Karlsruhe Institute of Technology

KIT Mobility Systems Center

Institute for Product Development (IPEK)

Modular Li-Ion Battery Concept

Flexible adaptation to various needs

The modular concept and more specifically flat modules (Fig. 1) allow the capacity, voltage, and size to be adapted to various needs. The number of cells and thereby the length of a single module can be varied. An advantage of this flexibility is the ability to keep a module under 60 V (14 cells) since modules with higher voltages must be handled by special trained persons. Another advantage of small modules is that they can be placed in smaller spaces. Furthermore any number of modules with the same length can be stacked. Within one stack the modules can be connected parallel, in series, serial-parallel or parallel-serial. This is possible because of an adaptable connection concept. To build larger distributed battery systems (e. g. for stationary energy storage), multiple battery packs can be connected.

Advantages of flat modules

Automated joint processing can be used because of the easily accessible conductors of the cells (Fig. 1 left). This also allows for detachable plug-type and clamping connections that are currently in development to be implemented. Coolant can be easily and if necessary in large volumes passed through a cooling channel next to the conductors (Fig. 2). This enables an effective cooling of the cells. Electrical connections and cooling channels are far away from the outer surface of the battery and therefore from the possible impact areas. In case of a crash, the cell additionally absorbs

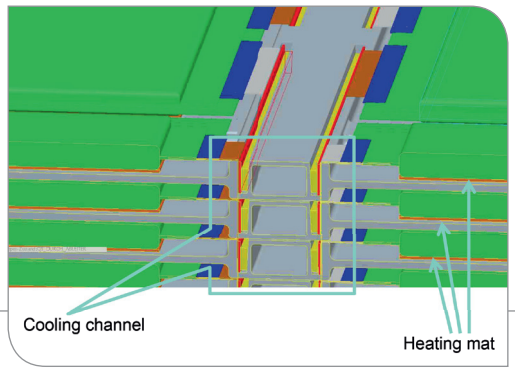

Fig. 2: Cross-section of a stack of modules

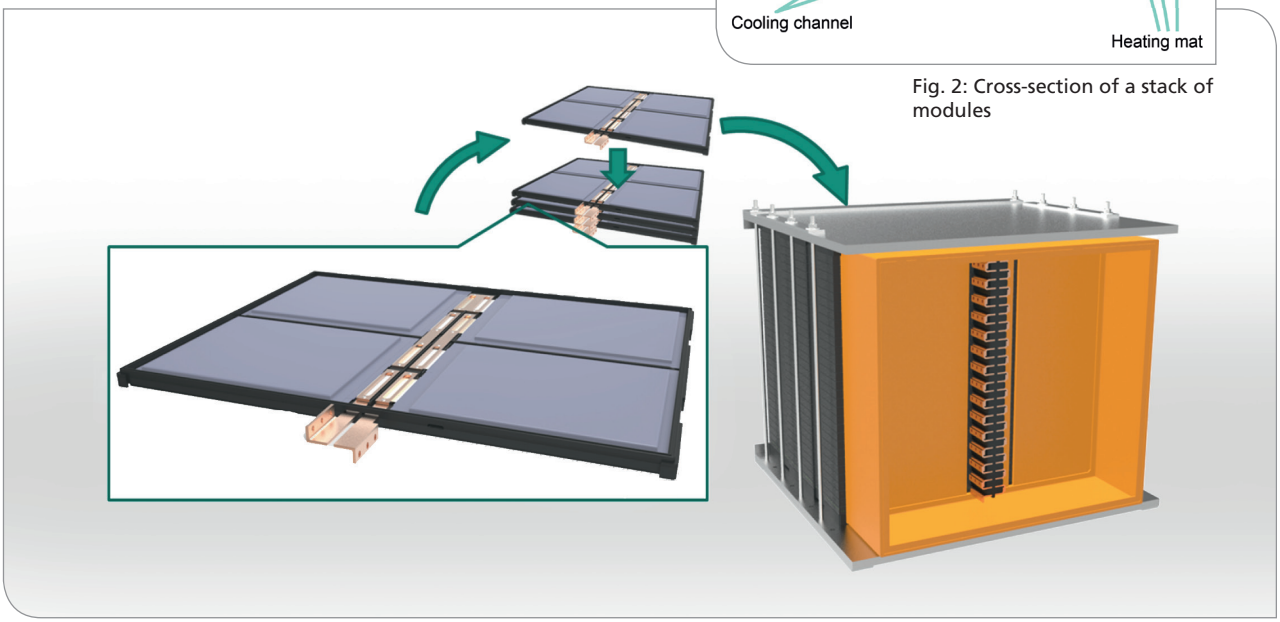

Fig. 1: single flat module of the battery (l), Stack of multiple modules (m), battery pack (r)

crash energy before electrical contacts and cooling channels are damaged. It is also possible to heat the cells using a surrounding heating mat, for example if the temperature is lower than 5 °C and the cell won't charge. The change in volume while charging and decharging of a pouchcell is compensated by an evenly compressable foam layer. The foam layer also helps to fix the cells between modules and distributes forces evenly. This prevents sliding of cells up to 30 g and reduces mechanical strain on the conductors.

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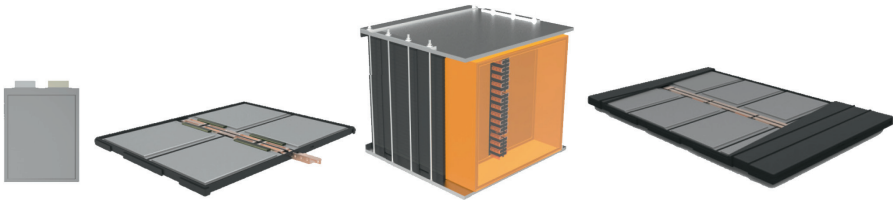

	Single cell	Single flat-module	Battery	Demonstrator
	3,0 to 4,2V	4-Cell-Module	120 cells in 30 modules	8-Cell-Module
Capacity	40 Ah	40 Ah	40 Ah	40 Ah
Energy content	148 Wh	0,6 kWh	17,76 kWh	1,184 kWh
Nominal voltage	3,7 V	14,8 V	444 V	29,6 V
End-of-charge voltage	4,2 V	16,8 V	504 V	33,6 V
Nominal demand (at 1C) Max. demand (at 4C) Peakdemand (at 5C, 10 Sek.)	148 W 592 W 740 W	0,6 kW 2,36 kW 2,96 kW	17,76 kW 71,04 kW 88,8 kW	1,18 kW 4,73 kW 5,92 kW
Nom. charge-demand (at 0,5C) Max. charge-demand (at 1C)	74 W 168 W	84 W 168 W	10,08 kW 20,16 kW	672 W 1,344 kW
Size (L x W x H)	N/D	467 x 592 x 16	550 x 610 x 560	917 x 592 x 46
Specific energy app. Specific demand (at 1C)	164 Wh/kg 164 W/kg	100 Wh/kg 100 W/kg	93,5 Wh/kg 93,5 W/kg	98,6 Wh/kg 98,6 W/kg

Technical data of the exhibits

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COMPETENCE E

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