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Battery Pack and Vehicle Comprising Same

Abstract

Provided are a battery pack with structural stability of battery modules and improved energy density, and a vehicle comprising the same. The battery pack according to the present disclosure includes at least one battery module and a pack case for receiving the battery module, the battery module including a battery cell stack including at least one battery cell, and a pair of end plates provided in close contact with front and rear sides of the battery cell stack on two sides of a lengthwise direction of the battery cell, and the pack case including a tray in which the battery module is mounted on an upper surface, and a top cover of which an outer periphery is coupled in contact with an outer periphery of the tray on the upper surface of the tray when the battery module is received inside, and wherein the end plates provide a mechanical support to protect the battery cell.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] The present application is a continuation of U.S. application Ser. No. 17/765,237, filed on Mar. 30, 2022, which is a national phase entry under 35 U.S.C. § 371 of International Application No. PCT/KR 2020/009953 filed on Jul. 28, 2020 which claims priority to Korean Patent Application No. 10-2019-0124812 filed on Oct. 8, 2019 with the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD
[0002] The present disclosure relates to a battery pack and a vehicle comprising the same, and more particularly, to a battery pack having a structure for mounting battery modules with space efficiency and a vehicle comprising the same.
BACKGROUND ART
[0003] As opposed to primary batteries that are non-rechargeable batteries, secondary batteries are rechargeable batteries, and they are used in not only mobile devices but also Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV) running on electricity. Currently, widely used secondary batteries include lithium ion batteries, lithium polymer batteries, nickel cadmium batteries, nickel hydride batteries and nickel zinc batteries. The operating voltage of a unit secondary battery cell, i.e., a unit battery cell is about 2.5V to 4.6V. Accordingly, when higher output voltage is required, a battery pack is constructed by connecting battery cells in series. Additionally, a battery pack may be constructed by connecting battery cells in parallel according to the charge/discharge capacity required for the battery pack. Accordingly, the number of battery cells included in the battery pack may be differently set depending on the required output voltage or charge/discharge capacity.
[0004] When the battery pack is constructed by connecting battery cells in series/parallel, it is typical to form a battery module including at least one battery cell, preferably a plurality of battery cells, and construct a battery pack using at least one battery module with the addition of other elements. Here, the battery module includes the battery cells connected in series or in parallel, and the battery pack includes the battery modules connected in series or in parallel to increase the capacity and output.
[0005] FIG. **1** is a schematic diagram showing the battery module arrangement in the conventional battery pack, FIG. **2** is a cross-sectional view of the battery pack of FIG. **1** taken along the line II-II′, and FIG. **3** is a cross-sectional view of the battery pack of FIG. **1** taken along the line III-III′.
[0006] FIG. **1** shows a total of 8 battery modules **20** arranged in a 2×4 matrix in the X direction (horizontal, the lengthwise direction of the battery module) x Y direction (vertical, the widthwise direction of the battery module) on the X-Y plane. To show the arrangement of the battery modules

20 more clearly, some elements are omitted.
[0007] Describing the battery pack **1** with reference to FIGS. **1** to **3**, the battery modules **20** are mounted in a pack case **10**, and protected by a crash beam **30** that is a rigid structure.
[0008] The pack case **10** includes a tray **12** and a top cover **14**. The battery module **20** includes a plurality of battery cells **22** and a module housing **24** in which the battery cells **22** are received. The battery modules **20** are mounted on the tray **12** and the battery modules **20** and the tray **12** are fastened by a mounting bolt **40**. The top cover **14** and the tray **12** are assembled with a sealing element **50** interposed between the top cover **14** and a sidewall **12***a* of the tray **12**.
[0009] Since the battery module **20** includes the plurality of battery cells **22** in combination, when overvoltage, overcurrent or overheat occurs in some battery cells, a big problem occurs in the safety and operational efficiency of the battery module **20**, and accordingly the means for detecting and controlling the overvoltage, overcurrent or overheat is necessary. Accordingly, a voltage sensor is connected to the battery cells **22** to monitor and control the operational condition in real time or at a regular time interval. The detection means is mounted or connected by a plurality of wires, and conventionally, a wire harness **60** including the wires is disposed between the battery modules **20** across the center of the battery pack **1**.
[0010] The battery module **20** and the pack case **10** are separated from each other, and the battery module **20** is a basic unit of the battery pack **1**, and it is a structure including the battery cells **22** disposed in the pack case **10** and protected by the rigid structure of the pack case **10**. The pack case **10** is a rigid structure that protects the battery modules **20**.
[0011] In the case of an electric vehicle, an unexpected impact and vibration may be applied to the battery pack **1** while driving. In this case, electrical connection between the battery modules **20** may be disconnected, or the pack case **10** that supports the battery modules **20** may be deformed. Accordingly, the battery pack especially for an electric vehicle needs durability that is high enough to withstand an external impact and vibration.
[0012] To meet the need, the battery modules **20** are arranged on the tray **12** at a predetermined distance d from the pack case **10** to protect the battery modules **20**. To protect the battery modules **20** of the battery pack **1** from an external impact, there is a gap d to separate the area of the pack case **10** and the area of the battery module **20**. However, not only is there a separate space for the mounting bolt **40** in the module housing **24** of the battery module **20**, but also a space for maintaining the gap d is necessary, causing a loss of use of the internal space of the battery pack **1**.
[0013] The crash beam **30** is used to increase the mechanical strength of the battery pack **1**. Here, the crash beam **30** is a beam type structure installed in the tray **12** of the pack case **10**, and may be provided between the plurality of battery modules **20** in all directions of the battery modules **20** including the left-right direction, up-down direction and front-rear direction. The tray **12** having the crash beam **30** has high shock resistance and is invulnerable to an external impact or vibration. However, the area occupied by the crash beam **30** and the gap d between the crash beam **30** and the battery module **20** reduce the space for mounting the battery modules **20**. Moreover, when an essential component such as a cooling configuration, for example, a heat sink **70**, is added, the floor area ratio or energy density of the battery pack **1** including the same will be lower.
[0014] Moreover, the tray **12** may sag S down due to the weight of the battery modules **20**, and a space for a lower rigid structure for supporting the weight is necessary, causing a spatial loss.
[0015] Despite the practical difficulty of achieving the mechanical strength and energy density of the battery pack, recently there is a growing demand for battery packs satisfying the structural stability, cooling performance and high energy density requirements in the industrial field related to secondary batteries.

DISCLOSURE

Technical Problem

[0016] The present disclosure is designed to solve the above-described problem, and therefore the present disclosure is directed to providing a battery pack with structural stability of battery modules

and improved energy density.
[0017] The present disclosure is further directed to providing a vehicle comprising the battery pack.
[0018] These and other objects and advantages of the present disclosure will be understood by the following description and will be apparent from the embodiments of the present disclosure. Further, it will be readily understood that the objects and advantages of the present disclosure are realized by the means set forth in the appended claims and combinations thereof.

Technical Solution

[0019] To achieve the above-described object, a battery pack according to the present disclosure includes at least one battery module and a pack case for receiving the battery module, the battery module including a battery cell stack including at least one battery cell, and a pair of end plates provided in close contact with front and rear sides of the battery cell stack on two sides of a lengthwise direction of the battery cell, and the pack case including a tray in which the battery module is mounted on an upper surface, and a top cover of which an outer periphery is coupled in contact with an outer periphery of the tray on the upper surface of the tray when the battery module is received inside, wherein the end plates provide a mechanical support to protect the battery cell.
[0020] The end plates protect the battery cell from an impact applied to the front and rear sides of the battery cell stack.
[0021] In an embodiment, the battery module includes a busbar frame assembled on the front and rear sides of the battery cell stack, an insulating cover coupled to an outer side of the busbar frame and a side plate coupled to an outermost battery cell of the battery cell stack, and the end plates are a plate-shaped structure that covers the outer side of the insulating cover.
[0022] In the present disclosure, the battery pack may further include a sealing element interposed between the outer periphery of the tray and the outer periphery of the top cover coupled in contact with each other.
[0023] The top cover may have, at the outer periphery, a fastening extension portion that is bent and extends in an outward direction of the battery pack for fastening to the tray, and a fastening element may be inserted into the fastening extension portion.
[0024] Here, the tray may have, at the outer periphery, a step that is bent up from a mounting area of the battery module to match the fastening extension portion, and the step may be coupled to the fastening extension portion by the fastening element at a sidewall disposed on the step.
[0025] Also, here, any one of the pair of end plates may have a flange, the flange may be disposed at a height between the fastening extension portion of the top cover and the step of the tray so that the flange is placed on the sidewall, and a fastening element may be inserted into the flange.
[0026] Also, here, a fastening seat may be formed at the bottom of the other of the pair of end plates, and a fastening element may be inserted into a bracket installed in the tray through the fastening seat.
[0027] Preferably, a wire harness is disposed in a space between the top cover and the sidewall.
[0028] In particular, preferably, the pair of end plates are shared between the plurality of battery modules to integrally connect the plurality of battery modules.
[0029] In a specific example, the battery modules are arranged in a 2×n (n is 1 or greater) matrix in the X direction (the lengthwise direction of the battery cell)×Y direction on an X-Y plane, the battery modules placed side by side along the X direction are arranged such that terminals face each other, and the pair of end plates are shared between the battery modules placed along the Y direction.
[0030] In this case, preferably, the end plate placed on an outer side of the battery pack among the pair of end plates has a flange, the flange is disposed at a height between the fastening extension portion of the top cover and the step of the tray so that the flange is placed on the sidewall, a fastening element is inserted into the flange, a fastening seat is formed at the bottom of the end plate on an inner side of the battery pack among the pair of end plates, and a fastening element is inserted into a bracket installed in the tray through the fastening seat.

[0031] In another embodiment, the battery module further includes a busbar frame assembled on the front and rear sides of the battery cell stack, an insulating cover coupled to an outer side of the busbar frame, and a side plate coupled to an outermost battery cell of the battery cell stack, wherein the two battery modules are coupled by a center plate to form a large module, and at least one large module is included in the battery pack.
[0032] Preferably, at least two large modules are arranged in a direction, and the pair of end plates are shared on an outer side of the insulating cover to form a sub pack.
[0033] In this instance, two sub packs may be arranged along the lengthwise direction of the battery cell.
[0034] Preferably, an empty space is formed between adjacent large modules in the sub pack.
[0035] A pack side beam may be further coupled to an outer side of at least one of the pair of end plates.
[0036] The pack side beam may be a sidewall of the tray.
[0037] Furthermore, according to the present disclosure, there may be provided a vehicle comprising the battery pack. The vehicle may include an electric vehicle (EV) or a hybrid electric vehicle (HEV).

Advantageous Effects

[0038] According to an aspect of the present disclosure, there is provided a battery pack having a structure for mounting battery modules with space efficiency.
[0039] According to another aspect of the present disclosure, it is possible to increase the strength and floor area ratio of the battery pack. It is possible to increase the floor area ratio of the battery cell/battery pack by 9% or higher.
[0040] According to still another aspect of the present disclosure, two battery modules are treated as a unit of array, and the array is diversified through extension of one unit, thereby freely realizing the battery pack in various capacities.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] The accompanying drawings illustrate the embodiments of the present disclosure, and together with the detailed description of the present disclosure described below, serve to provide a further understanding of the technical aspects of the present disclosure, and thus the present disclosure should not be construed as being limited to the drawings.
[0042] FIG. **1** is a schematic diagram showing the battery module arrangement in a conventional battery pack.
[0043] FIG. **2** is a cross-sectional view of the battery pack of FIG. **1** taken along the line II-II′.
[0044] FIG. **3** is a cross-sectional view of the battery pack of FIG. **1** taken along the line III-III′.
[0045] FIG. **4** is a schematic diagram showing the battery module arrangement in a battery pack according to an embodiment of the present disclosure.
[0046] FIG. **5** is a cross-sectional view of the battery pack of FIG. **4** taken along the line V-V′.
[0047] FIG. **6** is an exploded diagram of FIG. **5** before assembly.
[0048] FIG. **7** is a diagram showing a battery module included in a battery pack according to an embodiment of the present disclosure.
[0049] FIG. **8** is a diagram showing a comparison between the conventional battery pack and a battery pack according to an embodiment of the present disclosure.
[0050] FIG. **9** is a top view of a battery pack according to another embodiment of the present disclosure.
[0051] FIG. **10** is a diagram showing a battery module included in the battery pack of FIG. **9**.
[0052] FIG. **11** is a diagram showing a large module including two integrated battery modules of

FIG. **10**.
[0053] FIG. **12** is a diagram showing a sub pack including three integrated large modules of FIG. **11**.
[0054] FIG. **13** is a diagram showing a vehicle according to still another embodiment of the present disclosure.
DETAILED DESCRIPTION
[0055] The present disclosure will be apparent by describing the preferred embodiments of the present disclosure in detail with reference to the accompanying drawings. It should be understood that the disclosed embodiments are provided for illustration purposes to help the understanding of the present disclosure, and the present disclosure may be embodied in a variety of different forms other than the disclosed embodiments. Additionally, to help the understanding of the present disclosure, the accompanying drawings are not shown in the actual scale, and some components may be exaggerated.
[0056] That is, the embodiments described herein and illustrations shown in the drawings are just a most preferred embodiment of the present disclosure, but not intended to fully describe the technical aspects of the present disclosure, so it should be understood that other equivalents and modifications could be made thereto at the time of filing the application.
[0057] FIG. **4** is a schematic diagram showing the battery module arrangement in a battery pack according to an embodiment of the present disclosure. FIG. **5** is a cross-sectional view of the battery pack of FIG. **4** taken along the line V-V′. FIG. **6** is an exploded diagram of FIG. **5** before assembly. FIG. **7** is a diagram showing the battery module included in the battery pack according to an embodiment of the present disclosure.
[0058] FIG. **4** shows an example of a total of 8 battery modules **200** arranged in a 2×4 matrix in the X direction (horizontal, the lengthwise direction of the battery module in which each column is defined)×Y direction (vertical, the widthwise direction of the battery module in which each row is defined) on the X-Y plane. However, the battery pack of the present disclosure is not limited to the arrangement of the battery pack A shown in FIG. **4**. The battery pack of the present disclosure may have any modification to the specific structure of 2 rows and 4 columns depending on the required capacity and a structure in which the battery pack is mounted. Basically, the battery modules are arranged in 2×n (n is 1 or greater) matrix.
[0059] Meanwhile, the battery pack A may further include various types of devices (not shown) such as, for example, a Battery Management System (BMS), a current sensor and a fuse to control the charge/discharge of the battery modules **200**. To illustrate the arrangement of the battery modules **200** more clearly, some elements are omitted in FIG. **4**. The battery modules **200** include terminals t, and for example, the battery modules **200** disposed in the same column may be arranged such that the terminals t face each other. That is, the battery modules **200** placed side by side along the X direction may be arranged such that the terminals t face each other.
[0060] Describing the battery pack A according to an embodiment of the present disclosure with reference to FIGS. **4** to **7**, the battery pack A includes at least one battery module **200** and a pack case **100** in which the battery modules **200** are received.
[0061] In the shown example, two battery modules **200** are mounted along the X direction in the pack case **100**. For convenience of description, the battery module disposed on the left side in the drawings is referred to as a first battery module **200***a*, and the battery module disposed on the right side is referred to as a second battery module **200***b*. In FIG. **4**, the first battery module **200***a* is in the first row, and the second battery module **200***b* is in the second row. Each battery module **200***a*, **200***b* does not use the crash beam that is the rigid structure provided in the tray, and instead, includes an end plate **240** having a similar, possibly equivalent, rigidity. Each of the battery modules **200***a*, **200***b* basically includes at least battery cell **212** and a pair of end plates **240** provided on two sides of the lengthwise direction the battery cell **212**.
[0062] As shown in FIG. **7**, in detail, the battery modules **200** may include a battery cell stack **214**

including at least one battery cell **212**, preferably, a plurality of battery cells **212**, and various types of components. For example, the battery cell **212** may be a pouch-type secondary battery, and the plurality of battery cells **212** may be electrically connected to each other.

[0063] Although not shown, each battery cell **212** may include various components, for example, an electrode assembly, a battery case in which the electrode assembly is received and an electrode lead extending out of the battery case and electrically connected to the electrode assembly. The electrode lead may include a positive electrode lead and a negative electrode lead, the positive electrode lead may be connected to a positive electrode plate of the electrode assembly, and the negative electrode lead may be connected to a negative electrode plate of the electrode assembly. Additionally, in the case of a bidirectional battery, the positive electrode lead and the negative electrode lead may respectively extend to the two sides of the lengthwise direction of the battery cell **212**. In the case of a unidirectional battery, the positive electrode lead and the negative electrode lead may extend to one side of the lengthwise direction of the battery cell **212** side by side. The positive electrode lead and the negative electrode lead are connected to each other through a connecting structure such as a busbar to electrically connect the plurality of battery cells **212**.

[0064] The battery module **200** may further include a frame for stacking to stack and protect the pouch-type secondary batteries. The frame for stacking is the means for stacking the secondary batteries, and plays a role in not only holding the secondary batteries to prevent them from moving, but also stacking the secondary batteries to guide the assembly of the secondary batteries. For reference, the frame for stacking may be interchangeably used with a variety of other terms such as a cell cover or a cartridge.

[0065] In the case of a bidirectional battery, a busbar frame **220** may be assembled on the sides where the positive electrode lead and the negative electrode lead extend, i.e., the front and rear sides of the battery cell stack **214**. The busbar frame **220** includes a busbar assembled with a frame, and is coupled to the electrode leads of the battery cells **212** to connect the battery cells **212**. An insulating cover **224** may be further coupled to the outer side or face of the busbar frame **220**. The insulating cover **224** may be made of a reinforced plastic having high electrical insulation and shock resistance.

[0066] A side plate **226** may be further coupled to the outermost battery cell **212** of the battery cell stack **214**. The side plate **226** may be made of, for example, a metal such as aluminum (Al). All metals may be used, but in view of thermal conductivity, machinability and costs, steel or aluminum is desirable. Due to being lightweight, aluminum is especially desirable. As shown in FIGS. **2** and **3**, the conventional battery module **20** requires the module housing **24** that wraps around the entire surface of the battery cells **22**, but the battery module **200** included in the battery pack A according to an embodiment of the present disclosure covers the front and rear surfaces and the sides with the upper surface and the lower surface of the battery cell stack **214** being exposed to the outside, and this structure is advantageous to reduce the weight.

[0067] The end plates **240** are configured to protect and affix the battery cell stack **214** in the battery module **200**, and a pair of end plates **240** may be provided on the two sides of the lengthwise direction in the battery module **200** while not affecting the electrically connected part between the plurality of battery cells **212**. In this embodiment, the end plates **240** are provided in close contact with the front and rear sides of the battery cell stack **214**. For convenience of description, in the drawings, among the pair of end plates **240**, the end plate placed on the outer side of the battery pack A is referred to as a first end plate **240***a*, and the end plate placed on the inner side of the battery pack A is referred to as a second end plate **240***b*.

[0068] The end plates **240** may be individually provided for each battery module **200**, and the end plates **240** may be shared between the battery modules **200** to integrally connect the plurality of battery modules **200**. In an example, other first battery modules in front and rear of the first battery module **200***a*, i.e., battery modules in the first row arranged along Y direction in FIG. **4**, may share

a pair of end plates **240**. Likewise, other second battery modules in front and rear of the second battery module **200***b*, i.e., battery modules in the second row arranged along Y direction in FIG. **4**, may share a pair of end plates **240**.

[0069] Preferably, the plurality of battery modules **200** shares the pair of end plates **240** to ensure structural integrity as one. Accordingly, it would be easy to handle the plurality of battery modules **200** and assemble the battery pack A.

[0070] The end plate **240** may be a plate-shaped structure that covers at least one surface of the battery cell stack **214** in the battery module **200**, and in this embodiment, the outer side or face of the insulating cover **224**. The end plate **240** is preferably made of a metal having high mechanical strength and thermal conductivity, and the end plate **240** may replace the crash beam of the conventional battery pack structure. That is, the end plate **240** provides the mechanical support to protect the battery cells **212**. The end plate **240** may be made of a metal, for example, aluminum or steel and an extruded material, and other materials may be used.

[0071] The pack case **100** includes a tray **110** and a top cover **140**. The battery modules **200** are mounted on the upper surface of the tray **110**. A heat sink **170** may be placed on the tray **110** and the battery modules **200** may be mounted thereon. Due to the increased strength of the battery module **200** itself, it is possible to manufacture the pack case **100** included in the battery pack of the present disclosure with a slimmer design than the conventional pack case.

[0072] Although not shown, the battery module **200** may further include a cooling fin interposed between the battery cells **212**. The cooling fin is a thin element having thermal conductivity such as aluminum, with the end extending outward, and is connected to a heat absorbing medium such as the heat sink **170** to transmit heat from the battery cells **212** to the outside.

[0073] The tray **110** provides a space in which the plurality of battery modules **200** is placed. The top cover **140** is configured to package and receive the plurality of battery modules **200** together with the tray **110**.

[0074] The tray **110** and the top cover **140** may have a plate-shaped part having a generally wide area in mounting areas **111**, **141** of the battery modules **200**, and the cross section of the tray **110** and the top cover **140** may be a hat shape. The tray **110** and the top cover **140** are respectively disposed below and above the battery modules **200** to cover the lower part and the upper part of the battery modules **200**, respectively.

[0075] The top cover **140** may have, at the outer periphery, a fastening extension portion **142** that is bent and extends in the outward direction of the battery pack A for fastening to the tray **110**, and the fastening extension portion **142** may have a plurality of first holes into which a fastening element P**1** is inserted. The fastening element P**1** may include, for example, a bolt or a rivet, and it may be advantageous to use a bolt when taking each battery module **200** from the pack case **100** to repair.

[0076] The tray **110** may have, at the outer periphery, a step **112** that is bent up from the mounting area **111** of the battery module **200** to match the fastening extension portion **142** of the top cover **140**. A sidewall **112***a* may be provided on the step **112**. When the step **112** is high, the sidewall **112***a* may be omitted. The step **112** and the sidewall **112***a* may be a single component, or may be formed by coupling the components. The sidewall **112***a* may have a plurality of second holes in communication with the first holes of the fastening extension portion **142**. The top cover **140** and the tray **110** may be coupled by inserting the fastening element P**1** into the first holes and the second holes. The fastening element P**1** may fix the top cover **140** and the tray **110** by applying the pressure to the fastening extension portion **142** of the top cover **140** and the step **112** and part of the sidewall **112***a* of the tray **110** on the upper surface of the top cover **140**. Preferably, a sealing element **150** is interposed between the fastening extension portion **142** of the top cover **140** and the sidewall **112***a* on the step **112** of the tray **110**. The outer periphery of the top cover **140** is coupled to the outer periphery of the tray **110** in contact with each other on the upper surface of the tray **110**. The sealing element **150** is included in close contact between the outer periphery of the tray **110** and the outer periphery of the top cover **140** coupled in contact with each other. The sealing

element **150** prevents a wire harness **160** from being exposed to water going through the side of the battery pack A.

[0077] Preferably, the first end plate **240***a* has a flange **242**. The flange **242** may be disposed at the height between the fastening extension portion **142** of the top cover **140** and the step **112** of the tray **110** so that the flange **242** may be placed on the sidewall **112***a*. The flange **242** may have a third hole into which a fastening element P**2** is inserted. Additionally, the sidewall **112***a* may have a fourth hole at an inner position of the battery pack A than the second hole, the fourth hole being in communication with the third hole of the flange **242**. The first end plate **240***a* and the tray **110** may be coupled by inserting the fastening element P**2**. The fastening element P**2** may include, for example, a bolt or a rivet, and it may be advantageous to use a bolt when taking each battery modules **200** from the pack case **100** to repair. The fastening element P**2** may affix the flange **242** and the tray **110** by applying the pressure to the flange **242** and the step **112** and part of the sidewall **112***a* of the tray **110** on the upper surface of the flange **242**. The size and height of the flange **242** may be adjusted to correspondingly fit or align with the sidewall **112***a* on which the flange **242** is placed.

[0078] A fastening seat **246** may be formed on the bottom of the second end plate **240***b*, and for example, the second end plate **240***b* and the tray **110** may be coupled by installing a bracket **180** at a location corresponding to the fastening seat **246** at approximately the center of the tray **110**, and inserting a fastening element P**3**. The fastening element P**3** may include, for example, a bolt or a rivet, and it may be advantageous to use a bolt to allow for removability when taking each battery module **200** from the pack case **100** to repair. The fastening element P**3** may fix the second end plate **240***b* and the tray **110** by applying pressure to the fastening seat **246** and the bracket **180** on the upper surface of the tray **110**.

[0079] Meanwhile, the tray **110** may be an assembly type tray by assembling the sidewall **112***a* and the bracket **180**, or an integrally molded structure. In the case of integral molding, it is possible to reduce the number of components and the number of assembly processes, contributing to cost savings.

[0080] The pack case **100** may be made of plastic resin. In this case, pack case **100** may be produced by the injection molding process. In the injection molding, it is easy to form the fastening extension portion **142** of the top cover **140**, the first holes, the step **112** of the tray **110**, the sidewall **112***a*, the second holes and the fourth holes. The pack case **100** may be made by vacuum molding. That is, due to the simple cross section of the tray **110** and the top cover **140** in the shape of a hat, the shape may be formed through vacuum pressuring after placing the raw material of a solid sheet of uniform thickness on the mold.

[0081] The pack case **100** may be made of a metal, for example, steel such as high tensile steel. In this case, the pack case **100** may be produced by drawing type cold molding. Due to the simple cross section of the tray **110** and the top cover **140** in the shape of a hat, the shape may be formed through at least one drawing after placing the high tensile steel of uniform thickness on the mold. It is also contemplated that the pack case **100** may be formed by blow molding, compression molding, extrusion molding, etc.

[0082] Since the battery module **200** includes the plurality of battery cells **212** in combination, when overvoltage, overcurrent or overheat occurs in some battery cells, a big problem occurs in the safety and operational efficiency of the battery module **200**, and accordingly the means for detecting and controlling the overvoltage, overcurrent or overheat is necessary. Accordingly, a voltage sensor is connected to the battery cells **212** to monitor and control the operational condition in real time or at a regular time interval. The detection means is mounted or connected by a plurality of wires, and as opposed to the conventional art, the present disclosure does not place the wire harness **160** including the wires at the center of the battery pack A between the battery modules **200**, and may be disposed on each of the two outer sides of the battery modules **200**. In particular, the wire harness **160** is disposed in a space between the top cover **140** and the sidewall

112*a*.

[0083] In the present disclosure, the end plates **240***a*, **240***b* of the battery module **200** replace the crash beam of the conventional battery pack. The flange **242** is applied to the first end plate **240***a* disposed at the outer side like a T-shaped structure, the outer periphery of the top cover **140** may be lowered down to the tray **110** accordingly. That is, the fastening extension portion **142** may be lowered down to meet the tray **110**. The fastening element P**1** may be fastened to that location. By this structure, the wire harness **160** may be disposed at each of the two outer sides of the battery modules **200**.

[0084] Instead of the conventional pack case, the end plates **240** may play a role in providing the mechanical support for the battery modules **200**, and protecting the battery modules **200** from an external impact. In particular, the end plates **240** may protect the battery cells **212** from impacts applied to the front and rear sides of the battery cell stack **214**. The tray **110** and the top cover **140** may maintain a hermetic function as a cover.

[0085] Conventionally, rigidity is only provided to the pack case to protect the battery modules in the pack case, but the present disclosure gives rigidity to the battery modules **200** through the end plates **240**. The end plates **240** of the battery modules **200** forms a rigid structure in each direction of the battery pack A.

[0086] According to the present disclosure, the battery modules **200** themselves form part of the rigid structure of the battery pack A, and may act as a structure of the battery pack A. The pack case **100** may maintain a hermetic function as a cover. Accordingly, it is possible to simplify the fabrication of the component/structure. According to the present disclosure, rigidity/space integration of the battery pack and the battery modules is achieved by integration of rigidity, and as a result of omitting the required gap between the pack case and the battery modules and the structure such as the crash beam, the highest floor area ratio effect is provided, which minimizes the amount of open space within the battery pack and battery modules to secure the components in place.

[0087] FIG. **8** is a diagram showing a comparison between the conventional battery pack **1** and the battery pack A according to an embodiment of the present disclosure.

[0088] When comparing the positions of the sealing elements **50**, **150**, the sealing element **150** of the battery pack A according to an embodiment of the present disclosure may be disposed at the outer lower location than the conventional battery pack **1**. Conventionally, the wire harness **60** is integrally disposed between the battery modules **20**, but in the present disclosure, the wire harness **160** is disposed on each of the two outer sides of the battery modules **200**.

[0089] Conventionally, the sealing element **50** is disposed on top of the sidewall **12***a* of the pack case. Since the sealing element **50** occupies some areas to perform a hermetic function, it is difficult to reduce the size of the sidewall **12***a* that supports the sealing element **50**. With the flange **242** of the end plates **240**, the present disclosure may lower the location of the sealing element **150**. Accordingly, a new empty space is created between the top cover **140** and the sidewall **112***a*. Conventionally, the wire harness **60** is (integrally) placed between the crash beams **30**, requiring a large central empty space. In the present disclosure, the wire harness **160** is placed on each of the two outer sides and disposed at a new empty space created between the top cover **140** and the sidewall **112***a*. Accordingly, it is possible to reduce the empty space at the center inside the battery pack A. When the size of the battery packs **1**, A is the same, it is possible to make the size of the battery module **200** larger than the battery module **20**. In particular, in the present disclosure, the end plates **240***a*, **240***b* of the battery module **200** replace the crash beam **30** of the conventional battery pack **1**, so it is possible to make use of a space created by eliminating the crash beam **30** disposed at the center of the battery pack **1**. Accordingly, as shown in FIG. **8**, when the length of the conventional battery module **20** is L**1**, the length of the battery module **200** according to the present disclosure is L**2**, and when comparing L**1** with L**2**, it can be seen that it is possible to significantly increase the space of the battery modules **200**.

[0090] According to the present disclosure, it is possible to easily fix and mount the battery modules **200** on the tray **110** using the end plates **240** and the fastening elements P**2**, P**3**, and increase the mechanical strength of the battery modules **200** through the end plates **240**. Additionally, it is possible to efficiently make use of the space in which the wire harness **160** is placed in the pack case **100**. Accordingly, it is possible to mount the battery modules **200** in the battery pack A with space efficiency, thereby improving the space utility. As the length L**2** of the battery module **200** increases, it is possible to increase the space for the battery modules **200**, thereby increasing the floor area ratio of the battery pack A, i.e., reducing the amount of empty or unoccupied space within the battery pack.

[0091] Hereinafter, a battery pack according to another embodiment of the present disclosure will be described with reference to FIGS. **9** to **12**. In the drawings and description, the same reference numerals are given to the same elements as the previous embodiment, and redundant description is omitted herein.

[0092] FIG. **9** is a top view of another battery pack according to another embodiment of the present disclosure.

[0093] Referring to FIG. **9**, the battery pack B includes battery modules **200**′ arranged in a 2×6 matrix having two more columns than FIG. **4**. The battery modules **200**′ are placed on the tray **110**. The sealing element **150** is placed on the outer periphery of the tray **110**. The sealing element **150** is, for example, a gasket.

[0094] FIG. **10** is a diagram showing the battery module included in the battery pack of FIG. **9**.

[0095] Referring to FIG. **10**, in the same way as the battery module **200**, the battery module **200**′ includes the battery cell **212**, the busbar frame **220**, the insulating cover **224** and the side plate **226**.

[0096] FIG. **11** shows a large module **250** including two integrated battery modules **200**′ of FIG. **10**. The large module **250** may include two battery modules **200**′ arranged side by side in the Y direction. The large module **250** may include a center plate **230** including an empty space between the two battery modules **200**′. The center plate **230** may play a role in coupling the two battery modules **200**′ while keeping them spaced a uniform distance apart from each other. The center plate **230** includes an empty space, and may play a role in absorbing cell swelling during a contraction of the space.

[0097] The conventional battery pack **1** includes a plurality of battery modules **20** by the unit of the battery module **20**, while in the battery pack B according to another embodiment of the present disclosure, the two battery modules **200**′ coupled by the center plate **230** forms a large module **250** as a basic unit. Accordingly, double battery cells may be a basic unit of an array. For example, when one battery module **20**, **200**′, includes 24 battery cells, the large module **250** includes 48 battery cells.

[0098] FIG. **12** is a diagram for describing a sub pack **260** including the integrated large modules **250** of FIG. **11**.

[0099] The sub pack **260** may include at least two large modules **250** arranged in a direction, and in this embodiment, in the Y direction. In this embodiment, for example, to complete a 2×6 arrangement, three large modules **250** may be arranged. That is, the sub pack **260** is an extension of the large module **250** that is a basic unit of an array. The sub pack **260** is an integration of six battery modules **200**′. The sub pack **260** has an empty space g between the adjacent large modules **250** (see FIG. **9**). Accordingly, when an external impact is applied to the battery pack B, the impact is scarcely transmitted into the battery modules **200**′ across the large modules **250**, thereby preventing the battery module **200**′ from being damaged. Additionally, due to the empty space g, when an event, for example, a fire, occurs in one large module **250**, it is possible to prevent the fire from spreading to the other large module **250**, thereby ensuring the safety of the battery pack B while in use.

[0100] In the large modules **250** arranged along the Y direction, the pair of end plates **240** are coupled on two sides along the Y direction. The previous example describes that the plurality of

battery modules **200** shares the pair of end plates **240**, and that is the example. The pair of end plates **240** are shared on the outer side of the insulating cover **224** of each battery module **200′**. Here, to reinforce rigidity, an example is presented in which a pack side beam **270** may be further coupled to at least one of the pair of end plates **240**. In particular, the pack side beam **270** placed on the outer side of the battery pack B may be the sidewall **112***a* of the tray **110** mentioned in the previous embodiment. The pack side beam **270** and the sidewall **112***a* may co-exist, or the pack side beam **270** and the sidewall **112***a* may match.

[0101] The end plates **240** and the pack side beams **270** fasten the plurality of large modules **250** at the same time, for example, through fastening of a bolt **280**. Since the end plate **240** is made of a material having rigidity, the sub pack **260** becomes a unit structure having rigidity that is high enough to be regarded as the battery pack, and it is easy to handle, and facilitate the assembling of the battery pack B.

[0102] Conventionally, when mounting the battery module on the tray or replacing the battery module, it is necessary to align each battery module with the pack case and the crash beam in the front-rear and left-right directions, resulting in low operational performance. However, according to the present disclosure, it is easy to handle for each sub pack **260**, resulting in high operational performance.

[0103] In this embodiment, to complete the 2×6 arrangement, two sub packs **260** are placed side by side along the X direction, i.e., the lengthwise direction of the battery cell. To satisfy arrangements other than the 2×6 arrangement, those skilled in the art may change the number of sub packs and the number of large modules included in the sub pack. As described above, the present disclosure treats the large module including two battery modules **200′** as a unit of an array, and achieves various arrays through extension of one unit, thereby freely realizing the battery pack in various capacities.

[0104] As described above, in this embodiment, in particular, connection between the battery modules **200′** in the sub pack **260** is established by the end plates **240**, and thus the rigid structure necessary for the battery pack B is completed by the unit of the sub pack **260**. In the same way as the previous embodiment, the battery pack B may further include the pack case **100** to maintain a hermetic function as a cover. Accordingly, it is possible to simplify the fabrication of the component/structure, and in particular, the component/structure of the pack case **100**.

[0105] As mentioned previously, the conventional battery pack **1** has a spatial loss due to the gap between the battery modules **20**, and the gap between the battery modules **20** and the pack case **10**. The present disclosure does not need these gaps. When the large module **250** includes 48 battery cells, the simulation results show 9% increase in floor area ratio compared to the conventional battery pack **1** including the battery module **20** including 24 battery cells. According to the present disclosure, it is possible to increase the strength and floor area ratio of the battery pack.

[0106] FIG. **13** is a diagram showing a vehicle according to still another embodiment of the present disclosure.

[0107] Referring to FIG. **13**, the vehicle C may include the battery pack A or the battery pack B of the previous embodiment. In the shown example, the vehicle C includes the battery pack A. The vehicle C may be an electric vehicle or a hybrid electric vehicle, a vehicle using the battery pack A as a source of fuel.

[0108] The vehicle C according to this embodiment includes the battery pack A of the previous embodiment, and includes all the advantages of the battery pack A of the previous embodiment. In addition to the vehicle C, obviously, the battery pack A may be provided in an energy storage device or other device or equipment using the battery pack A as a source of energy.

[0109] According to various embodiments as described above, there may be provided a battery pack with improved energy density and a vehicle including the battery pack.

[0110] While the preferred embodiments of the present disclosure have been hereinabove shown and described, the present disclosure is not limited to the above-described specific preferred

embodiment, and it is obvious to those skilled in the art that many modifications may be made thereto without departing from the subject matter of the present disclosure set forth in the appended claims, and such modifications fall in the scope of the appended claims.
[0111] It is noted that the terms indicating directions as used herein such as upper, lower, left, right, front and rear are used for convenience of description only, and it is obvious to those skilled in the art that the term may change depending on the position of an observer or the stated elements.

Claims

1. A battery pack comprising: at least one battery module including: a battery cell stack including at least one battery cell; and a pair of end plates abutting opposing sides of the battery cell stack on two sides in a lengthwise direction of the battery cell, and a pack case for receiving the battery module, the pack case including: a tray in which the battery module is coupled on an upper surface; and a top cover having an outer periphery which is coupled with an outer periphery of the tray on the upper surface of the tray when the battery module is received in the pack case, and wherein the top cover has, at the outer periphery, a fastening extension portion that is bent and extends in an outward direction of the battery pack for fastening to the tray.
2. The battery pack according to claim 1, wherein the battery module includes: a busbar frame assembled on the opposing sides of the battery cell stack; an insulating cover coupled to an outer side of the busbar frame; and a side plate coupled to an outermost battery cell of the battery cell stack, wherein the end plates are a plate-shaped structure that cover an outer side of the insulating cover.
3. The battery pack according to claim 1, further comprising: a sealing element interposed between the outer periphery of the tray and the outer periphery of the top cover.
4. The battery pack according to claim 1, wherein a fastening element is inserted into the fastening extension portion.
5. The battery pack according to claim 4, wherein the tray has, at the outer periphery, a step that is bent from a mounting area of the battery module to match the fastening extension portion, and the step is coupled to the fastening extension portion by the fastening element at a sidewall disposed on the step.
6. The battery pack according to claim 5, wherein any one of the pair of end plates has a flange disposed between the fastening extension portion of the top cover and the step of the tray, so that the flange is positioned on the sidewall, and a fastening element is inserted into the flange.
7. The battery pack according to claim 6, wherein a fastening seat is formed at an end of the other of the pair of end plates, and a fastening element is inserted through the fastening seat into a bracket installed in the tray.
8. The battery pack according to claim 6, wherein a wire harness is disposed in a space between the top cover and the sidewall.
9. The battery pack according to claim 1, wherein the pair of end plates are shared between the plurality of battery modules to integrally connect the plurality of battery modules.
10. The battery pack according to claim 9, wherein the battery modules are arranged in a 2×n (n is 1 or greater) matrix in an X direction (the lengthwise direction of the battery cell)×Y direction on an X-Y plane, the battery modules placed side by side along the X direction are arranged such that terminals face each other, and the pair of end plates are shared between the battery modules placed along the Y direction.
11. The battery pack according to claim 10, wherein an end plate placed on an outer side of the battery pack among the pair of end plates has a flange disposed between the fastening extension portion of the top cover and the step of the tray so that the flange is placed on the sidewall, and a fastening element is inserted into the flange, and a fastening seat is formed at an end of an end plate on an inner side of the battery pack among the pair of end plates, and a fastening element is

inserted through the fastening seat into a bracket installed in the tray.

12. The battery pack according to claim 1, wherein the battery module further includes: a busbar frame assembled on the opposing sides of the battery cell stack; an insulating cover coupled to an outer side of the busbar frame; and a side plate coupled to an outermost battery cell of the battery cell stack, wherein the two battery modules are coupled by a center plate to form a large module, and at least one large module is included in the battery pack.

13. The battery pack according to claim 12, wherein at least two large modules are arranged in a direction, and the pair of end plates are shared on an outer side of the insulating cover to form a sub pack.

14. The battery pack according to claim 13, wherein two sub packs are arranged along the lengthwise direction of the battery cell.

15. The battery pack according to claim 13, wherein an empty space is formed between adjacent large modules in the sub pack.

16. The battery pack according to claim 13, wherein a pack side beam is further coupled to an outer side of at least one of the pair of end plates.

17. A vehicle comprising the battery pack according to claim 1.