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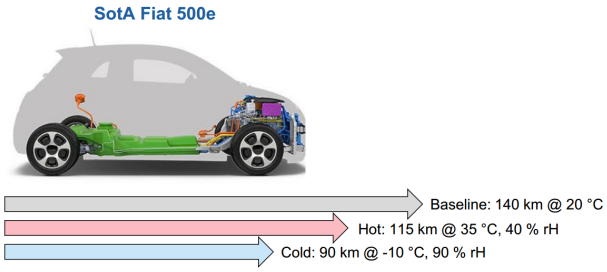

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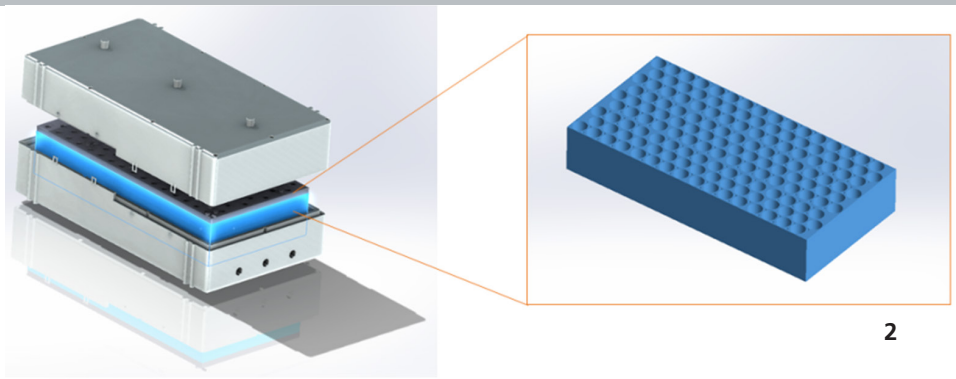

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1 *Driving ranges of the reference vehicle (Fiat 500e) at different ambient climates (© ika Aachen).*

2 *CAD model of the traction battery with increased thermal capacity consisting of the thermal storage material (blue) and the hybrid composite sandwich battery housing (grey).*

FUNCTIONALIZED CFRTP SANDWICH COMPONENTS WITHIN MINUTES

In times of impending bans for diesel and generally internal combustion engine (ICE) vehicles, battery electric vehicles (BEVs) are becoming increasingly interesting for buyers, especially in urban environments. Boosting battery capacities enable longer travels, however driving range of EVs varies especially at low ambient temperatures. Within the EU project "OPTEMUS" (Optimized Energy Management and Use), a large number of efficiency-enhancing technologies were therefore developed and holistically linked, in particular to reduce the range variation of a Fiat 500e EV. This includes a traction battery with thermal storage capacity, which the Fraunhofer Institute for Structural Durability and System Reliability LBF has developed with partners. The focus is on a novel sandwich battery housing made of continuous fibre reinforced thermoplastics (CFRTP), which helps to insulate stored heat in the traction battery for preconditioning.

Challenge

- EV driving range decreases at extreme ambient climate
- Passenger comfort technologies require electric energy
- Battery electrical performance itself is temperature dependent

Solution

- Advanced thermal battery structures & materials
- Battery thermal storage: Increased thermal storage capacity for thermal battery and interior preconditioning
- Battery Module Housing: Avoid loss of thermal energy of preconditioned battery via novel insulating composite housing

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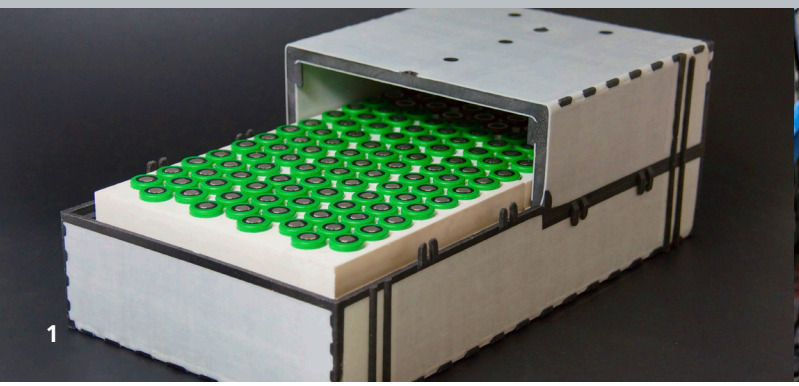

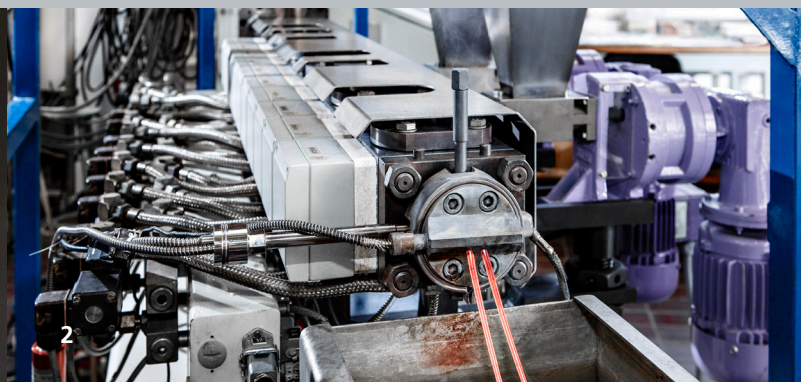

Challenge: EV driving range varies with ambient climate

- Due to the efficiency of the electric drive train, dissipation energy cannot be used for component heating and passenger comfort
- Especially at cold temperatures the driving range can severely decrease by up to 50%
- The EU-project OPTEMUS has targeted an increase of driving range at extreme ambient temperatures

Solution: Traction battery with thermal storage

- Thermal storage material included in cell holder which enables the increased storage of thermal energy for preconditioning
- The battery is encased in a novel functionalized lightweight design housing
  - Integral polymer foam (black) provides high thermal insulation
  - Composite facesheet preforms (UD tapes) bear mechanical loads

Thermal Storage: Materials

- Novel phase change material (PCM) composite providing up to 25 Wh/kg thermal storage
- Allows thermal preconditioning as well as fast charge buffering up to 3C
- Continuous material production enables low material cost

Battery Housing: CFRTP Sandwich Structure

- Integral polymer foam provides high thermal insulation
- Composite facesheets (CFRTP) bear mechanical loads
- Novel hybrid manufacturing process enables low cycle times and low component cost

Battery Housing: Efficient Hybrid Manufacture

- Novel in-situ manufacturing process enables production of CFRTP sandwich components
- A polymer foam core is injection moulded between preformed CFRTP facesheets
- The facesheets consist of a consolidated laminate of UD tapes (UDMAX™, SABIC) with cross composite (0/90/90/0) layup
- After preforming of the laminate, the CFRTP preforms are inserted in the mould and polymer foam is injected between two preform covers.
- The process enables the manufacture of functionalized CFRTP sandwich structures in only about two minutes.

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OPTIMIZED ENERGY MANAGEMENT AND USE OPTEMUS

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1 *Novel lightweight battery module housing consisting of a thermally insulating polymer foam (black) covered with continuous fibre reinforced (CFRTP) facesheets.*

2 *Continuous manufacture of the thermal storage material providing a polymer based thermal storage granulate.*