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Battery module and battery pack including the same

Abstract

A battery module includes a battery cell stack in which a plurality of battery cells are stacked, a frame member for housing the battery cell stack and having an opened upper portion, and an upper plate for covering the battery cell stack on an upper portion of the frame member, wherein a stepped portion is formed at the bottom portion of the frame member corresponding to the upper plate, the stepped portion is formed in each of both end portions and between both end portions with respect to the longitudinal direction of the battery cell, and wherein the stepped portion is formed by a bending section of the bottom portion of the frame member.

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Background/Summary

TECHNICAL FIELD

Cross Citation with Related Application(s)

(1) This application claims the benefit of Korean Patent Application No. 10-2020-0107736 filed on Aug. 26, 2020 with the Korean Intellectual Property Office, the disclosure of which is incorporated

herein by reference in its entirety.
(2) The present disclosure relates to a battery module and a battery pack including the same, and more particularly, to a battery module that improves the space utilization rate and minimizes the use amount of thermal conductive resin and a battery pack including the same.

BACKGROUND

(3) Secondary batteries, which are easily applicable to various product groups and has electrical characteristics such as high energy density, are universally applied not only for a portable device but also for an electric vehicle or a hybrid electric vehicle, an energy storage system or the like, which is driven by an electric driving source. Such secondary battery is attracting attention as a new environment-friendly energy source for improving energy efficiency since it gives a primary advantage of remarkably reducing the use of fossil fuels and also does not generate by-products from the use of energy at all.
(4) Small-sized mobile devices use one or several battery cells for each device, whereas middle or large-sized devices such as vehicles require high power and large capacity. Therefore, a middle or large-sized battery module having a plurality of battery cells electrically connected to one another is used.
(5) The middle or large-sized battery module is preferably manufactured so as to have as small a size and weight as possible. Therefore, a prismatic battery, a pouch-shaped battery or the like, which can be stacked with high integration and has a small weight relative to capacity, is usually used as a battery cell of the middle or large-sized battery module. Meanwhile, in order to protect the battery cell stack from external impact, heat or vibration, the battery module may include a module frame of which a front surface and a rear surface are opened so as to house the battery cell stack in an internal space.
(6) FIG. **1** is an exploded perspective view illustrating a battery module having a mono frame according to the related art.
(7) Referring to FIG. **1**, a battery module may include a battery cell stack **12** formed by stacking a plurality of battery cells **11**, a mono frame **20** of which a front surface and a rear surface are opened so as to cover the battery cell stack **12**, and end plates **60** that cover the front and rear surfaces of the mono frame **20**. In order to form such a battery module, it is necessary to horizontally assemble the battery module such that the battery cell stack **12** is inserted into the opened front surface or rear surface of the mono frame **20** along the X-axis direction as shown by the arrow in FIG. **1**. However, in order to stably perform such a horizontal assembly, a sufficient clearance has to be secured between the battery cell stack **12** and the mono frame **20**. Here, the clearance refers to a gap generated by press-fitting and the like.
(8) A thermal conductive resin layer (not shown) may be formed between the battery cell stack **12** and the bottom portion of the mono frame **20**. The thermal conductive resin layer can play a role of transferring the heat generated from the battery cell stack to the outside of the battery module, and fixing the battery cell stack inside the battery module. When the clearance becomes larger, the use amount of the thermal conductive resin layer may become larger than necessary.
(9) In addition, the height of the mono frame **20** should be designed large in consideration of the maximum height of the battery cell stack **12** and an assembly tolerance during the insertion process, and the like, which may lead to generation of unnecessary wasted space.

DETAILED DESCRIPTION OF THE INVENTION

Technical Problem

(10) It is an object of the present disclosure to provide a battery module that improves the space utilization rate and minimizes the use amount of thermal conductive resin by deforming the structure of the frame member surrounding the battery cell stack, and a battery pack including the same.
(11) However, the technical problem to be solved by embodiments of the present disclosure is not limited to the above-described problems, and can be variously expanded within the scope of the

technical idea included in the present disclosure.

Technical Solution

(12) According to one embodiment of the present disclosure, there is provided a battery module comprising: a battery cell stack in which a plurality of battery cells are stacked in a first direction, a frame member for housing the battery cell stack and having an opened upper portion, and an upper plate for covering the battery cell stack on an upper portion of the frame member, wherein a stepped portion is formed at a bottom portion of the frame member, wherein the stepped portion is formed in each end portion of the bottom portion of the frame member, and wherein each stepped portion is formed by a bending section of the bottom portion of the frame member.

(13) Each battery cell of the plurality of battery cells may include a protrusion portion that protrudes toward the stepped portion formed on at least one end portion of the battery cell.

(14) The bottom portion of the frame member may include an edge portion and a main portion surrounded by the edge portion, the edge portion may include a first portion located at an edge of the bottom portion based on a second direction, and a second portion located at an edge of the bottom portion based on the first direction, and the edge portion corresponds to the stepped portion, and the thicknesses of the edge portion and the main portion may be equal to each other.

(15) The battery module may further comprise a thermal conductive resin layer between the bottom portion of the frame member and the battery cell stack in the region corresponding to the main portion.

(16) The bottom portion of the frame member may include a concave portion and convex portions, the concave portion may include a first portion located at an edge with respect to the second direction, and a second portion located at the central portion with respect to the second direction, the second portion of the concave portion is located between adjacent convex portions, and the concave portion may correspond to the stepped portion, and the thicknesses of the concave portion and the convex portions are equal to each other.

(17) The battery module may further include a thermal conductive resin layer that is located between the bottom portion of the frame member and the battery cell stack in a region corresponding to the convex portions.

(18) The thermal conductive resin layer may include a first thermal conductive resin layer and a second thermal conductive resin layer that are spaced apart from each other with respect to the second portion of the concave portion.

(19) The bottom portion of the frame member may include a concave portion and a convex portion, the concave portion may include a first portion corresponding to an edge of the bottom portion, a second portion located in the central portion with respect to the longitudinal direction of the battery cell, and a third portion, a third portion of the concave portion may be formed in a middle of the convex portion, the concave portion may corresponds to the stepped portion, and the thicknesses of the concave portion and the convex portion may be equal to each other.

(20) The battery module may further include a thermal conductive resin layer that is located between the bottom portion of the frame member and the battery cell stack in a region corresponding to the convex portion and the third portion of the concave portion.

(21) The battery module may further include an insulating sheet located between the stepped portion and the protrusion portion of the battery cell.

(22) The insulating sheet may be formed of polyethylene terephthalate (PET).

(23) The protrusion portion may be formed in a height direction of the battery cell.

(24) The battery module may further include end plates coupled to the opposite sides of the frame member, respectively, wherein the opposite sides of the frame member face each other with respect to t the second direction.

(25) The frame member may further include two side surface portions facing each other while being connected by the bottom portion, and a distance between the two side surface portions may be equal to a width of the upper plate.

(26) According to another embodiment of the present disclosure, there is provided a battery pack comprising the above-mentioned battery module.

Advantageous Effects

(27) According to embodiments of the present disclosure, the bottom portion of the frame member can be press-molded to reduce the gap between the battery cell stack and the frame member, thereby improving the space utilization in the height direction and minimizing the amount of application of the thermal conductive resin.

(28) The effects of the present disclosure are not limited to the effects mentioned above and additional other effects not described above will be clearly understood from the description of the appended claims by those skilled in the art.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is an exploded perspective view illustrating a battery module having a mono frame according to the related art;

(2) FIG. **2** is an exploded perspective view illustrating a battery module according to an embodiment of the present disclosure;

(3) FIG. **3** is a perspective view illustrating a state in which components constituting the battery module of FIG. **2** are combined;

(4) FIG. **4** is a perspective view illustrating a pouch-type battery according to an embodiment of the present disclosure;

(5) FIG. **5** is a perspective view illustrating a frame member in the battery module of FIG. **2**;

(6) FIG. **6** is a perspective view illustrating a thermal conductive resin layer formed on a bottom portion of a frame member in FIG. **5**;

(7) FIG. **7** is a view illustrating a part of a cross-section taken along the XZ plane of FIG. **3**;

(8) FIG. **8** is a cross-sectional view according to the comparative example of FIG. **7**;

(9) FIG. **9** is a perspective view illustrating an insulating sheet included in a battery module according to another embodiment of the present disclosure;

(10) FIG. **10** is a perspective view illustrating a frame member according to another embodiment of the present disclosure;

(11) FIG. **11** is a plan view of the frame member of FIG. **10**;

(12) FIG. **12** is a perspective view illustrating a frame member according to another embodiment of the present disclosure;

(13) FIG. **13** is a plan view of the frame member of FIG. **12**;

(14) FIG. **14** is a perspective view illustrating a frame member according to another embodiment of the present disclosure; and

(15) FIG. **15** is a plan view of the frame member of FIG. **14**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

(16) Hereinafter, various embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that those skilled in the art can easily carry out them. The present disclosure may be modified in various different ways, and is not limited to the embodiments set forth herein.

(17) Portions that are irrelevant to the description will be omitted to clearly describe the present disclosure, and like reference numerals designate like elements throughout the specification.

(18) Further, in the drawings, the size and thickness of each element are arbitrarily illustrated for convenience of the description, and the present disclosure is not necessarily limited to those illustrated in the drawings. In the drawings, the thickness of layers, regions, etc. are exaggerated for clarity. In the drawings, for convenience of the description, the thicknesses of some layers and

regions are shown to be exaggerated.
(19) In addition, it will be understood that when an element such as a layer, film, region, or plate is referred to as being “on” or “above” another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being “directly on” another element, it means that other intervening elements are not present. Further, the word “on” or “above” means disposed on or below a reference portion, and does not necessarily mean being disposed “on” or “above” the reference portion toward the opposite direction of gravity.
(20) Further, throughout the specification, when a portion is referred to as “including” a certain component, it means that the portion can further include other components, without excluding the other components, unless otherwise stated.
(21) Further, throughout the specification, when referred to as “planar”, it means when a target portion is viewed from the upper side, and when referred to as “cross-sectional”, it means when a target portion is viewed from the side of a cross section cut vertically.
(22) FIG. **2** is an exploded perspective view illustrating a battery module according to an embodiment of the present disclosure. FIG. **3** is a perspective view illustrating a state in which components constituting the battery module of FIG. **2** are combined. FIG. **4** is a perspective view illustrating a pouch-type battery according to an embodiment of the present disclosure.
(23) Referring to FIGS. **2** and **3**, a battery module **100** according to the present embodiment includes a battery cell stack **120** containing a plurality of battery cells **110**, a frame member **300** of which an upper surface, a front surface and a rear surface are opened, an upper plate **400** that covers the upper portion of the battery cell stack **120**, end plates **150** each locating on the front surface and the rear surface of the battery cell stack **120**, and a busbar frame **130** located between the battery cell stack **120** and the end plate **150**.
(24) When opened both sides of the frame member **300** are referred to as a first side and a second side, respectively, the frame member **300** has a plate-shaped structure that is bent so as to continuously wrap the front surface, lower surface and rear surface adjacent to each other among the remaining outer surfaces excluding surfaces of the battery cell stack **120** corresponding to the first side and the second side. The upper surface corresponding to the lower surface of the frame member **300** is opened. The front surface, bottom surface and rear surface of the frame member **300** may be integrally formed.
(25) The upper plate **400** is constituted of a single plate-shaped structure that wraps the remaining upper surface excluding the front surface, lower surface and rear surface which are wrapped by the frame member **300**. The frame member **300** and the upper plate **400** can be coupled by welding or the like in a state in which the corresponding corner areas are in contact with each other, thereby forming a structure wrapping the battery cell stack **120**. That is, the frame member **300** and the upper plate **400** can have a coupling part CP formed at a corner area corresponding to each other by a coupling method such as welding.
(26) The battery cell stack **120** includes a plurality of battery cells **110** stacked in one direction, and the plurality of battery cells **110** may be stacked in the Y-axis direction as shown in FIG. **2**. The battery cell **110** is preferably a pouch-type battery cell. For example, referring to FIG. **4**, the battery cell **110** according to the present embodiment may have a structure in which the two electrode leads **111** and **112** are protruded from one end portion **114***a* and the other end portion **114***b* of the battery body **113**, while being opposite to each other. The battery cell **110** can be manufactured by coupling both end portions **114***a* and **114***b* of a cell case **114** and one side portion **114***c* connecting them in a state in which an electrode assembly (not shown) is housed in the cell case **114**. In other words, the battery cell **110** according to the present embodiment has a total of three sealing parts **114***sa*, **114***sb* and **114***sc*, and the sealing parts **114***sa*, **114***sb* and **114***sc* have a structure being sealed by a method such as heat fusion, and the remaining other one side portion may be formed of a connection part **115**. Between both end portions **114***a* and **114***b* of the battery case **114** is defined as a longitudinal

direction of the battery cell **110**, and between the one side portion **114***c* and the connection part **115** that connect both end portions **114***a* and **114***b* of the battery case **114** is defined as a height direction of the battery cell **110**.

(27) The connection part **115** is a region extending long along one edge of the battery cell **110**, and a protrusion portion **110***p* of the battery cell **110** may be formed at an end portion of the connection part **115**. The protrusion portion **110***p* may be formed on at least one of both end portions of the connection part **115** and may protrude in a direction perpendicular to the direction in which the connection part **115** extends. The protrusion portion **110***p* may be located between one of the sealing parts **114***sa* and **114***sb* of both end portions **114***a* and **114***b* of the battery case **114**, and the connection part **115**.

(28) The battery case **114** is generally formed of a laminate structure of a resin layer/metallic thin film layer/resin layer. For example, in case where the battery case surface is formed of an O(oriented)-nylon layer, it tends to slide easily by an external impact when a plurality of battery cells are stacked to form a medium or large-sized battery module. Therefore, in order to prevent this sliding and maintain a stable stacked structure of the battery cells, an adhesive member, for example, a sticky adhesive such as a double-sided tape or a chemical adhesive coupled by a chemical reaction upon adhesion can be adhered to the surface of the battery case to form the battery cell stack **120**. In the present embodiment, the battery cell stack **120** is stacked in a Y-axis direction and housed into the frame member **300** in a Z-axis direction, and then heat transfer can be performed by a heat conductive resin layer described later. As a comparative example thereto, there is a case where the battery cells are formed as cartridge-shaped components so that fixing between the battery cells is constituted by assembling by the battery module frame. In this comparative example, due to the presence of the cartridge-shaped components, the cooling action may be little or be proceeded in a surface direction of the battery cells, whereby the cooling is not performed in the height direction of the battery module.

(29) FIG. **5** is a perspective view illustrating a frame member in the battery module of FIG. **2**. FIG. **6** is a perspective view illustrating a thermal conductive resin layer formed on a bottom portion of a frame member in FIG. **5**.

(30) Referring to FIG. **5**, the frame member **300** according to the present embodiment includes a bottom portion **300***a* and two side surface portions **300***b* facing each other. Before the battery cell stack **120** is mounted on the bottom portion **300***a* of the frame member **300**, a thermal conductive resin is applied onto the bottom portion of the frame member **300** and the thermally conductive resin is cured, thereby capable of forming a thermal conductive resin layer **310**.

(31) Before the thermal conductive resin layer **310** is formed, that is, before the applied thermal conductive resin is cured, the battery cell stack **120** may be mounted on the bottom portion **300***a* of the module frame **300** while moving along in a direction that is perpendicular to the bottom portion **300***a* of the module frame **300**. Thereafter, the thermal conductive resin layer **310** that is formed by the curing of the thermal conductive resin is located between the bottom portion **300***a* of the module frame **300** and the battery cell stack **120**. Referring to FIGS. **2** and **6**, the thermal conductive resin layer **310** can perform the role of transferring the heat generated from the battery cells **110** to a bottom of the battery module **100**, and fixing the battery cell stack **120**.

(32) The bottom portion **300***a* of the frame member **300** according to the present embodiment includes a first portion **300***a***1** and a second portion **300***a***2**, the first portion **300***a***1** is located at the edge with respect to the longitudinal direction of the battery cell **110**, and the second portion **300***a***2** is located at the inside of the first portion **300***a***1**. The thermal conductive resin layer **310** may be formed on the second portion **300***a***2**. Here, the longitudinal direction of the battery cell **110** may be the X-axis direction of FIG. **5**. At this time, the thickness of the first portion **300***a***1** is equal to the thickness of the second portion **300***a***2**, the portion of the bottom portion **300***a* to which the second portion **300***a***2** and the first portion **300***a***1** are connected can be bent, and a stepped portion **300***s* is formed in a region corresponding to the first portion **300***a***1**. Here, the stepped portion refers to a

structure resulting from a difference in height from the periphery.
(33) The stepped portion **300***s* may be formed by press-molding the bottom portion **300***a* of the frame member **300**. As will be described later, the battery cell stack **120** is mounted on the bottom portion **300***a* of the frame member **300** so that the protrusion portion **110***p* of the battery cell **110** according to the present embodiment protrudes toward the stepped portion **300***s*.
(34) Referring back to FIGS. **2** and **3**, the width of the side surface portion **300***b* and the upper plate **400** of the frame member **300** according to the present embodiment may be equal to each other. In other words, the edge portion along the X-axis direction of the upper plate **400** and the edge portion along the X-axis direction of the side surface portion **300***b* of the frame member **300** can be directly met and coupled by a method such as welding.
(35) FIG. **7** is a view illustrating a part of a cross-section taken along the XZ plane of FIG. **3**.
(36) Referring to FIGS. **3** and **7**, the battery module **100** according to the present embodiment includes a bottom portion of the frame member **300** having a first portion **300***a***1** and a second portion **300***a***2**. The thicknesses of the first portion **300***a***1** and the second portion **300***a***2** are equal to each other, and the first portion **300***a***1** and the second portion **300***a***2** are connected to each other by the bending part **305**. The second portion **300***a***2** is located at a higher level than the first portion **300***a***1**. The protrusion portion **110***p* of the battery cell **110** is protruded toward the stepped portion **300***s* formed in the first portion **300***a***1**. Therefore, it is possible to prevent the protrusion portion **110***p* from hanging on the step difference between the first portion **300***a***1** and the second portion **300***a***2** and flowing due to an external impact. In addition, by press-molding the bottom portion **300***a* of the frame member **300**, the gap between the battery cell **110** and the frame member can be reduced, and the gap reducing effect causes a synergistic action with the gap reducing effect that can be obtained through height direction assembly, thereby maximizing the overall space efficiency. In addition, the protrusion portion **110***p* of the battery cell **110** is formed in the stepped portion **300***s*, whereby the separation distance between the battery cell **110** and the bottom portion **300***a* of the frame member **300** is minimized, which not only reduces the space efficiency, but also reduces the use amount of thermal conductive resin to form a thermal conductive resin layer, thereby reducing the costs. Therefore, the cooling efficiency can also be improved.
(37) FIG. **8** is a cross-sectional view according to the comparative example of FIG. **7**.
(38) Referring to FIG. **8**, in the comparative example of FIG. **8**, the bottom portion of the frame member can form a stepped portion by processing the edge of the bottom portion of the frame member or press-compressing the edge of the bottom portion of the frame member. At this time, the bottom portion of the frame member includes a first portion **300***a***1**′ and a second portion **300***a***2**′ having different thicknesses from each other. In the case of this comparative example, the thickness of the bottom portion of the frame member corresponding to the second portion **300***a***2**′ can be increased to form the stepped portion. On the other hand, in the battery module according to the embodiment of FIG. **7**, since the thickness of the frame bottom portion can be reduced by forming the stepped portion **300***s* through press molding, it can be designed for reducing the height of the case of the battery pack in which the battery module is mounted.
(39) FIG. **9** is a perspective view illustrating an insulating sheet included in a battery module according to another embodiment of the present disclosure.
(40) Referring to FIGS. **6**, **7** and **9**, the battery module according to the present embodiment may further include an insulating sheet **315** formed on the stepped portion **300***s*. The insulating sheet **315** may be formed of polyethylene terephthalate (PET), and may be located between the protrusion portion **110***p* and the stepped portion **300***s* of the battery cell **110** described above. The insulating sheet **315** functions to electrically insulate between the protrusion portion **110***p* of the battery cell **110** and the bottom portion **300***a* of the frame member. At this time, the insulating sheet **315** can come into contact with the protrusion portion **110***p* of the battery cell **110**. Further, an undercut shape **300***r* may be formed in the stepped portion **300***s*. The undercut shape **300***r* may have a round shape. The shape of the insulating sheet **315** may be simplified by the undercut shape

300*r* formed in the stepped portion **300***s*. That is, the insulating sheet **315** can be applied only to the inside of the press-molded portion, and the corners of the insulating sheet **315** adjacent to the undercut shape **300***r* can be simplified and formed into a right angle.

(41) FIG. **10** is a perspective view illustrating a frame member according to another embodiment of the present disclosure. FIG. **11** is a plan view of the frame member of FIG. **10**.

(42) Referring to FIGS. **2**, **10** and **11**, the frame member **500** according to the present embodiment includes a bottom portion **500***a* and two side surface portions **500***b* facing each other.

(43) The bottom portion **500***a* of the frame member **500** according to the present embodiment includes an edge portion **500***a***1** and a main portion **500***a***2**. The edge portion **500***a***1** includes a first portion **500***a***11** located at the edge with respect to the longitudinal direction of the battery cell **110** and a second portion **500***a***12** located at the edge with respect to the width direction of the battery cell **110**. The second part **500***a***12** of the edge portion **500***a***1** is formed between the main portion **500***a***2** and the side portion **500***b* of the frame member **500**.

(44) The main portion **500***a***2** may be surrounded by the edge portion **500***a***1**. The thermal conductive resin layer **310** may be formed in a region corresponding to the main portion **500***a***2**. Here, the longitudinal direction of the battery cell **110** is the x-axis direction of FIG. **5**, and the width direction of the battery cell **110** may be the y-axis direction of FIG. **5**. At this time, the thickness of the edge portion **500***a***1** is equal to the thickness of the main portion **500***a***2**, and the portion of the bottom portion **500***a* where the main portion **500***a***2** and the edge portion **500***a***1** are connected is bent, so that a stepped portion **500***s* can be formed in a region corresponding to the edge portion **500***a***1**. Here, the stepped portion refers to a structure resulting from a difference in height from the periphery. The edge portion **500***a***1** and the main portion **500***a***2** are connected by the bending portion **505**. The main portion **500***a***2** is located at a higher level than the edge portion **500***a***1**. The protrusion portion **110***p* of the battery cell **110** protrudes toward the stepped portion **500***s* formed in the first portion **500***a***11** of the edge portion **500***a***1**.

(45) The stepped portion **500***s* can be formed by press-molding the bottom portion **500***a* of the frame member **500**. The battery cell stack **120** is mounted on the bottom portion **500***a* of the frame member **500** so that the protrusion portion **110***p* of the battery cell **110** according to the present embodiment protrudes toward the first portion **500***a***11** of the bottom portion **500***a* among the stepped portion **500***s*.

(46) The frame member **500** of FIGS. **10** and **11** is a modified example of the frame member **300** to described in FIG. **5**. In addition to the differences described above, all the contents described with reference to FIG. **5** can be applied to the present embodiment. In the case of the frame member **300** described with reference to FIG. **5**, the sagging may occur in the central portion of the bottom portion **300***a* with respect to the longitudinal direction of the battery cell **110**. Due to such sagging, an air gap may be formed between the thermal conductive resin layer **310** and the battery cell **110** of FIG. **2**, or an external force generated by the sagging may be applied to the battery cell **110** to damage the battery cell **110**. On the other hand, according to the present embodiment, the second portion **500***a***12** of the edge portion **500***a***1** is formed between the main portion **500***a***2** and the side surface portion **500***b* of the frame member **500**, thereby capable of preventing the sagging along the longitudinal direction of the battery cell **110**. In addition, the structural rigidity can be further improved by press-forming on the second portion **500***a***12** of the edge portion **500***a***1**.

(47) FIG. **12** is a perspective view illustrating a frame member according to another embodiment of the present disclosure. FIG. **13** is a plan view of the frame member of FIG. **12**.

(48) Referring to FIGS. **2**, **12** and **13**, the frame member **600** according to the present embodiment includes a bottom portion **600***a* and two side surface portions **600***b* facing each other.

(49) The bottom portion **600***a* of the frame member **600** according to the present embodiment includes a concave portion **600***a***1** and a convex portion **600***a***2**. The concave portion **600***a***1** includes a first portion **600***a***11** located at the edge of the battery cell **110** with respect to the longitudinal direction, and a second portion **600***a***12** located at the central portion with respect to the

longitudinal direction of the battery cell **110**. The convex portions **600***a***2** may be formed by a plurality of numbers. The second portion **600***a***12** of the concave portion **600***a***1** is formed between the convex portions **600***a***2** adjacent to each other.

(50) The thermal conductive resin layer **310** may be formed on the convex portion **600***a***2**. Although not shown, the thermal conductive resin layer **310** may include a first thermal conductive resin layer and a second thermal conductive resin layer that are located to be spaced apart from the second portion **600***a***12** of the concave portion **600***a***1**. At this time, an additional insulating sheet may be formed in the second portion **600***a***12** of the concave portion **600***a***1**.

(51) In a modified example, the thermal conductive resin layer **310** may be formed so as to extend to the second portion **600***a***12** of the concave portion **600***a***1**.

(52) Here, the longitudinal direction of the battery cell **110** may be the x-axis direction of FIG. **5**. At this time, the thickness of the concave portion **600***a***1** is equal to the thickness of the convex portion **600***a***2**, and a portion of the bottom portion **600***a* connected to the convex portion **600***a***2** and the concave portion **600***a***1** may be bent, so that a stepped portion **600***s* can be formed in a region corresponding to the second portion **600***a***12** of the concave portion **600***a***1**. Here, the stepped portion refers to a structure resulting from a difference in height from the periphery. The concave portion **600***a***1** and the convex portion **600***a***2** are connected by the bending portion **605**. The convex portion **600***a***2** is located at a higher level than the concave portion **600***a***1**. The protrusion portion **110***p* of the battery cell **110** is protruded toward the stepped portion **600***s* formed in the first portion **600***a***11** of the concave portion **600***a***1**.

(53) The frame member **600** of FIGS. **12** and **13** is a modified example of the frame member **300** described in FIG. **5**. In addition to the differences described above, all the contents described with reference to FIG. **5** can be applied to the present embodiment. In the case of the frame member **300** described with reference to FIG. **5**, the sagging occur in the central portion of the bottom portion **300***a* with respect to the longitudinal direction of the battery cell **110**. Due to such sagging, an air gap is formed between the thermal conductive resin layer **310** and the battery cell **110** of FIG. **2**, or an external force resulting from the sagging is applied to the battery cell **110**, which may damage the battery cell **110**. On the other hand, according to the present embodiment, the second portion **600***a***12** of the concave portion **600***a***1** is formed between the convex portions **600***a***2** adjacent to each other, thereby capable of preventing the sagging along the longitudinal direction of the battery cell **110**. In addition, the structural rigidity can be further improved by press-forming the second portion **600***a***12** of the concave portion **600***a***1**. Further, according to the present embodiment, since the second portion **600***a***12** of the concave portion **600***a***1** is formed so as to correspond to the occurrence region of the sagging with respect to the longitudinal direction of the battery cell **110**, the effect of preventing sagging and the effect of improving structural rigidity are significant as compared with the frame member **500** described with reference to FIGS. **10** and **11**.

(54) FIG. **14** is a perspective view illustrating a frame member according to another embodiment of the present disclosure. FIG. **15** is a plan view of the frame member of FIG. **14**.

(55) Referring to FIGS. **2**, **14** and **15**, the frame member **700** according to the present embodiment includes a bottom portion **700***a* and two side surface portions **700***b* facing each other.

(56) The bottom portion **700***a* of the frame member **700** according to the present embodiment includes a concave portion **700***a***1** and a convex portion **700***a***2**. The concave portion **700***a***1** includes a first portion **700***a***11** located at the edge of the bottom portion **700***a*, a second portion **700***a***12** located at the central portion with respect to the longitudinal direction of the battery cell **110**, and a third portion **700***a***13** recessed inside the convex portion **700***a***2**. The third portion **700***a***12** of the concave portion **700***a***1** may be formed in the middle of the convex portion **700***a***2**.

(57) The thermal conductive resin layer **310** can be formed so as to cover the convex portion **700***a***2** and the third portion **700***a***12** of the concave portion **700***a***1**. In addition, the thermal conductive resin layer **310** may be formed so as to extend to the second portion **700***a***12** of the concave portion **700***a***1**. Here, the longitudinal direction of the battery cell **110** may be the x-axis direction of FIG. **5**.

At this time, the thickness of the concave portion **700***a***1** is equal to the thickness of the convex portion **700***a***2**, and a portion of the bottom portion **700***a* where the convex portion **700***a***2** and the concave portion **700***a***1** are connected is bent, so that a stepped portion **700***s* can be formed in a region corresponding to the concave portion **700***a***1**. Here, the stepped portion refers to a structure resulting from a difference in height from the periphery. The concave portion **700***a***1** and the convex portion **700***a***2** are connected by the bending portion **705**. The convex portion **700***a***2** is located at a higher level than the concave portion **700***a***1**. The protrusion portion **110***p* of the battery cell **110** is protruded toward the stepped portion **700***s* formed in the first portion **700***a***11** of the concave portion **700***a***1**.

(58) The stepped portion **700***s* can be formed by press-molding the bottom portion **700***a* of the frame member **700**. The battery cell stack **120** is mounted on the bottom portion **700***a* of the frame member **700**, so that the protrusion portion **110***p* of the battery cell **110** according to the present embodiment is protruded toward the edge with respect to the longitudinal direction of the battery cell **110** among the first portions **700***a***11** of the bottom portion **700***a*.

(59) The frame member **700** of FIGS. **14** and **15** is a modified example of the frame member **300** described in FIG. **5**. In addition to the differences described above, all the contents described with reference to FIG. **5** may be applied to the present embodiment. In the case of the frame member **300** described with reference to FIG. **5**, the sagging may occur in the central portion of the bottom portion **300***a* with respect to the longitudinal direction of the battery cell **110**. Due to such sagging, an air gap is formed between the thermal conductive resin layer **310** and the battery cell **110** of FIG. **2**, or external force resulting from the sagging is applied to the battery cell **110**, so that the battery cell **110** is likely to be damaged. On the other hand, according to the present embodiment, the second portion **700***a***12** located at the central portion with respect to the longitudinal direction of the battery cell **110** and the third portion **700***a***13** recessed inside the convex portion **700***a***2** are formed, thereby capable of preventing the sagging along the longitudinal direction of the battery cell **110**. In addition, the structural rigidity can be improved by press-forming the second portion **700***a***12** and the third portion **700***a***13**. In addition, according to the present embodiment, the second portion **700***a***12** of the concave portion **700***a***1** is formed so as to correspond to the region where the sagging occurs with respect to the longitudinal direction of the battery cell **110**. Additionally, since the third portion **700***a***12** is formed inside the convex portion **700***a***2**, the sagging preventing effect and the structural rigidity improving effect are significantly exhibited, as compared with the frame member **500** described with reference to FIGS. **10** and **11** and the frame member **600** described with reference to FIGS. **12** and **13**.

(60) On the other hand, one or more of the battery modules according to the present embodiments can be packaged in a pack case to form a battery pack.

(61) The above-mentioned battery module and battery pack including the same can be applied to various devices. Such a device can be applied to a vehicle means such as an electric bicycle, an electric vehicle, or a hybrid vehicle, but the present disclosure is not limited thereto, and is applicable to various devices capable of using a battery module, which also falls under the scope of the present disclosure.

(62) Although the invention has been shown and described above with reference to the preferred embodiments, the scope of the present disclosure is not limited thereto, and numerous other modifications and improvements made by those skilled in the art using the basic principles of the invention described in the appended claims will fall within the spirit and scope of the present disclosure.

DESCRIPTION OF REFERENCE NUMERALS

(63) **100**: battery module **300**, **500**, **600**, **700**: frame member **300***a*, **500***a*, **600***a*, **700***a*: bottom portion **300***b*, **500***b*, **600***b*, **700***b*: side surface portion **300***r*: undercut shape **310**: thermal conductive resin layer **400**: upper plate

Claims

1. A battery module comprising: a battery cell stack in which a plurality of battery cells are stacked in a first direction, a frame member for housing the battery cell stack and having an opened upper portion, and an upper plate for covering the battery cell stack on an upper portion of the frame member, wherein a stepped portion is formed at a bottom portion of the frame member, wherein the stepped portion is formed in each end portion of the bottom portion of the frame member, and wherein each stepped portion is a depression in the bottom portion of the frame member.
2. The battery module according to claim 1, wherein: the bottom portion of the frame member includes a first portion and a second portion, the first portion is located at an edge with respect to the longitudinal direction of the battery cell, and the second portion is located at the inside of the first portion, a portion of the bottom portion to which the second portion and the first portion are connected is bent, and the stepped portion is formed in a region corresponding to the first portion.
3. The battery module according to claim 2, wherein: each battery cell of the plurality of battery cells comprises a protrusion portion that protrudes into at least one of the stepped portions.
4. The battery module according to claim 3, wherein: the battery cell stack is mounted on the bottom portion of the frame member so that the protrusion portion of the battery cell protrudes toward the first portion of the bottom portion.
5. The battery module according to claim 3, wherein: the bottom portion of the frame member comprises an edge portion and a main portion surrounded by the edge portion, the edge portion includes a first portion located at an edge of the bottom portion based on a second direction, and a second portion located at an edge of the bottom portion based on the first direction, and the edge portion corresponds to the stepped portion, and the thicknesses of the edge portion and the main portion are equal to each other.
6. The battery module according to claim 5, further comprising a thermal conductive resin layer between the bottom portion of the frame member and the battery cell stack in the region corresponding to the main portion.
7. The battery module according to claim 3, wherein: the bottom portion of the frame member comprises a concave portion and convex portions, the concave portion comprises a first portion located at an edge with respect to the second direction, and a second portion located at the central portion with respect to the second direction, the second portion of the concave portion is located between adjacent convex portions, and the concave portion corresponds to the stepped portion, and the thicknesses of the concave portion and the convex portions are equal to each other.
8. The battery module according to claim 7, further comprising a thermal conductive resin layer that is located between the bottom portion of the frame member and the battery cell stack in a region corresponding to the convex portions.
9. The battery module according to claim 8, wherein: the thermal conductive resin layer comprises a first thermal conductive resin layer and a second thermal conductive resin layer that are spaced apart from each other with respect to the second portion of the concave portion.
10. The battery module according to claim 3, wherein: the bottom portion of the frame member comprises a concave portion and a convex portion, the concave portion comprises a first portion corresponding to an edge of the bottom portion, a second portion located in the central portion with respect to the longitudinal direction of the battery cell, and a third portion, the third portion of the concave portion is formed in a middle of the convex portion, and the concave portion corresponds to the stepped portion, and the thicknesses of the concave portion and the convex portion are equal to each other.
11. The battery module according to claim 10, further comprising a thermal conductive resin layer that is located between the bottom portion of the frame member and the battery cell stack in a region corresponding to the convex portion and the third portion of the concave portion.

12. The battery module according to claim 3, further comprising an insulating sheet located between the stepped portion and the protrusion portion of the battery cell.
13. The battery module according to claim 12, wherein: the insulating sheet is formed of polyethylene terephthalate (PET).
14. The battery module according to claim 3, wherein: the protrusion portion is formed in a height direction of the battery cell.
15. The battery module according to claim 1, further comprising end plates coupled to opposite sides of the frame member, respectively, wherein the opposite sides of the frame member face each other with respect to the first direction.
16. The battery module according to claim 15, wherein: the frame member further comprises two side surface portions facing each other while being connected by the bottom portion, and a distance between the two side surface portions is equal to a width of the upper plate.
17. A battery pack comprising the battery module according to claim 16.
18. The battery module according to claim 1, wherein each stepped portion extends under the battery cell stack.
19. The battery module according to claim 1, wherein each stepped portion extends across an entire width in the first direction of the bottom portion of the frame.
20. The battery module according to claim 1, wherein each stepped portion is a reduction in a thickness of the bottom portion of the frame.