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PRESS RELEASE – ThinKing August 2021

The battery reinvents itself: Lightweight, flexible and long-lasting

Smaller, lighter, safer, longer-lasting, more flexible and more economical – these are all good reasons to make changes to components and technologies used in the automotive field. Because of this, the ThinKing for the month of August goes to a modular battery system made by the company TGM Lightweight Solutions GmbH. Its rigid, prism-shaped plastic housing contains long-lasting battery cells arranged in packs that can be adapted to the specific application in a flexible, modular fashion – from commercial vehicles to sports cars, and from combustion engines to electric vehicles.

The Baden-Württemberg State Agency for Lightweight Design will present the ThinKing for this innovation in August of 2021. Each month, Leichtbau BW GmbH uses this label to award innovative lightweight design products or services from Baden-Württemberg.

At a glance:

- ▶ **Low weight:** The cell arrangement and technology, as well as an optimised housing ensure direct and indirect lightweight design effects.
- ▶ **Minimised installation space:** The installation space for the battery is significantly smaller, due to the prismatic shape and optimized arrangement of the cylindrical battery cells.
- ▶ **High safety:** The housing is stiffer due to the prismatic shape. In addition, in case of a crash part of the energy from the impact is dissipated when the modules push against one another.
- ▶ **Long service life:** The battery cells selected for the project triple the service life of the starter battery.
- ▶ **Economical manufacturing:** Cylindrical lithium battery cells (LiFePO₄), packaged in an injection-moulded plastic housing with identical parts.
- ▶ **Modular design:** Flexible use as a starter battery for combustion engines, hybrids or electric vehicles, as well as a traction battery with different cells.

Despite efforts at lightweight design, the technology used in vehicle starter batteries has remained unchanged for many years. The original lead-acid battery weighs around 30 kg; current lithium-gel batteries are much lighter, even though they still weigh around 10 to 15 kg. In both cases, the energy is stored in a panel design in a standard rectangular housing, which has likewise remained unchanged for many decades.

“The first idea for a modern, lightweight starter battery was created as part of a project focused on reducing axle load. At that time, many years ago, the idea was not implemented, but the potential was clear and we never stopped thinking about the challenge” says Florian Wätzold, project manager at TGM Lightweight Solutions GmbH, describing where the idea for the new battery system came from.

The lightweight design battery housing, which is receiving the ThinkKing for August and which has been submitted for a patent, uses a stiff, prismatic shape and a modular construction. Inside, it contains cell packs consisting of cylindrical battery cells with LiFePO₄ technology.

Prismatic shape increases safety in case of a crash

The design and interaction between components reduces loads inside the battery system, resulting in weight savings in the housing. In a crash, the prismatic shape also allows the modules, which are arranged in parallel along the angled edge, to shift, thereby dissipating the energy of the impact and protecting the cells. This design eliminated the need for further measures to absorb this crash energy in the vehicle, as well as the expense and mass that go along with them.

Flexible installation and minimised space

Originally, the lightweight design battery housing was intended to substitute for existing starter batteries based on lithium-iron phosphate cells or lead-acid batteries. Because of this, the dimensions for the base surface of the battery housing were selected so that it could replace existing solutions when installed. Thanks to the space-saving arrangement of the cylindrical battery cells, however, the height was reduced by around a quarter.

Due to the low overall weight and smaller volume of the battery, new fastening designs are also possible, and the battery can be placed in an optimal position within the vehicle. Optimising the installation location of the battery allows for further cost and weight savings by shortening the wiring harnesses or changing the crash-relevant structure. Other fastening concepts would come with further secondary savings, such as on the battery holder, clamps and cables.

Economical and modular design

From the start, the concept for the lightweight design battery housing was focused on ensuring production was economical and suitable for large-scale series. All housing components are manufactured using plastic injection moulding. They are designed for economical production, and can even use around ten percent recycled materials. To allow for recycling and to further extend their service life, snap connections were added between the modules so that all components can be exchanged. The Koller Group from Dietfurt was involved in the project for the manufacturing process.

The battery cells and power electronics used in the project – a battery management system successfully used in motorsports by partner LITEWERKS – is placed in holders inside. This structure provides additional support to the housing and creates a cooling airspace for the cells and electronics. Several of these packs can be combined easily using snap connections, so that batteries can be sized as needed for the specific application, and repaired. In addition, further installation space is provided in the modular design for an optional cooling aggregate and air passages.

In addition to being used as a replacement for 12V starter batteries, which are also used in electric vehicles, and upcoming 48V solutions, the lightweight design battery housing can also serve as a traction battery with different cells, thanks to its good crash rating and control and cooling options.

Added value through lightweight design

Through a separate project with the BMW X5 (hybrid drive) as reference vehicle, the additional costs for the lightweight design were valued at around 18 euros per kilogram of weight savings in collaboration with the National Manufacturing Institute Scotland (NMIS).

This saved around 33 kilograms of mass and approximately ten litres of installation space. The majority of the weight reduction was due to switching to LiFePO₄ technology. These cells are not only lighter, their rated capacity is almost entirely utilised – in contrast to a lead variant. Therefore, a lower rated capacity is required for the supply. Likewise, the housing concept has been designed to meet the needs of the project, and contributes to the weight reduction as well.

However, the added costs for lightweight design are compensated for through lower consumption, additional savings in the wiring harness and crash structures, and a longer service life.

TGM Lightweight Solutions GmbH will be developing the lightweight battery further. Therefore, industrial partners for specific vehicle applications are welcome to further specify aspects such as the particular installation situation, geometry and connection optimisation, power and competitive aspects for series readiness.

About TGM Lightweight Solutions GmbH

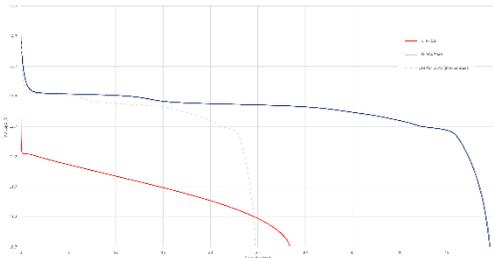
TGM Lightweight Solutions GmbH is an engineering consulting firm with a unique specialisation in comprehensive lightweight design for systematic and structural weight optimisation and lightweight design development, using a design-to-cost approach. The company's portfolio of services also includes developing software tools in-house and specialised consulting concepts for technical weight management, in the target industries of automotive construction, railway technology, aviation and aerospace and ship building. The company offers solutions from the vehicle to the component level. Unique features of the company's service include its own methods and tools, which quickly bring results even in the early phases, as well as its over 20 years of supporting vehicle development processes.



[Battery System_TGM_Image-3.jpg]

Size comparison between a 70 Ah standard battery and 140 Ah equivalent demonstrator of the new lightweight design battery housing.

Image: TGM Lightweight Solutions GmbH



[Battery System_TGM_Figure-2.jpg]

Comparison of lead-acid and LiFePO4 battery technology in terms of usable rated capacity.

Image: TGM Lightweight Solutions /
LITEWERKS GmbH

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