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SECONDARY BATTERY AND METHOD OF MANUFACTURING A SECONDARY BATTERY

Abstract

A secondary battery includes a subplate connected at a first end to a plurality of tabs of an electrode assembly, an insulator coupled to the subplate, and a cap plate configured to receive a bottom portion of the insulator, wherein the subplate extends through the insulator and the cap plate to expose a second end of the subplate is exposed to outside of the secondary battery.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to and the benefit of Korean Application No. 10-2024-0023747, filed on Feb. 19, 2024, in the Korean Intellectual Property Office, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

1. Field

[0002] The present disclosure relates to secondary batteries and methods of manufacturing the secondary batteries.

2. Description of the Related Art

[0003] Unlike primary batteries that are not designed to be (re) charged, secondary (or rechargeable) batteries are batteries that are designed to be discharged and recharged. Low-capacity secondary batteries are used in portable, small electronic devices, such as smart phones, feature phones, notebook computers, digital cameras, and camcorders, while large-capacity secondary batteries are widely used as power sources for driving motors in hybrid vehicles and electric vehicles and for storing power (e.g., home and/or utility scale power storage). A secondary battery generally includes an electrode assembly composed of a positive electrode and a negative electrode, a case accommodating the same, and electrode terminals connected to the electrode assembly.

[0004] Among secondary batteries, a side terminal cell has a cell structure in which positive and negative terminals are positioned on opposite sides of a secondary battery. Each of such side terminal cells may include electrode assemblies, subtabs, current collectors, rivets, terminal plates, and the like. One problem, however, is that each of these components may have a unique resistance, and as the number of components increases, the performance of the cell may decrease as the component resistance increases.

[0005] The above information disclosed in this Background section is for enhancement of understanding of the background of the present disclosure, and therefore, it may contain information that does not constitute related (or prior) art.

SUMMARY

[0006] Embodiments of the present disclosure provide a secondary battery and method of manufacturing same.

[0007] These and other aspects and features of the present disclosure will be described in or will be apparent from the following description of embodiments of the present disclosure.

[0008] Some secondary batteries of the present disclosure include a subplate connected at a first end to a plurality of tabs of an electrode assembly, an insulator coupled to the subplate, and a cap plate configured to receive a bottom portion of the insulator, wherein the subplate extends through the insulator and the cap plate to expose a second end of the subplate to outside of the secondary battery.

[0009] According to some embodiments, a side of the subplate has a thickness of 0.5 mm to 1.0 mm. a side of the subplate has a thickness of 0.5 mm to 1.0 mm.

[0010] According to some embodiments, the thickness of the subplate is constant.

[0011] According to some embodiments, the tabs of the electrode assembly are electrically connected to the subplate by laser welding or ultrasonic welding.

[0012] According to some embodiments, the tabs of the electrode assembly are connected to a front surface and a rear surface of the subplate.

[0013] According to some embodiments, the cap plate comprises a cap plate through-hole through which the subplate extends.
[0014] According to some embodiments, the insulator comprises an insulator through-hole through which the subplate extends.
[0015] According to some embodiments, a lower surface of the insulator is coupled to an upper surface of the cap plate, and an inner surface of the insulator through-hole is coupled to an intermediate portion of the subplate.
[0016] According to some embodiments, the secondary battery further includes a sealing part positioned between the subplate and the cap plate. a sealing part positioned between the subplate and the cap plate.
[0017] According to some embodiments, a second end of the subplate is positioned higher than a top surface of the insulator.
[0018] According to some embodiments, the secondary battery further includes a sealing part positioned between the subplate and the cap plate and a case configured to receive the electrode assembly, the case comprising a first open area and a second open area opposite the first open area, wherein the cap plate comprises a first cap plate disposed over the first open area and a second cap plate disposed over the second open area.
[0019] According to some embodiments, the subplate comprises a first subplate comprising a first end and a second end, the first subplate corresponding to a positive electrode and a second subplate comprising a first end and a second end, the second subplate corresponding to a negative electrode, and a first end the first subplate is connected to corresponding tabs of the tabs of the electrode assembly and the second subplate is connected to corresponding tabs of the tabs of the electrode assembly.
[0020] According to some embodiments, a second end of the first subplate is exposed to outside of the secondary battery and the first subplate extends through a first insulator that is received in the first cap plate, and a second end of the second subplate is exposed to outside of the secondary battery and the second subplate extends through a second insulator that is received in the second cap plate.
[0021] A method of manufacturing a secondary battery of the present disclosure includes connecting a plurality of tabs of an electrode assembly to a first end of a subplate, coupling the subplate to a cap plate such that the subplate extends through a cap plate through-hole of the cap plate, coupling an insulator to an upper portion of the cap plate and coupling a case receiving the electrode assembly to the cap plate.
[0022] According to some embodiments, the connecting of the tabs of the electrode assembly to the first end of the subplate comprises welding the tabs of the electrode assembly to a front surface and a rear surface of the subplate.
[0023] According to some embodiments, the method further includes before coupling the subplate to the cap plate, disposing a sealing part around an intermediate portion of the subplate.
[0024] According to some embodiments, coupling the subplate and the cap plate comprises coupling the cap plate to an outer surface of a protrusion of the sealing part.
[0025] According to some embodiments, coupling of the insulator to the upper portion of the cap plate comprises coupling a lower surface of the insulator to an upper surface of the cap plate, and coupling an inner surface of a insulator through-hole of the insulator through which the subplate extends to an intermediate portion of the subplate.
[0026] According to some embodiments, a second end of the subplate is positioned higher than a top surface of the insulator.
[0027] A method of manufacturing a secondary battery of the present disclosure includes connecting a plurality of first tabs of an electrode assembly to a first end of a first subplate, connecting a plurality of second tabs of the electrode assembly to a first end of a second subplate that is opposite the first subplate, coupling the first subplate and a first cap plate such that the first

subplate extends through a through-hole of the first cap plate, coupling a first insulator to an upper portion of the first cap plate, coupling a first area of a case that receives the electrode assembly to the first cap plate, coupling the second subplate to a second cap plate such that the second subplate extends through a through-hole of the second cap plate, coupling a second insulator to an upper portion of the second cap plate, and coupling a second area of the case that is opposite the first area to the second cap plate.

[0028] According to some embodiments of the present disclosure, when compared to conventional side terminal cells, components such as terminal plates, rivets, current collectors, sub-tabs, etc. may be eliminated. Accordingly, the resistance of the components may also be reduced, which may improve the performance of the secondary battery.

[0029] According to some embodiments of the present disclosure, the cost of manufacturing the secondary battery may be reduced as the number of components for manufacturing the secondary battery is reduced by simplifying the components within the secondary battery. In addition, the productivity of the secondary battery may be improved because the process of welding the current collector and the sub-tabs is not necessary.

[0030] However, aspects and features of the present disclosure are not limited to those described above, and other aspects and features not mentioned will be clearly understood by a person skilled in the art from the detailed description, described below.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The following drawings attached to this specification illustrate embodiments of the present disclosure, and further describe aspects and features of the present disclosure together with the detailed description of the present disclosure. Thus, the present disclosure should not be construed as being limited to the drawings:

[0032] FIG. **1** illustrates a perspective diagram showing a secondary battery according to embodiments of the present disclosure.

[0033] FIG. **2** illustrates a side diagram of the secondary battery according to embodiments of the present disclosure.

[0034] FIG. **3** illustrates a front diagram of the secondary battery according to embodiments of the present disclosure.

[0035] FIG. **4** illustrates a plan diagram of the secondary battery according to embodiments of the present disclosure.

[0036] FIG. **5** illustrates an A-A cross-section of FIG. **2**.

[0037] FIG. **6** illustrates a B-B cross-section of FIG. **4**.

[0038] FIG. **7** illustrates an example of coupling the insulator of the secondary battery according to embodiments of the present disclosure.

[0039] FIG. **8** illustrates an example of molds used in the coupling of the insulator.

[0040] FIG. **9** illustrates a flowchart showing an example of a method of manufacturing a secondary battery according to embodiments of the present disclosure.

[0041] FIGS. **10** to **15** illustrate schematic diagrams showing example steps of the secondary battery manufacturing method.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0042] Hereinafter, embodiments of the present disclosure will be described, in detail, with reference to the accompanying drawings. The terms or words used in this specification and claims should not be construed as being limited to the usual or dictionary meaning and should be interpreted as meaning and concept consistent with the technical idea of the present disclosure based on the principle that the inventor can be his/her own lexicographer to appropriately define

the concept of the term to explain his/her invention in the best way.
[0043] The embodiments described in this specification and the configurations shown in the drawings are only some of the embodiments of the present disclosure and do not represent all of the technical ideas, aspects, and features of the present disclosure. Accordingly, it should be understood that there may be various equivalents and modifications that can replace or modify the embodiments described herein at the time of filing this application.
[0044] It will be understood that when an element or layer is referred to as being “on,” “connected to,” or “coupled to” another element or layer, it may be directly on, connected, or coupled to the other element or layer or one or more intervening elements or layers may also be present. When an element or layer is referred to as being “directly on,” “directly connected to,” or “directly coupled to” another element or layer, there are no intervening elements or layers present. For example, when a first element is described as being “coupled” or “connected” to a second element, the first element may be directly coupled or connected to the second element or the first element may be indirectly coupled or connected to the second element via one or more intervening elements.
[0045] In the figures, dimensions of the various elements, layers, etc. may be exaggerated for clarity of illustration. The same reference numerals designate the same elements. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Further, the use of “may” when describing embodiments of the present disclosure relates to “one or more embodiments of the present disclosure.” Expressions, such as “at least one of” and “any one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list. When phrases such as “at least one of A, B and C, “at least one of A, B or C,” “at least one selected from a group of A, B and C,” or “at least one selected from among A, B and C” are used to designate a list of elements A, B and C, the phrase may refer to any and all suitable combinations or a subset of A, B and C, such as A, B, C, A and B, A and C, B and C, or A and B and C. As used herein, the terms “use,” “using,” and “used” may be considered synonymous with the terms “utilize,” “utilizing,” and “utilized,” respectively. As used herein, the terms “substantially,” “about,” and similar terms are used as terms of approximation and not as terms of degree, and are intended to account for the inherent variations in measured or calculated values that would be recognized by those of ordinary skill in the art.
[0046] It will be understood that, although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer, or section from another element, component, region, layer, or section. Thus, a first element, component, region, layer, or section discussed below could be termed a second element, component, region, layer, or section without departing from the teachings of example embodiments.
[0047] Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper,” and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” or “over” the other elements or features. Thus, the term “below” may encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations), and the spatially relative descriptors used herein should be interpreted accordingly.
[0048] The terminology used herein is for the purpose of describing embodiments of the present disclosure and is not intended to be limiting of the present disclosure. As used herein, the singular forms “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “includes,” “including,”

"comprises," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0049] Also, any numerical range disclosed and/or recited herein is intended to include all sub-ranges of the same numerical precision subsumed within the recited range. For example, a range of "1.0 to 10.0" is intended to include all subranges between (and including) the recited minimum value of 1.0 and the recited maximum value of 10.0, that is, having a minimum value equal to or greater than 1.0 and a maximum value equal to or less than 10.0, such as, for example, 2.4 to 7.6. Any maximum numerical limitation recited herein is intended to include all lower numerical limitations subsumed therein, and any minimum numerical limitation recited in this specification is intended to include all higher numerical limitations subsumed therein. Accordingly, Applicant reserves the right to amend this specification, including the claims, to expressly recite any sub-range subsumed within the ranges expressly recited herein. All such ranges are intended to be inherently described in this specification such that amending to expressly recite any such subranges would comply with the requirements of 35 U.S.C. § 112 (a) and 35 U.S.C. § 132 (a).

[0050] References to two compared elements, features, etc. as being "the same" may mean that they are "substantially the same". Thus, the phrase "substantially the same" may include a case having a deviation that is considered low in the art, for example, a deviation of 5% or less. In addition, when a certain parameter is referred to as being uniform in a given region, it may mean that it is uniform in terms of an average.

[0051] Throughout the specification, unless otherwise stated, each element may be singular or plural.

[0052] Arranging an arbitrary element "above (or below)" or "on (under)" another element may mean that the arbitrary element may be disposed in contact with the upper (or lower) surface of the element, and another element may also be interposed between the element and the arbitrary element disposed on (or under) the element.

[0053] In addition, it will be understood that when a component is referred to as being "linked," "coupled," or "connected" to another component, the elements may be directly "coupled," "linked" or "connected" to each other, or another component may be "interposed" between the components".

[0054] Throughout the specification, when "A and/or B" is stated, it means A, B or A and B, unless otherwise stated. That is, "and/or" includes any or all combinations of a plurality of items enumerated. When "C to D" is stated, it means C or more and D or less, unless otherwise specified.

[0055] FIG. **1** illustrates a perspective diagram showing a secondary battery according to embodiments of the present disclosure, FIG. **2** illustrates a side diagram of the secondary battery according to embodiments of the present disclosure, FIG. **3** illustrates a front diagram of the secondary battery according to embodiments of the present disclosure, and FIG. **4** illustrates a plan diagram of the secondary battery according to embodiments of the present disclosure.

[0056] Referring to FIGS. **1** to **4**, a secondary battery **100** may include subplates **110** each connected at a first end to a plurality of tabs of an electrode assembly (not shown), insulators **120** coupled to the subplates **110**, cap plates **130** receiving the insulators **120** from the bottoms of the insulators **120**, and a case **140**. In some embodiments, the secondary battery **100** may further include a sealing part (not shown) disposed between the subplates **110** and the cap plates **130**. An example of the sealing part will be described in detail later with reference to FIGS. **5** and **7**.

[0057] The electrode assembly (not shown) may be received in the case **140**. An electrode assembly may be formed by winding or stacking a stack of a first electrode plate, a separator, and a second electrode plate, which are formed as thin plates or films. When the electrode assembly is a wound stack, a winding axis may be parallel to the longitudinal direction (e.g., the y direction) of the case. In some embodiments, the electrode assembly may be a stack type rather than a winding

type, and the shape of the electrode assembly is not limited in the present disclosure. In some embodiments, the electrode assembly may be a Z-stack electrode assembly in which a positive electrode plate and a negative electrode plate are inserted into both sides of a separator, which is then bent into a Z-stack. In some embodiments, one or more electrode assemblies may be stacked such that long sides of the electrode assemblies are adjacent to each other and accommodated in the case, and the number of electrode assemblies in the case is not limited in the present disclosure. The first electrode plate of the electrode assembly may act as a negative electrode, and the second electrode plate may act as a positive electrode. The reverse is also possible.

[0058] The first electrode plate may be formed by applying a first electrode active material, such as graphite or carbon, to a first electrode current collector formed of a metal foil, such as copper, a copper alloy, nickel, or a nickel alloy. The first electrode plate may include a first electrode tab (e.g., a first uncoated portion) that is a region to which the first electrode active material is not applied. The first electrode tab may act as a current flow path between the first electrode plate and the first current collector. In some embodiments, when the first electrode plate is manufactured, the first electrode tab may be formed by being cut in advance to protrude to one side of the electrode assembly, or the first electrode tab may protrude to one side of the electrode assembly more than (e.g., farther than or beyond) the separator without being separately cut.

[0059] The second electrode plate may be formed by applying a second electrode active material, such as a transition metal oxide, on a second electrode current collector formed of a metal foil, such as aluminum or an aluminum alloy. The second electrode plate may include a second electrode tab (e.g., a second uncoated portion) that is a region to which the second electrode active material is not applied. The second electrode tab may act as a current flow path between the second electrode plate and the second current collector. In some embodiments, the second electrode tab may be formed by being cut in advance to protrude to the other side (e.g., the opposite side) of the electrode assembly when the second electrode plate is manufactured, or the second electrode plate may protrude to the other side of the electrode assembly more than (e.g., farther than or beyond) the separator without being separately cut.

[0060] In some embodiments, the first electrode tab may be positioned on the left side of the electrode assembly, and the second electrode tab may be positioned on the right side of the electrode assembly. In some embodiments, the first electrode tab and the second electrode tab may be positioned on one side of the electrode assembly in the same direction. Herein, for ease of description, the left and right sides are defined according to the secondary battery as oriented in FIG. **1**, and positions thereof may change in response to a case where the secondary battery is rotated left and right or up and down. In addition, the left and right sides may refer to the z-axis direction in FIGS. **1** to **4**, but a direction toward the center of the secondary battery **100** may be referred to as downward and a direction away from the secondary battery **100** may be referred to as upward in order to indicate relative positions of the components.

[0061] In some embodiments, the subplates **110** may include a first subplate corresponding to a positive electrode and a second subplate corresponding to a negative electrode. Herein, a first end of each of the first subplate and the second subplate may be connected to a plurality of tabs of the electrode assembly received in the case **140**. For example, the first subplate may be connected to a first electrode tab. Similarly, the second subplate may be connected to a second electrode tab. Herein, the tabs of the electrode assembly may be connected to the subplate **110** by laser welding or ultrasonic welding.

[0062] In some embodiments, each of the subplates **110** may extend through the corresponding insulator **120** and the corresponding cap plate **130**. Specifically, the cap plate **130** may include a cap plate through-hole through which the subplate **110** extends. Similarly, the insulator **120** may include an insulator through-hole through which the subplate **110** extends. Accordingly, the subplate **110** may extend through the cap plate through-hole and the insulator through-hole, such that a second end of the subplate **110** is exposed to the outside of the insulator **120**.

[0063] For example, the second end of the first subplate may be exposed outwardly from the left side of the secondary battery **100**, and the second end of the second subplate may be exposed outwardly from the right side of the secondary battery **100**. A busbar may be welded to the second end of such subplate **110** so as to be electrically connected to another secondary battery.
[0064] In some embodiments, the thickness of the subplate **110** may be constant. For example, the subplate **110** may have the shape of a plate. Further, the thickness of each side of subplate **110** may be 0.5 mm to 1.0 mm, but is not limited thereto. In FIGS. **1** to **4**, the subplate **110** is shown as having the shape of a rectangular plate, but is not limited thereto.
[0065] In some embodiments, the case **140** may include a first open area and a second open area opposite the first open area. In some embodiments, the cap plate **130** may include a first cap plate disposed over the first open area and a second cap plate disposed over the second open area. For example, the first cap plate may cover the first open area on the left side of the secondary battery **100**, and the second cap plate may cover the second open area on the right side of the secondary battery **100**.
[0066] FIG. **5** illustrates an A-A cross-section of FIG. **2**, and FIG. **6** illustrates a B-B cross-section of FIG. **4**.
[0067] In some embodiments, the first end of the subplate **110** may be electrically connected to the electrode assembly **160**. Specifically, the tabs **162** of the electrode assembly **160** may be electrically connected to the front and rear sides of the subplate **110**. For example, the tabs **162** of the electrode assembly **160** may be laser welded or ultrasonically welded to welding areas **170** of the subplate **110**. Accordingly, the subplate **110** may contact the connected plurality of tabs **162** to represent a positive electrode or a negative electrode.
[0068] In some embodiments, the secondary battery **100** may include a sealing part **150** disposed between the subplate **110** and the cap plate **130**. Specifically, the sealing part **150** may include a third through-hole through which the subplate **110** extends. In some embodiments, the inner surface of the third through-hole of the sealing part **150** may be coupled to an intermediate portion of the subplate **110**. In some embodiments, the sealing part **150** may be coupled to the inner surface of the cap plate through-hole of the cap plate **130**. Accordingly, the sealing part **150** may provide a seal between the subplate **110** and the cap plate **130**.
[0069] In some embodiments, at least a portion of the cap plate **130** may be recessed. Specifically, a first portion of the cap plate **130** may be inwardly recessed. Additionally, the bottom surface of the insulator **120** may be coupled to the top surface of the first portion of the cap plate **130**. In some embodiments, the area of the top surface of the first portion of the cap plate **130** may be the same as or similar to the area of the bottom surface of the insulator **120**. In some embodiments, at least a portion of the lower surface of the insulator **120** may be in contact with at least a portion of the cap plate **130**.
[0070] In some embodiments, the subplate **110** may include an electrically conductive material (e.g., copper (Cu)). Further, the cap plate **130** may be formed of aluminum (Al), but is not limited thereto. The sealing part **150** may include an insulating material (e.g., ethylene propylene diene monomer (EPDM)). The insulator **120** may also include an insulating material (e.g., polycarbonate (PC)).
[0071] With this configuration, components such as terminal plates, rivets, current collectors, and sub-tabs may be eliminated when compared to a conventional side terminal cell. Accordingly, the resistance of the components may be reduced, which may improve the performance of the secondary battery. Furthermore, the cost of manufacturing the secondary battery may be reduced as the number of components for manufacturing the secondary battery is reduced by simplifying the components within the secondary battery. In addition, the productivity of the secondary battery may be improved because the process of welding the current collector and the sub-tabs may not be necessary.
[0072] FIG. **7** illustrates an example of coupling the insulator **120** of the secondary battery **100**

according to embodiments of the present disclosure, and FIG. **8** illustrates an example of molds **710_1** and **710_2** used in the coupling of the insulator **120**.

[0073] In some embodiments, the insulator **120** may be coupled to the subplate **110**, the cap plate **130**, and the sealing part **150**. For example, the insulator **120** may include an insulator through-hole through which the subplate **110** extends. Herein, the inner surface of the insulator through-hole may be coupled to an intermediate portion of the subplate **110**. Further, the lower surface of the insulator **120** may be coupled to the upper surface of the cap plate **130** and the upper surface of the sealing part **150**. Herein, the upper surface and the lower surface are determined for ease of description with respect to the secondary battery **100** in FIG. **7**. The term "lower" may indicate an inward direction of the secondary battery **100** and the term "upper" may indicate an outward direction of the secondary battery **100**, and positions thereof may change in response to a case where the secondary battery is rotated to left and right or up and down.

[0074] In some embodiments, the insulator **120** may be coupled to a recessed first portion of the cap plate **130** by an injection process. For example, the molds **710_1** and **710_2** including an internal hollow space corresponding to the insulator **120** may be fixed to a non-recessed second portion of the cap plate **130**. Herein, the molds **710_1** and **710_2** may include a through-hole **712** through which the subplate **110** extends. Thereafter, the insulator **120** may be coupled to the top surface of the first portion of the cap plate **130** and the top surface of the sealing part **150** using the molds **710_1** and **710_2** by an injection process. Subsequently, the first mold **710_1** and the second mold **710_2** may be separated and removed in opposite directions. The insulator **120** is described as being coupled by the injection process with reference to FIGS. **7** and **8**, but the present disclosure is not limited thereto, and may be coupled by various coupling methods.

[0075] In some embodiments, the top surface of the second portion of the cap plate **130** may be formed higher than the top surface of the first portion of the cap plate **130**. In some embodiments, the top surface of the insulator **120** may be formed higher than the top surface of the second portion. In some embodiments, the second end of the subplate **110** protruding outward may be formed higher than the top surface of the insulator **120**.

[0076] FIG. **9** illustrates a flowchart showing an example of a method of manufacturing a secondary battery (hereinafter, referred to as the "secondary battery manufacturing method") **900** according to embodiments of the present disclosure, and FIGS. **10** to **15** illustrate schematic diagrams showing example steps of the secondary battery manufacturing method **900**.

[0077] The secondary battery manufacturing method **900** may be started by electrically connecting a plurality of tabs of an electrode assembly with a first end of a subplate in S**910**. In some embodiments, referring to FIG. **10**, a plurality of first tabs **162_1** of the electrode assembly **160** may be connected to a front side **110**_P**1** and a back side **110**_P**2** of a first subplate **110_1**. Herein, the first tabs **162_1** of the electrode assembly **160** may be electrically connected to the first subplate **110_1** by laser welding, ultrasonic welding, or the like. Similarly, a second subplate **110_2** may also be connected to a plurality of second tabs **162_2** of the electrode assembly **160**. In some embodiments, the first subplate **110_1** may correspond to a positive/negative electrode, and the second subplate **110_2** may correspond to a negative/positive electrode. Herein, the front surface and the rear surface are determined for ease of description with respect to the secondary battery in FIGS. **10** to **15**. The front surface and the rear surface may be determined in the X-axis direction, and the top surface and the rear surface may be determined in the Z-axis direction, and the positions thereof may change in response to a case where the secondary battery is rotated left and right or up and down.

[0078] Thereafter, the sealing part may be disposed to surround an intermediate portion of the subplate. In some embodiments, referring to FIG. **11**, a first sealing portion **150_1** may include a through-hole through which the first subplate **110_1** extends. In some embodiments, the inner surface **150**_P**1** of the through-hole may be coupled to an intermediate portion in the first subplate **110_1**. The first sealing portion **150_1** may include a base **152** and a protrusion **154** projecting

upwardly from the base **152**. In some embodiments, the base **152** and the protrusion **154** may form a stepped portion. The through-hole may be formed continuously to penetrate the base **152** and the protrusion **154** together.

[0079] A second sealing portion **150_2** may have a structure symmetrical with respect to the first sealing portion **150_1**. Similar to the first sealing portion **150_1**, the second sealing portion **150_2** may also be coupled to the second subplate **110_2**. Herein, the direction in which the second sealing portion **150_2** is coupled to the second subplate **110_2** may be symmetrical with respect to the direction in which the first sealing portion **150_1** is coupled to the first subplate **110_1** with respect to the center of the secondary battery.

[0080] Thereafter, the subplates may be coupled to the cap plates, respectively, such that the second ends of the subplates extend through the cap plate through-holes of the cap plates, respectively, in S**920**. In some embodiments, referring to FIG. **12**, the inner surface of the cap plate through-hole of a first cap plate **130_1** may be coupled to the outer surface **150**_P**3** of the protrusion **154** of the first sealing portion **150_1**. In some embodiments, the lower surface of the first cap plate **130_1** may be coupled to the top surface **150**_P**2** of the base **152** of the first sealing portion **150_1**. Accordingly, the first subplate **110_1**, the first sealing portion **150_1**, and the first cap plate **130_1** may be coupled to each other. In addition, the first sealing portion **150_1** may provide a seal between the first subplate **110_1** and the first cap plate **130_1**.

[0081] Thereafter, an insulator may be coupled to the upper portion of the cap plate in S**930**. In some embodiments, referring to FIG. **13**, a first insulator **120_1** may be coupled to the upper portion of the first cap plate **130_1**. In some embodiments, the bottom surface of the first insulator **120_1** may be coupled to the top surface **130**_P**1** of the first cap plate **130_1** and the top surface **150**_P**4** of the protrusion **154** of the first sealing portion **150_1**. In addition, the first insulator **120_1** may include a insulator through-hole through which the first subplate **110_1** extends. In some embodiments, the inner surface **120**_P**1** of the insulator through-hole may be coupled to an intermediate portion of the first subplate **110_1**. The first insulator **120_1** may be coupled to the first cap plate **130_1** by an injection process, but is not limited thereto. Herein, the top surface of the first subplate **110_1** may be formed higher than the top surface of the first insulator **120_1**.

[0082] Thereafter, the case receiving the electrode assembly and the cap plates may be coupled together. In some embodiments, referring to FIG. **14**, the first cap plate **130_1** and the case **140** may be coupled together by, for example, welding. Herein, the case **140** may receive the electrode assembly **160** and may include a first open area and a second open area opposite the first open area. The first cap plate **130_1** may be coupled to the case **140** so as to be disposed over the first open area.

[0083] In some embodiments, referring to FIG. **15**, similar to the first subplate **110_1** being coupled to the first cap plate **130_1** and the first insulator **120_1**, the second subplate **110_2** may be coupled to a second cap plate **130_2** and a second insulator **120_2**. Herein, the direction in which the second subplate **110_2** is coupled to the second cap plate **130_2** and the second insulator **120_2** and the direction in which the first subplate **110_1** is coupled to the first cap plate **130_1** and the first insulator **120_1** may be symmetrical with respect to the center of the secondary battery. In some embodiments, by coupling the second cap plate **130_2** to the case **140**, a secondary battery may be produced.

[0084] Although the present disclosure has been described above with respect to embodiments thereof, the present disclosure is not limited thereto. Various modifications and variations can be made thereto by those skilled in the art within the spirit of the present disclosure and the equivalent scope of the appended claims.

Claims

1. A secondary battery comprising: a subplate connected at a first end of the subplate to a plurality of tabs of an electrode assembly; an insulator coupled to the subplate; and a cap plate configured to receive a bottom portion of the insulator, wherein the subplate extends through the insulator and the cap plate to expose a second end of the subplate to outside of the of the secondary battery.
2. The secondary battery as recited in claim 1, wherein a side of the subplate has a thickness of 0.5 mm to 1.0 mm.
3. The secondary battery as recited in claim 1, wherein the thickness of the subplate is constant.
4. The secondary battery as recited in claim 1, wherein the tabs of the electrode assembly are electrically connected to the subplate by laser welding or ultrasonic welding.
5. The secondary battery as recited in claim 1, wherein the tabs of the electrode assembly are connected to a front surface and a rear surface of the subplate.
6. The secondary battery as recited in claim 1, wherein the cap plate comprises a cap plate through-hole through which the subplate extends.
7. The secondary battery as recited in claim 1, wherein the insulator comprises an insulator through-hole through which the subplate extends.
8. The secondary battery as recited in claim 7, wherein a lower surface of the insulator is coupled to an upper surface of the cap plate, and wherein an inner surface of the insulator through-hole is coupled to an intermediate portion of the subplate.
9. The secondary battery as recited in claim 1, further comprising a sealing part positioned between the subplate and the cap plate.
10. The secondary battery as recited in claim 1, wherein the second end of the subplate is positioned higher than a top surface of the insulator.
11. The secondary battery as recited in claim 1, further comprising: a sealing part positioned between the subplate and the cap plate; and a case configured to receive the electrode assembly, the case comprising a first open area and a second open area opposite the first open area, wherein the cap plate comprises a first cap plate disposed over the first open area and a second cap plate disposed over the second open area.
12. The secondary battery as recited in claim 11, wherein the subplate comprises a first subplate comprising a first end and a second end, the first subplate corresponding to a positive electrode, and a second subplate comprising a first end and a second end, the second subplate corresponding to a negative electrode, and wherein the first end of the first subplate is connected to corresponding tabs of the tabs of the electrode assembly and the first end of the second subplate is connected to corresponding tabs of the tabs of the electrode assembly.
13. The secondary battery as recited in claim 12, wherein the second end of the first subplate is exposed to outside of the secondary battery and the first subplate extends through a first insulator that is received in the first cap plate, and wherein the second end of the second subplate is exposed to outside of the secondary battery and the second subplate extends through a second insulator that is received in the second cap plate.
14. A method of manufacturing a secondary battery, the method comprising: connecting a plurality of tabs of an electrode assembly to a first end of a subplate; coupling the subplate to a cap plate so that the subplate extends through a cap plate through-hole; coupling an insulator to an upper portion of the cap plate; and coupling a case receiving the electrode assembly to the cap plate.
15. The method as recited in claim 14, wherein connecting the plurality of tabs of the electrode assembly to the first end of the subplate comprises welding the plurality of tabs of the electrode assembly to a front surface and a rear surface of the subplate.
16. The method as recited in claim 14, further comprising, before coupling the subplate to the cap plate, disposing a sealing part around an intermediate portion of the subplate.
17. The method as recited in claim 16, wherein coupling the subplate to the cap plate comprises coupling the cap plate to an outer surface of a protrusion of the sealing part.

18. The method as recited in claim 14, wherein coupling the insulator to the upper portion of the cap plate comprises: coupling a lower surface of the insulator to an upper surface of the cap plate; and coupling an inner surface of an insulator through-hole through which the subplate extends to an intermediate portion of the subplate.

19. The method as recited in claim 14, wherein the second end of the subplate is positioned higher than a top surface of the insulator.

20. A method of manufacturing a secondary battery, the method comprising: connecting a plurality of first tabs of an electrode assembly to a first end of a first subplate; connecting a plurality of second tabs of the electrode assembly to a first end of a second subplate that is opposite the first subplate; coupling the first subplate to a first cap plate such that the first subplate extends through a through-hole of the first cap plate; coupling a first insulator to an upper portion of the first cap plate; coupling a first area of a case that receives the electrode assembly to the first cap plate; coupling the second subplate to a second cap plate such that the second subplate extends through a through-hole of the second cap plate; coupling a second insulator to an upper portion of the second cap plate; and coupling a second area of the case that is opposite the first area to the second cap plate.