

- 1 7 modules consisting of 24 cells (20 Ah) connected as a system inside the open enclosure.
- 2 Li-ion battery housing.

## LITHIUM-ION BATTERY FOR PHEV APPLICATIONS

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### Lithium-ion battery for PHEV applications

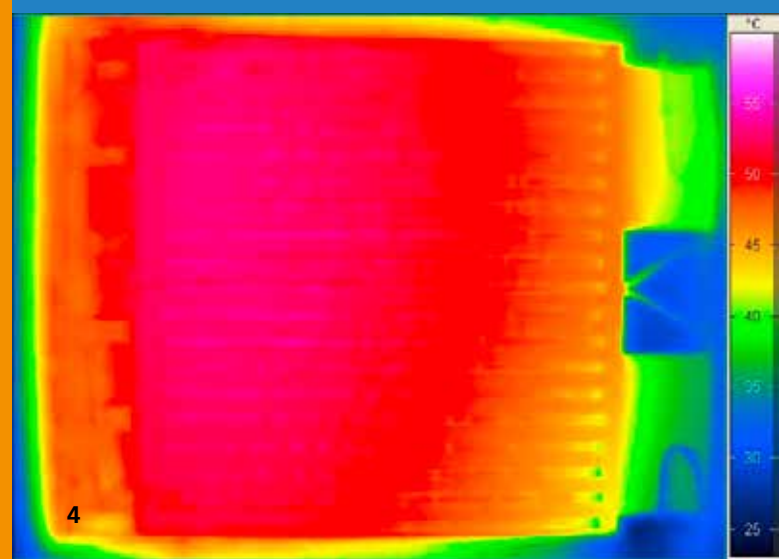
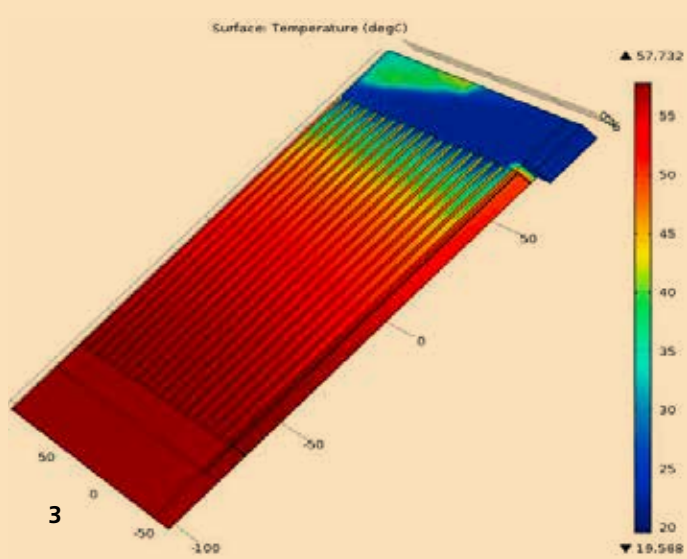
A Li-ion battery system has been developed and constructed for mobile use in PHEVs (plug-in hybrid electric vehicle) by the Fraunhofer Institute for Chemical Technology ICT and the Fraunhofer Institute for Integrated Circuits IIS.

The Fraunhofer ICT designed the battery, including the module construction and the connection of high-voltage cells and modules, and developed the concept for the cooling. The battery management system (BMS), consisting of the corresponding slave boards and master system was designed by the Fraunhofer IIS.

### System construction

The battery system is composed of eight modules, each with 24 20Ah-NMC/graphite cells. Two cells are connected in parallel and 12 of these cell-pairs are connected in series to form one module. Due to the special design of each module and of the battery housing, the system can be cooled by air flow.

The BMS consists of several slave boards and a master system. One slave observes 12 cells by measuring the temperature and the voltage, and it actively balances the cells with currents up to 4 A. With the help of electrochemical impedance spectroscopy (EIS) the state-of-health of each cell can be detected. The master system finally calculates the state-of-charge from the collected data. The communication takes place via CAN-buses. These buses are also available for communication with the electric vehicle.



### Technical data

- 8 modules with 24 cells (each cell 20 Ah), connection: 2 parallel/ 12 in series
- weight: 190 kg
- operation temperature: -25 °C to 55 °C
- cooling system: air
- available energy : 11.4 kWh
- nominal voltage: 355 V
- charging voltage limit: 394 V
- discharging voltage limit: 288 V
- power:
  - discharge:
    - 65 kW / 30 s (25 °C)
    - 30 kW / continuous (25 °C)
  - charge:
    - 40 kW / 30 s (20-45 °C)
    - 30 kW/ continuous (20-45 °C)

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3 Thermal simulation of a single cell.

4 Verification of the simulation by thermographic measurement.