ALBATROSS

Advanced Light-weight BATteRy systems Optimized for fast charging, Safety, and Second-life applications

DECEMBER 2023

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WP2 - Battery Modules and Packaging

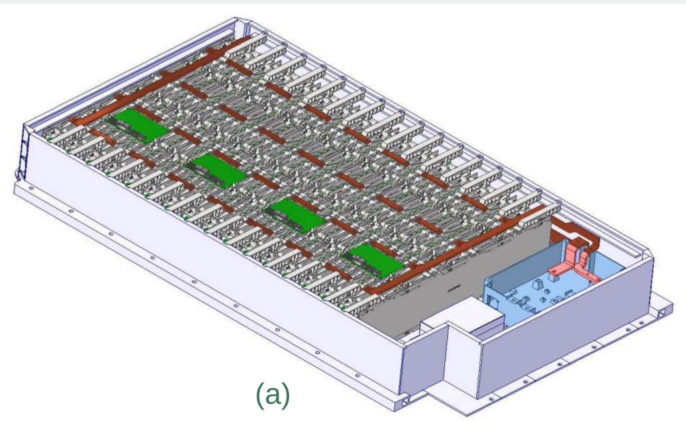
The updates of the activities carried out for Work Package (WP) 2 are presented in this technical newsletter. Take a read to know all details about the solutions found to optimize the design of the battery module.

Optimised Battery Module Design

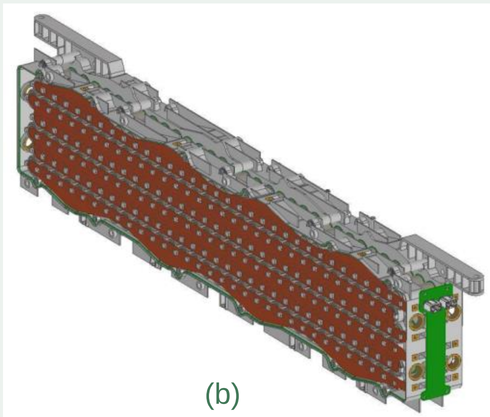
The modifications employed to produce an optimized battery module design were carried out to ensure the integration and producibility of these modules, in comparison with the original designs that were previously presented, and which served as the starting point.

The optimization process started at the cell interconnection with an improved busbar shape, which allows for a better connection between the separate modules, through special inserts. This also allows for a better current distribution, ensuring an equal spread of heat load across the parallel cells in the system. Four different busbars designs with different shapes were produced to enable an even current flow from and into the cells.

Other busbars that connect the positive and negative terminals of the pack also had their designs changed. The resulting layout can be seen in Figure 2a.



(a)



(b)

Figure 1. ALBATROSS battery pack (a) and submodule (b).

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To improve the mechanical properties of the modules, as well as the sealing and mounting, the parts of the submodules have been modified, as it can be seen in Figure 2b.

The first modification is the addition of bridges to reach from the module to the flanges of the battery tray (see Figure 2), that will support the clip for holding the modules to the battery tray. However, this has created a larger difference between the two sides of the sub-modules, as indicated by the cell holders of Figure 3, where only one of them has bridges. This way, when the submodules are joined, every interface between the sub-modules will have a bridge on either side.

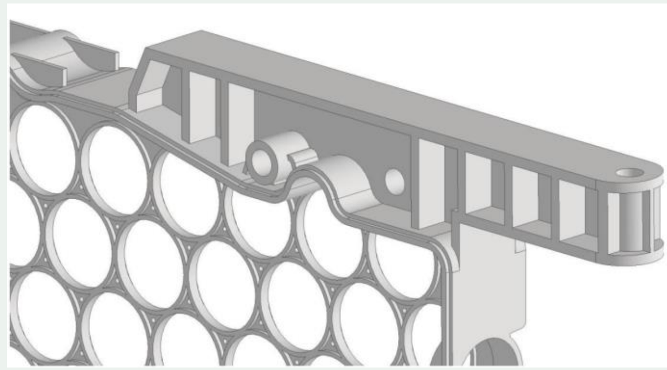
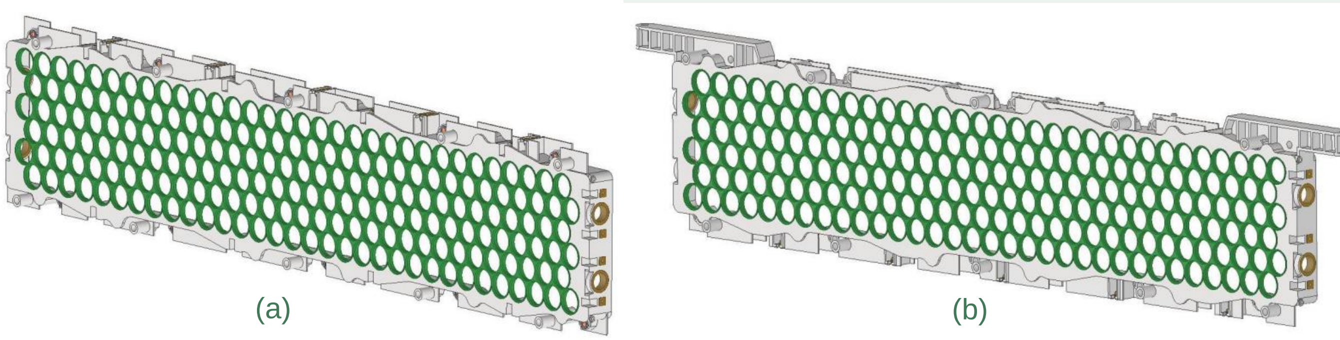


Figure 2. Bridge in Cell Holder.



(a) (b)

Figure 3. Cell holder without (a) and with bridges (b).

The remaining modifications to the cell holders consist of small design alterations to improve the mounting and inclusion of clips and inserts. The extra mounting interfaces have been added for additional strength while still allowing an easy assembly. This has also resulted in a modified cell stop design which allows to compensate for the difference in height between positive and negative terminals, allowing to space all cells evenly.

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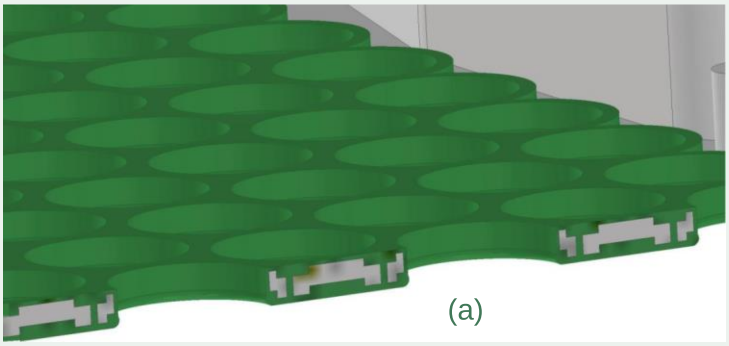
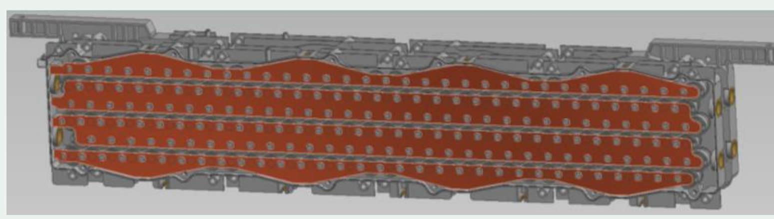
Finally, the sealing has also been further improved through the design of cell seals, as those presented in Figure 4, which are produced with a two component and two step injection moulding process. The sub-module casing seal is also being optimized for the injection moulding process with producers and suppliers. Overall, sealing is the biggest challenge of partial immersion cooling.


(a)


(b)

Figure 4. (a) Cell seal and (b) submodule seal.

To connect the battery cells, lightweight laser-cut ETP-Cu busbars have been developed, as it can be seen in tvhe CAD model of Figure 5, that displays the two sides of a submodule. The busbars consist of 2 single-row and 5 double-row strips with widths of 27.5 mm and 33 mm, respectively. They have a maximum length of 752.7 mm and a thickness of 0.2 mm. Since there are 16 identical modules, a total of 89 double-row and 32 single-row busbars are required for the entire battery pack.


(a)

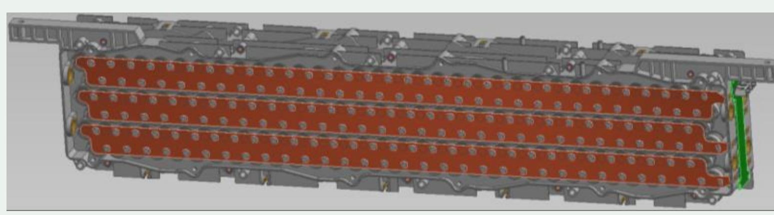

(b)

Figure 5. CAD model of the (a) front and (b) back side of a battery submodule.

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On the front side, the busbars connect to the exterior of the sealed plastic cell holder using brass inserts located on the left, top, and bottom. These inserts enable power transmission and voltage measurement for the various controllers and battery management systems. Between each cell, there is an elliptical cut-out shape to the cell holder, which supports the precise placement of the busbars during the welding process.

Additional functionality has been incorporated into the busbars. Instead of using the industry-standard nickel-plated strips, pure copper was employed, reducing the reliance on rare nickel elements and eliminating the need for expensive plating steps.

To enhance the busbar performance, the DLIP (Direct Laser Interference Patterning) technique was utilized by the partner Fraunhofer IWS to modify the top surface with a deep line-like texture, which increases the surface area of the busbar and improves light absorption. The machine can be seen in Figure 6.

The increased surface area and roughness of the busbars facilitate a better heat transfer from the cell tabs to the cooling liquid through the copper busbars. Additionally, the improved light absorption enhances the weldability of the busbars.

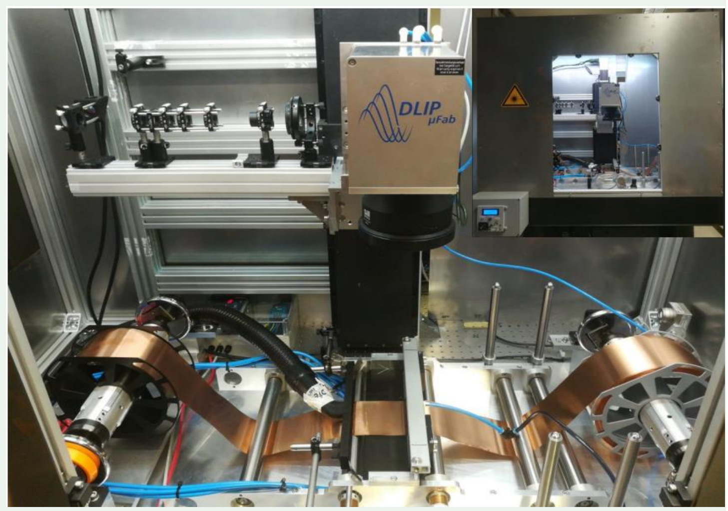

Figure 6. A photograph of the roll-to-roll (R2R) machine to DLIP texture the copper busbars.

The laser texturing process alters the surface topography, creating a light reflection-trapping effect that reduces the reflectivity from nearly complete reflection (in solid form) to only 30-40% reflection for the infrared wavelength (around 1064 nm) utilized in laser welding.

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The laser beam is shaped into an elongated line using an interference pattern, resulting in dimensions of 50 µm by 410 µm and a spatial period of 16.8 µm. To generate the desired line-like pattern, the scanner moves the beams perpendicular to the direction of the band. Subsequently, the coil of textured band is transferred to another machine equipped with a 2KW infrared laser and a galvano-scanner, which is responsible for cutting the busbars to the desired shape. To ensure the flatness of the sample, a custom-made holder is utilized during the cutting process, which allows for three busbars to be cut in parallel from the 100 mm-wide coil, while it is securely held in place.

With a blank coil length of 75 m, over 190 double-row and 85 single-row busbars can be produced.

In the next newsletter, more details will be provided regarding the joining of the battery cells to the busbars. Stay tuned!

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