **more effective**
- ✓ and finally get **the most out of your battery**.

Web

INNOVATION LAB thinking works

Social Media

Dr. Florian Ullrich
Head of
Business Development

The solution is **customizable** to your specific requirements and **approved by OEM**!

Contact us or place your order at:

BaMoS@innovationlab.de