Part 05

Making History:
The Large Format Lithium Ion Battery

Changes to the Battery Case and the Improving Lock Structure

In Part Four of this series we highlighted two of GS Yuasa' s developments: the conductive path structure and the bolt terminal fastening structure which makes use of a gasket. Here we discuss the gasket, the various considerations that lead to providing a locking mechanism in the battery case, and the evolution of the structures surrounding the bolt terminal.

1. The Battery Case: A Closer Look

The large-format lithium ion battery initially developed by GS Yuasa employed a stainless steel battery case. Stainless steel is hard metal that tends not to deform. While the stainless steel battery case is hard and tends not to deform, it is still heavy. In other applications, such as automotives, the lithium ion batteries may employ a lighter metal such as aluminum, instead of stainless steel for the battery case.

Of course, assembly and cost are also important considerations. When tightening the nut, the bolt terminal and the terminal connection plate attempt to turn due to the torque acting on the bolt terminal. However, these components may be reliably prevented from turning by providing a structure where stud bolts are placed on the stainless steel battery case, and the terminal connection plate is covered from above with a retainer plate (●Fig. 1).

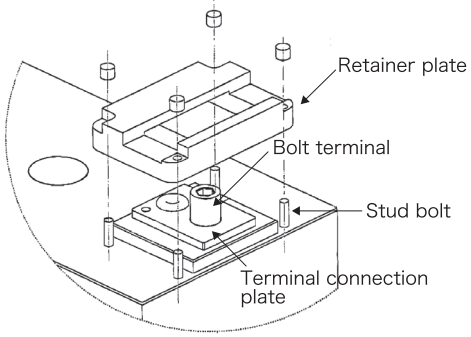
When considering improving yields and reducing costs, a novel implementation of the lock structure to replace the stud bolt system was desirable. These considerations lead us to develop a battery case with a lock mechanism.

2. Battery Case with Lock Mechanism

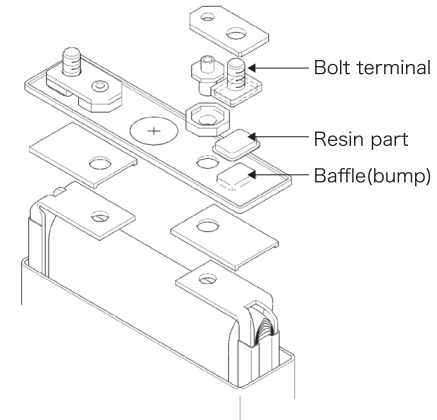
Battery cases are usually provided with a flat surface that serves as the lid. When first developing the aluminum battery case, GS Yuasa came up with adding bumps to the surface of the battery case lid, and using the bumps to baffle the bolt terminal (●Fig. 2).

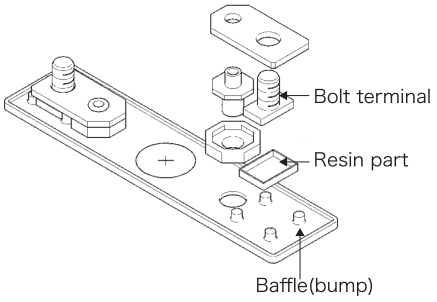
These bumps are integrated into the battery case lid, and can be easily formed by press machining the lid. Providing the bumps in the lid, and then having the bumps retain the resin part of the lock mechanism and the bolt terminal removes the need for components such as the typical stud bolt and retainer plate. This facilitates assembly, improves yield, and reduces costs.

●Fig. 1 Typical lock structure[1]



●Fig. 2 Battery Case with Lock Mechanism[2]





3. Adapting the Gasket for an Aluminum Battery Case

GS Yuasa then reevaluated the gasket material, and as a result, developed a novel concept of a gasket better suited to the aluminum battery case. As is well known, aluminum is a lighter and more easily deformable metal than stainless steel. Although the gasket is molded from a resin, depending on the materials used in the resin, the gasket, which should in fact be relatively and sufficiently softer, may end up being almost as hard as the aluminum battery case. In many cases, a polyphenylene sulfide (PPS) resin serves as the gasket material. However, a PPS resin gasket is hard, and, there are cases where the desired amount of battery sealing is not achieved when such a gasket is mounted on an aluminum battery case. Consequently, we came up with making the gasket placed between the lid and the rivet more flexible by including an elastomer (a material with rubber elasticity) in the PPS (●Fig. 3).

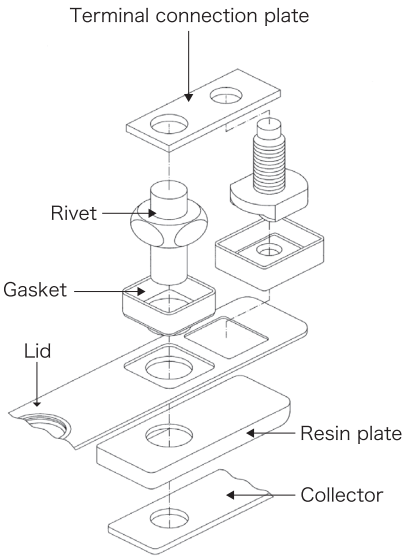
When gathering and securing the components sandwiched between the upper terminal connection plate and the lower collector (i.e., the gasket, lid, and resin plate) via the rivet, the gasket and the lid are firmly pressed against each other. At this point, the elastomer-containing gasket flexibly deforms and fills the space between itself and the lid to reliably seal the battery case.

GS Yuasa also re-examined the material used for the resin part (lock mechanism) that is placed between the lid and the bolt terminal. We decided to mix glass fibers into the resin part so that the underside of the resin part, which comes in contact with the aluminum lid, would be a coarse surface where the glass fibers are exposed (●Fig. 4).

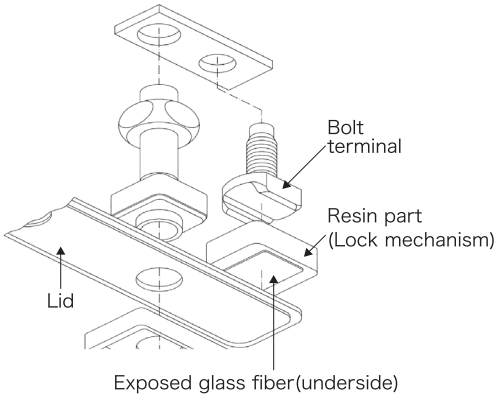
Mixing in the glass fibers reinforces the resin used for the lock mechanism and also holds the bolt terminal firmly in place. Given that glass fiber has good adhesion characteristics, the lock mechanism can be securely bonded to the lid using an adhesive.

In this article, we discussed the changes to the battery case and the improvements to the lock structure. In Part Six we will discuss further improvements to the battery case lid and the development of the insulating structure inside the battery case.

●Fig. 3 Our more flexible gasket[3]



●Fig. 4 Resin part containing glass fibers[4]



1.Japan Patent No. 4247595 (Filed in 2002)
2.Japan Patent Nos. 5418809, 5737638 (Filed in 2008), U.S. Patent Nos. 8748034, 9118051, 9379372 (Filed in 2011)
3.China Patent No. 201210016490.5 (Filed in 2011)
4.Japan Patent No. 5920650, U.S. Patent No. 8598471 (Filed in 2011)

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