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SECONDARY BATTERY AND METHOD OF MANUFACTURING A SECONDARY BATTERY

Abstract

A secondary battery comprises an electrode assembly, a case accommodating the electrode assembly, a subplate assembly coupled to a first side of the electrode assembly, and a cap assembly coupled to the subplate assembly. The subplate assembly comprises a subplate connected to the electrode assembly and a current collector coupled to the subplate, and the case comprises a bottom portion, a side portion connected to the bottom portion, and a cover facing the bottom portion. The cover is welded to the side portion of the case.

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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. 10-2024-0023760, 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] Aspects of embodiments of the present disclosure relate to a secondary battery and a method of manufacturing a secondary battery.

2. Description of the Related Art

[0003] A secondary battery refers to a rechargeable battery that may be charged and discharged a plurality of times. Such secondary batteries are mainly used in various applications such as electronics (e.g., smartphones, notebook computers, and tablets), electric vehicles, solar power generation, and emergency power supplies. For example, lithium (Li)-ion batteries are used in various electronic products and electric vehicles due to their high energy density and high charge and discharge efficiency.

[0004] Secondary batteries may be categorized as cylindrical secondary batteries, prismatic secondary batteries, and pouch secondary batteries, depending on the shape of the case. A prismatic secondary battery has a structure in which an electrode assembly is embedded in a cylindrical metal can. The electrode assembly is inserted into the prismatic metal can, and a cap plate is welded to seal the can. In a case where there is a poor or loose fit between a current collector and a terminal plate, the electrical characteristics of the secondary battery may be degraded.

[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] An aspect of the present disclosure is to provide a secondary battery that may be configured to solve at least one of the above-described problems and a method of manufacturing a secondary batter.

[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] According to some embodiments of the present disclosure, a secondary battery comprises an electrode assembly, a case in which the electrode assembly is accommodated, a subplate assembly coupled to a first side of the electrode assembly, and a cap assembly coupled to the subplate assembly, wherein the subplate assembly comprises a subplate connected to the electrode assembly and a current collector coupled to the subplate, and the case comprises a bottom portion, a side portion connected to the bottom portion, and a cover facing the bottom portion, wherein the cover is welded to the side portion.

[0009] In some embodiments, the current collector comprises a planar portion and a protruding portion, the planar portion and the protruding portion being integral.

[0010] In some embodiments, the case further comprises a first open area and a second open area facing the first open area, and the cap assembly comprises a cap plate covering at least one of the first open area or the second open area, a terminal plate coupled to the cap plate, and a sealing member disposed between the cap plate and the terminal plate.

[0011] In some embodiments, the secondary battery further comprises a vent provided in the cover.
[0012] In some embodiments, the secondary battery further comprises a vent provided in the bottom portion.
[0013] In some embodiments, the cover comprises a first bend, and the weld region is defined as a region where the first bend and the side portion overlap.
[0014] In some embodiments, the side portion comprises a second bend, and the cover and the side portion are welded in a region where first bend and the cover overlap and a region where the second bend and the cover overlap.
[0015] In some embodiments, the cover comprises a stepped portion overlapping a portion of the side portion, and the stepped portion is welded to the side portion.
[0016] In some embodiments, an area of the bottom portion is less than an area of the side portion.
[0017] According to some embodiments of the present disclosure, a secondary battery comprises, an electrode assembly, a case in which the electrode assembly is accommodated, a subplate assembly coupled to a first side of the electrode assembly, and a cap assembly coupled to the subplate assembly, wherein the cap assembly comprises a terminal plate, the terminal platen is welded to the subplate assembly, and the case comprises a bottom portion, a side portion connected to the bottom portion, and a cover facing the bottom portion, wherein the cover is welded to the side portion.
[0018] In some embodiments, the side portion comprises a stepped portion that overlaps a portion of the cover, and the stepped portion is welded to the cover.
[0019] In some embodiments, the terminal plate comprises an upper terminal plate and a lower terminal plate, wherein the upper terminal plate and the lower terminal plate are formed of different materials.
[0020] According to some embodiments of the present disclosure, a method of manufacturing a secondary battery, the method comprises, coupling a first subplate assembly and a second subplate assembly to opposite sides of an electrode assembly, forming a cap-subplate electrode assembly by coupling a first cap assembly to the first subplate assembly and a second cap assembly to the second subplate assembly, inserting the cap-subplate electrode assembly into a case, wherein the case comprises a first open area, a second open area facing the first open area in a first direction, and a third open area open in a second direction that is orthogonal to the first direction, and welding a cover positioned in the third open area to the case.
[0021] In some embodiments, the method further comprises, before welding the cover to the case, welding the first cap assembly positioned in the first open area to the case, and welding the second cap assembly positioned in the second open area to the case.
[0022] In some embodiments, the method further comprises, welding the cover to the first cap assembly and welding the cover to the second cap assembly.
[0023] In some embodiments, the method further comprises, welding the first cap assembly positioned in the first open area to the case, and welding the second cap assembly positioned in the second open area to the case.
[0024] In some embodiments, the first subplate assembly comprises a current collector comprising a protruding portion, and the first cap assembly comprises a terminal plate, the method further comprising welding the protruding portion to the terminal plate.
[0025] In some embodiments, the cover comprises a vent.
[0026] In some embodiments, the cover comprises a first bend, and the welding of the cover to the case comprises welding an overlapping portion of the first bend and a side portion of the case.
[0027] In some embodiments, the cover comprises a second bend, and the welding of the cover to the case comprises welding an overlapping portion of the second bend and the cover.
[0028] According to embodiments of the present disclosure, the cover may include the stepped portion, and the side portion may include the stepped portion. Due to the stepped shape of the stepped portions, the cover and the side portion may be welded together in an aligned state, thereby

reducing defects in a secondary battery and improving the reliability of the secondary battery.
[0029] According to embodiments of the present disclosure, during the process of forming the cap-sub electrode assembly, the fitting and alignment of the current collector and the terminal plates are checked before the welding operation is performed. Accordingly, the defect rate of the secondary battery may be reduced and the reliability of the secondary battery may be improved.
[0030] According to embodiments of the present disclosure, the cover may be manufactured separately from the case body. Accordingly, in a case where the vent is provided on the cover, the difficulty of the manufacturing process may be reduced.
[0031] 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
[0032] 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:
[0033] FIG. **1** illustrates a perspective diagram showing a secondary battery according to some embodiments of the present disclosure;
[0034] FIG. **2** illustrates a perspective diagram showing a case according to some embodiments of the present disclosure;
[0035] FIG. **3** illustrates an exploded perspective diagram showing the case according to some embodiments of the present disclosure;
[0036] FIG. **4** illustrates an exploded diagram showing the case according to some embodiments of the present disclosure;
[0037] FIG. **5** illustrates an exploded perspective diagram showing the case according to some embodiments of the present disclosure;
[0038] FIG. **6** illustrates an exploded diagram showing the case according to some embodiments of the present disclosure;
[0039] FIG. **7** illustrates a cross-sectional diagram showing a secondary battery according to some embodiments of the present disclosure;
[0040] FIG. **8** illustrates an exploded diagram showing region R**1** in FIG. **7**;
[0041] FIG. **9** illustrates the first cap assembly according to some embodiments of the present disclosure;
[0042] FIG. **10** illustrates an exploded diagram showing region R**2** in FIG. **7**;
[0043] FIG. **11** illustrates the second cap assembly according to some embodiments of the present disclosure;
[0044] FIGS. **12** to **14** illustrate a method of manufacturing a secondary battery according to some embodiments of the present disclosure;
[0045] FIG. **15** illustrates a flowchart showing the method of manufacturing a secondary battery according to some embodiments of the present disclosure.
DETAILED DESCRIPTION OF THE EMBODIMENTS
[0046] 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.
[0047] 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.
[0048] 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.
[0049] 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.
[0050] 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.
[0051] 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.
[0052] 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.

[0053] 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.
[0054] 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).
[0055] 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.
[0056] Throughout the specification, unless otherwise stated, each element may be singular or plural.
[0057] 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.
[0058] 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”.
[0059] 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.
[0060] FIG. **1** illustrates a perspective diagram showing a secondary battery according to some embodiments of the present disclosure.
[0061] Referring to FIG. **1**, the secondary battery may include an electrode assembly, a first subplate assembly, a second subplate assembly, a case **200**, a first cap assembly, a second assembly, and the like.
[0062] The electrode assembly may be housed within the case **200**. The electrode assembly may be provided by stacking (or laminating) or winding negative electrode plates, separators, and positive electrode plates having the shape of a thin plate or film.
[0063] In some embodiments, an electrolyte inlet **130** may be provided on a first cap plate **360**. Electrolyte may be injected into the case **200** through the electrolyte inlet **130**. In FIG. **1**, the electrolyte inlet **130** is shown as being provided on the first cap plate **360**, but is not limited thereto. After the injection of electrolyte is complete, the electrolyte inlet **130** may be sealed using a sealing means such as a stopper.
[0064] In some embodiments, a vent **110** may be provided on a cover. The vent **110** may prevent the secondary battery from exploding or prevent a chain exothermic reaction of secondary batteries arranged in close proximity.

[0065] In an example, the vent **110** may be configured to open when the internal pressure of the secondary battery exceeds a predetermined critical pressure. The critical pressure may be set differently depending on the application, material, purpose, and the like of the secondary battery. In addition or in another example, the vent **110** may be configured to open when the internal pressure exceeds a predetermined critical pressure.

[0066] In FIG. **1**, the vent **110** is shown as being provided at the center of the cover, but is not limited thereto. Any number of vents **110** may be provided at any positions in a surface of the case **200**. For example, two or more vents **110** may be provided on the cover.

[0067] A first cap assembly may be coupled to an open first side of the case **200**. A second cap assembly may be coupled to an open second side of the case **200**. The shape of the case **200** will be described in detail below.

[0068] FIG. **2** illustrates a perspective diagram showing a case according to some embodiments of the present disclosure. FIG. **3** illustrates an exploded perspective diagram showing the case according to some embodiments of the present disclosure.

[0069] Referring to FIGS. **2** and **3**, a case **200** may include a first open area **210**, a second open area **220**, a bottom portion **250**, side portions **260**, and a cover **270**.

[0070] The case **200** may be formed of a conductive metal, such as aluminum (Al), an Al alloy, or Ni-plated steel.

[0071] A first direction X may refer to the X-axis direction. A second direction Y may be orthogonal to the first direction X. The second direction Y may refer to the Y-axis direction. A third direction Z may be orthogonal to both the first direction X and the second direction Y. The third direction Z may refer to the Z-axis direction.

[0072] The bottom portion **250** may extend in the first direction X. The first direction X may be the longitudinal direction of the case **200**. The bottom portion **250** may face the cover **270** in the third direction Z. The bottom portion **250** and the cover **270** may face each other while being spaced apart in the third direction Z.

[0073] The side portions **260** may be connected to the bottom portion **250**. The side portions **260** may be in contact with the cover **270**. The area of the bottom portion **250** may be less than the area of the side portions **260**. The side portions **260** may include a first side portion and a second side portion. The first side portion and the second side portion may face each other. The first side portion and the second side portion may face each other while being spaced apart in the second direction Y.

[0074] The first open area **210** and the second open area **220** may be provided on opposite sides of the case **200**. The first open area **210** may face the second open area **220**. The first open area **210** and the second open area **220** may face each other while being spaced apart in the first direction X. Each of the first open area **210** and the second open area **220** may be defined by the bottom portion **250**, the side portions **260**, and the cover **270**.

[0075] In some embodiments, the vent **110** may be provided on the cover **270**, but is not limited thereto. In some embodiments, the vent **110** may be provided on the bottom portion **250**.

[0076] The cover **270** may be coupled to the side portions **260**. Specifically, the cover **270** may be coupled to each of a first end of the first side portion and a first end of the second side portion.

[0077] FIG. **4** illustrates an exploded diagram showing the case according to some embodiments of the present disclosure. For reference, FIG. **4** illustrates an exploded diagram showing Q region in FIG. **2**. With reference to FIG. **4**, the joining operation between the cover **270** and the side portions **260** will be described in detail.

[0078] The cover **270** may include a plate, first bends **275**, and stepped portions **271**. A pair of first bends **275** may be provided on opposite edges of the plate. The first bends **275** may have a shape bent from the cover **270** toward the side portions **260**. In other words, the first bends **275** may have a shape rounded from the second direction Y to the third direction Z. The first stepped portions **271** may be provided on ends of the first bends **275**.

[0079] Each of the side portions **260** may include a second stepped portion **261**. The second stepped portions **261** may be provided on ends of the side portions **260**. In order for the side portions **260** and the cover **270** to be joined, the first stepped portions **271** and the second stepped portions **261** may overlap in the second direction Y. That is, as shown in FIG. **4**, the first stepped portions **271** may have a shape corresponding to the second stepped portions **261**.
[0080] The cover **270** may be welded (and joined) to the side portions **260**. Specifically, the first stepped portions **271** and the second stepped portions **261** may be welded together. As a result, a first weld region CWR**1** may be formed on each of the first stepped portions **271**. The first weld region CWR**1** may include a weld bead or the like. The first welding region CWR**1** may extend in the first direction X.
[0081] In a secondary battery, the electrode assembly is inserted into the case, which may be sealed by welding the cover. However, if the case and the cover are misaligned, the case and the cover may not be joined, thereby resulting in leakage of the electrolyte.
[0082] According to some embodiments of the present disclosure, the cover **270** may include the first stepped portions **271**, and the side portions **260** may include the second stepped portions **261**. Because of the stepped shape of the first stepped portions **271** and the second stepped portions **261**, the cover **270** and the side portions **260** may be welded together in an aligned state. Accordingly, defects in the secondary battery may be reduced, and the reliability of the secondary battery may be improved.
[0083] FIG. **5** illustrates an exploded perspective diagram showing the case according to some embodiments of the present disclosure. FIG. **6** illustrates an exploded diagram showing the case according to some embodiments of the present disclosure. For ease of description, the following description will focus on features that are different from those described with reference to FIGS. **2** to **4**.
[0084] Referring to FIGS. **5** and **6**, the cover **270** may include a plate and third stepped portions **276**. The third stepped portions **276** may be provided on opposite edges of the plate.
[0085] Each of the side portions **260** may include a second bend **265** and a fourth stepped portion **266** on the distal end. The second bend **265** may have a shape bent from the side portion **260** toward the cover **270**. In other words, the second bend **265** may have a rounded shape from the third direction Z to the second direction Y. The fourth stepped portion **266** may be provided on the end of the second bend **265**.
[0086] In order for the side portions **260** and the cover **270** to be joined together, the third stepped portions **276** and the fourth stepped portions **266** may overlap in the third direction Z. That is, as shown in FIG. **6**, the third stepped portions **276** may have a shape corresponding to the fourth stepped portions **266**.
[0087] The cover **270** may be welded to the side portions **260**. Specifically, the third stepped portions **276** and the fourth stepped portions **266** may be welded together. As a result, second weld regions CWR**2** may be formed on the third stepped portions **276**. Each of the second weld regions CWR**2** may include a weld bead or the like. The second weld regions CWR**2** may extend in the first direction X.
[0088] In a secondary battery, the electrode assembly may be inserted into the case, and the case may be sealed by welding the cover. However, when the case and the cover are misaligned, the case and the cover may not be joined together, thereby resulting in leakage of the electrolyte.
[0089] According to some embodiments of the present disclosure, the cover **270** may include the third stepped portions **276**, and the side portions **260** may include the fourth stepped portions **266**. Because of the stepped shape of the third stepped portions **276** and the fourth stepped portions **266**, the cover **270** and the side portions **260** may be welded together in an aligned state. Accordingly, defects in the secondary battery may be reduced, and the reliability of the secondary battery may be improved.
[0090] FIG. **7** illustrates a cross-sectional diagram showing a secondary battery according to some

embodiments of the present disclosure. For reference, FIG. **7** may be a cross-sectional diagram of the secondary battery of FIG. **1** taken on a plane defined by the first direction X and the third direction Z.

[0091] Referring to FIGS. **1** and **7**, the secondary battery may include an electrode assembly **100**, a case **200** accommodating the electrode assembly **100**, a first subplate assembly **310**, a second subplate assembly **410**, a first cap assembly **350**, and a second cap assembly **450**. Herein, the case **200** may be the case **200** described above with reference to FIGS. **2** to **6**.

[0092] The electrode assembly **100** may be accommodated in the case **200**. The electrode assembly **100** may be provided by winding or stacking a laminate including a first electrode plate (not shown), a separator (not shown), and a second electrode plate (not shown) each formed of a thin plate or film. In a case where the electrode assembly **100** is a wound laminate, the axis of the winding may be parallel to the longitudinal direction of the case **200**. The electrode assembly **100** may be a stack type instead of being a wound type, but the shape of the electrode assembly **100** of the present disclosure is not limited thereto. The electrode assembly **100** may be a Z stack electrode assembly in which a positive electrode plate and a negative electrode plate are provided on opposite sides of the separator bent into a Z-shaped stack. One or more electrode assemblies **100** may be stacked and received in the case **200** such that the long sides thereof are adjacent to each other. The present disclosure is not limited with respect to the number of electrode assemblies **100**. In the electrode assembly **100**, the first electrode plate may act as a positive electrode, and the second electrode plate may act as a negative electrode. The reverse is also possible.

[0093] The first electrode plate may be formed by applying a first electrode active material, such as graphite or carbon, to a first electrode collector plate formed of a metal foil of, for example, copper (Cu), a Cu alloy, nickel (Ni), or a Ni alloy, and may include a first electrode tab (or a first uncoated portion), which is a portion to which the first electrode active material is not applied. The first electrode tab may be a path for current flow between the first electrode plate and the first subplate assembly **310**. In some examples, the first electrode tab may be formed by cutting the first electrode plate so that the first electrode tab protrudes from a first side when the first electrode plate is fabricated, and the first electrode plate may protrude further from the first side than the separator without additional cutting.

[0094] The second electrode plate is formed by applying a second electrode active material, such as a transition metal oxide, to a second electrode collector plate formed of a metal foil of, for example, aluminum (Al) or an Al alloy, and may include a second electrode tab (or a second uncoated portion), which is a portion to which the second electrode active material is not applied. The second electrode tab may be a path for current flow between the second electrode plate and the second subplate assembly **410**. In some examples, the second electrode tab may be formed by cutting the second electrode plate so that the second electrode tab protrudes from a second side when the second electrode plate is fabricated, and the second electrode plate may protrude further from the second side than the separator without additional cutting.

[0095] In some examples, the first electrode tab may be positioned on the right end side of the electrode assembly, and the second electrode tab may be positioned on the left end side of the electrode assembly. The terms “left” and “right” are used herein for ease of description with respect to the secondary battery shown in FIG. **2**, and the positions may change as the secondary battery is rotated left and right or up and down.

[0096] FIG. **8** illustrates an exploded diagram showing region R**1** in FIG. **7**.

[0097] Referring to FIG. **8**, the first subplate assembly **310** and the first cap assembly **350** may be coupled to a first side of the electrode assembly **100**.

[0098] The first subplate assembly **310** may be coupled to the first side of the electrode assembly **100** and be electrically connected to the first electrode plate (e.g., the positive electrode plate) of the electrode assembly **100**. The first subplate assembly **310** may include a first subplate **320** and a first current collector **330**.

[0099] The first subplate **320** may be coupled to a first electrode tab of the electrode assembly **100**. For example, the first electrode tab may be welded to the first subplate **320**. The first subplate **320** may be connected to the first electrode tab and be electrically connected to the first electrode plate.
[0100] The first current collector **330** may be coupled to the first subplate **320**. For example, the first current collector **330** and the first subplate **320** may be welded together. The first current collector **330** and the first subplate **320** may be electrically connected to each other.
[0101] The first current collector **330** may include a first planar portion **330**_PL and a first protruding portion **330**_PR. The first planar portion **330**_PL may be welded to the first subplate **320**. The first protruding portion **330**_PR may protrude from the first planar portion **330**_PL, and may have the shape of, for example, a cylinder.
[0102] A first insulation member **340** may be disposed between the first subplate assembly **310** and the first cap assembly **350**. The first insulation member **340** may prevent the first subplate **320** and a first cap plate **360** from contacting each other.
[0103] The first cap assembly **350** may include the first cap plate **360**, a first sealing member **370**, and a first terminal plate **380**.
[0104] The first sealing member **370** may be coupled to the first cap plate **360**. The first cap plate **360** may have a through-hole. The first sealing member **370** may provide a seal between the first terminal plate **380** and the first cap plate **360**. The first sealing member **370** may include an insulating material. The first sealing member **370** may insulate the first cap plate **360** and the first terminal plate **380** from each other.
[0105] The first terminal plate **380** may be coupled to a surface of the first sealing member **370**. The top surface of the first terminal plate **380** may have a recess. For example, the recess may be formed in a portion of the top surface of the first terminal plate **380** overlapping the first protruding portion **330**_PR in the first direction X. The recess results in the thickness of the central portion of the first terminal plate **380** to be less than the thickness of the other portions.
[0106] The first terminal plate **380** may be a positive electrode terminal of a secondary battery. For example, a busbar may be welded to a surface of the first terminal plate **380** and be electrically connected to another secondary battery.
[0107] In some embodiments, the first terminal plate **380** may have a first hole H**1**. The first hole H**1** may be provided in the recess of the first terminal plate **380**. A portion of the top surface of the first protruding portion **330**_PR may be exposed through the first hole H**1**. However, the present disclosure is not limited thereto. For example, the first terminal plate **380** may not be provided with the first hole H**1**, thereby completely covering the top surface of the first protruding portion **330**_PR.
[0108] The first current collector **330** may be coupled to the first terminal plate **380**. Specifically, the first protruding portion **330**_PR may extend through the through hole of the first sealing member **370** and contact the first terminal plate **380**. The first protruding portion **330**_PR and the first terminal plate **380** may be welded together.
[0109] FIG. **9** illustrates the first cap assembly according to some embodiments of the present disclosure. For reference, FIG. **9** may be a plan view of the secondary battery of FIG. **7** viewed in the first direction X.
[0110] Referring to FIG. **9**, a first terminal weld region DWR**1** may be provided on the top surface of the first terminal plate **380**. A welding process may be performed in the first terminal weld region DWR**1**, thereby joining the first terminal plate **380** and the first current collector **330**. Accordingly, the first current collector **330** and the first terminal plate **380** may be electrically connected. A weld bead or the like may be provided on the first terminal weld region DWR**1** as a result of the welding process. The first terminal weld region DWR**1** is shown as having a donut shape, but is not limited thereto. The first terminal weld region DWR**1** may have any shape in which the first terminal plate **380** and the first current collector **330** are welded together.
[0111] FIG. **10** illustrates an exploded diagram showing region R**2** in FIG. **7**.

[0112] Referring to FIG. **6**, the second subplate assembly **410** and the second cap assembly **450** may be coupled to the second side of the electrode assembly **100**.
[0113] The second subplate assembly **410** may be coupled to the second side of the electrode assembly **100** and electrically connected to a second electrode plate (e.g., a negative electrode plate) of the electrode assembly **100**. The second first subplate assembly **410** may include a second first subplate **420** and a second current collector **430**.
[0114] The second first subplate **420** may be coupled to a second electrode tab of the electrode assembly **100**. For example, the second electrode tab may be welded to the second subplate **420**. The second subplate **420** may be connected to the second electrode tab, and may be electrically connected to the second electrode plate.
[0115] The second current collector **430** may be coupled to the second first subplate **420**. For example, the second current collector **430** and the second first subplate **420** may be welded together. The second current collector **430** may be electrically connected to the second first subplate **420**.
[0116] The second current collector **430** may include a second planar portion **430**_PL and a second protruding portion **430**_PR. The second planar portion **430**_PL may be welded to the second first subplate **420**. The second protruding portion **430**_PR may protrude from the second planar portion **430**_PL, and may have the shape of, for example, a cylinder.
[0117] A second insulation member **440** may be disposed between the second subplate assembly **410** and the second cap assembly **450**. The second insulation member **440** may prevent the second subplate **420** and a second cap plate **460** from contacting each other.
[0118] The second cap assembly **450** may include the second cap plate **460**, a second sealing member **470**, and a second terminal plate **480**.
[0119] The second sealing member **470** may be coupled to the second cap plate **460**. The second cap plate **460** may have a through-hole. The second sealing member **470** may provide a seal between the second terminal plate **480** and the second cap plate **460**. The second sealing member **470** may include an insulating material. The second sealing member **470** may insulate the second cap plate **460** and the second terminal plate **480** from each other.
[0120] The second terminal plate **480** may be coupled to a surface of the second sealing member **470**. The second terminal plate **480** may be a positive electrode terminal of the secondary battery. A busbar may be welded to a surface of the second terminal plate **480** to be electrically connected to another secondary battery. For example, the busbar may be welded to an upper terminal plate **480**_UT.
[0121] The second terminal plate **480** may include the upper terminal plate **480**_UT and a lower terminal plate **480**_LT. The lower terminal plate **480**_LT may be in contact with the second sealing member **470**. The upper terminal plate **480**_UT may be disposed on top of the lower terminal plate **480**_LT. That is, the lower terminal plate **480**_LT may be disposed between the sealing member **470** and the upper terminal plate **480**_UT.
[0122] The top surface of the second terminal plate **480** may have a recess. The upper terminal plate **480**_UT may expose a portion of the lower terminal plate **480**_LT. For example, a portion of the lower terminal plate **480**_LT may be exposed through a recess in the central portion of the upper terminal plate **480**_UT. The recess of the upper terminal plate **480**_UT may overlap the second protruding portion **430**_PR in the first direction X. The recess of the upper terminal plate **480**_UT may the same shape as the recess of the first terminal plate **380** in FIG. **8**.
[0123] In some embodiments, the upper terminal plate **480**_UT and the lower terminal plate **480**_LT may be formed of different materials. The upper terminal plate **480**_UT may include, for example, aluminum (Al). The lower terminal plate **480**_LT may include, for example, copper (Cu). That is, the upper terminal plate **480**_UT may be a conductive material containing Al as a major component, and the lower terminal plate **480**_LT may be a conductive material containing Cu as a major component. As used herein, the term major component means the predominant content

material among the materials of the alloy, in the language of a person having ordinary knowledge in the art.

[0124] Although the upper terminal plate **480**_UT has been described as including Al and the lower terminal plate **480**_LT has been described as including Cu, this should be understood as illustrative. In some embodiments, the upper terminal plate **480**_UT and the lower terminal plate **480**_LT may include other conductive metals.

[0125] In some embodiments, the lower terminal plate **480**_LT may include a second hole H**2**. The second hole H**2** may be formed in the lower terminal plate **480**_LT and exposed through the upper terminal plate **480**_UT. A portion of the top surface of the second protruding portion **430**_PR may be exposed through the hole H**2**. However, the present disclosure is not limited thereto. For example, the second terminal plate **480** may not be provided with the second hole H**2**, thereby completely covering the top surface of the second protruding portion **430**_PR.

[0126] The second current collector **430** may be coupled to the second terminal plate **480**. Specifically, the second protruding portion **430**_PR may extend through the through hole of the second sealing member **470** to contact the lower terminal plate **480**_LT. The second protruding portion **430**_PR and the second terminal plate **480** may be welded.

[0127] FIG. **11** illustrates the second cap assembly according to some embodiments of the present disclosure. For reference, FIG. **11** may be a plan view of the secondary battery of FIG. **7** viewed in the first direction X.

[0128] Referring to FIG. **11**, a second terminal weld region DWR**2** may be provided on the top surface of the lower terminal plate **480**_LT. A welding process may be performed in the second terminal weld region DWR**2** to join the second terminal plate **480** and the second current collector **430**. Accordingly, the second current collector **430** and the second terminal plate **480** may be electrically connected. A weld bead or the like may be provided in the second terminal weld region DWR**2** as a result of the welding process. The second terminal weld region DWR**2** is shown as having a donut shape, but is not limited thereto. The second terminal weld region DWR**2** may have any shape, by which the second terminal plate **480** and the second current collector **430** are welded together.

[0129] FIGS. **12** to **14** illustrate a method of manufacturing a secondary battery according to some embodiments of the present disclosure.

[0130] Referring to FIG. **12**, a cap-subplate electrode assembly may be formed by combining the first subplate assembly **310**, the second subplate assembly, the first cap assembly **350**, and the second cap assembly **450** on the electrode assembly **100**.

[0131] Specifically, the first subplate assembly **310** may be coupled to a first side of the electrode assembly **100**, and a second subplate assembly may be coupled to a second side of the electrode assembly **100**. Thereafter, the first cap assembly **350** may be coupled to a surface of the first subplate assembly **310**, and the second cap assembly **450** may be coupled to a surface of the second subplate assembly, thereby forming a cap-subplate electrode assembly (**100**CS in FIG. **13**).

[0132] The first subplate assembly **310** and the first cap assembly **350** may be welded together to form a first terminal weld region (DWR**1** in FIG. **9**). Specifically, the first protruding portion (**330**_PR in FIG. **8**) and the first terminal plate (**380** in FIG. **8**) may be welded together to form the first terminal weld region (DWR**1**). Referring to FIG. **13**, the cap-subplate electrode assembly **100**CS may be inserted into a case body **200**B.

[0133] The case body **200**B may include a first open area **210**, a second open area **220**, a third open area **230**, a bottom portion **250**, and side portions **260**. The description of the first open area **210**, the second open area **220**, the bottom portion **250**, and the side portions **260** may be substantially the same as described with reference to FIG. **2**. For ease of description, the following description will focus on features that are different from those described above.

[0134] The third open area **230** may be a portion open in the third direction Z. The third open area **230** may be opposite to the bottom portion **250** in the third direction Z.

[0135] In some embodiments, the side portions **260** may include the second bends **265** in FIG. **5**.
[0136] The cap-subplate electrode assembly **100**CS may be inserted into the case body **200**B so that the first cap assembly **350** is positioned in the second open area **220** and the second cap assembly **450** is positioned in the first open area **210**. The cap-subplate electrode assembly **100**CS may be inserted into the case body **200**B by moving in the first direction X or the third direction Z. Referring to FIGS. **13** and **14**, the cover **270** may be joined to a surface of the case body **200**B.
[0137] Specifically, the cover **270** may be welded to the third open area **230** of the case body **200**B.
[0138] In some embodiments, the cover **270** may include vent **110**, but the present disclosure is not limited thereto. For example, the vent **110** may be provided on the bottom portion **250**. Because the cover **270** is fabricated separately from the case body **200**B, the manufacturing process may be easier when the vent **110** is provided on the cover **270**.
[0139] In some embodiments, the cover **270** may include the first bends **275** in FIG. **3**.
[0140] In some embodiments, before the cover **270** is welded to the case body **200**B, the case body **200**B, the first cap assembly **350**, and the second cap assembly **450** may be joined. Specifically, the first cap assembly **350** in the second open area **220** may be welded to the case body **200**B, and the second cap assembly **450** in the first open area **210** may be welded to the case body **200**B. Thereafter, the cover **270** in the third open area **230** may be welded to the case body **200**B.
[0141] In some embodiments, a method of joining the cover **270** in the third open area **230** and the case body **200**B by welding may include joining the side portions **260** and the cover **270** by welding the cover **270** to each of the first cap assembly **350** and the second cap assembly **450**.
[0142] By coupling the cover **270** in the third open area **230**, the secondary battery of FIG. **1** may be manufactured.
[0143] A secondary battery may be manufactured by coupling the electrode assembly and the current collector and coupling the current collector and the terminal plate. In such a secondary battery manufacturing process, the current collector and the terminal plate may not be tightly fitted to each other such that a defect may occur in the welding and joining operation. For example, when the electrode assembly and the current collector are coupled and the cap plate is coupled to a surface of the case, it may not be possible to determine whether the terminal plate and the current collector are tightly fitted to each other. When the current collector and the terminal plate are not tightly fitted or are not aligned, the electrical characteristics of the secondary battery may be degraded.
[0144] A method of manufacturing a secondary battery according to some embodiments of the present disclosure may include inserting the cap-subplate electrode assembly **100**CS into the case body **200**B and joining the cover **270** to the case body **200**B. Accordingly, in the process of forming the cap-subplate electrode assembly **100**CS, after checking to ensure a tightly fit and alignment of the current collectors (capacitors) **330** and **430** and the terminal plates **380** and **480**, the joint may be welded. Accordingly, the defect rate of the secondary battery may be reduced and the reliability of the secondary battery may be improved.
[0145] FIG. **15** illustrates a flowchart showing the method of manufacturing a secondary battery according to some embodiments of the present disclosure.
[0146] Referring to FIG. **15**, in step **1310** each of a first subplate assembly and a second subplate assembly may be coupled to opposite sides of the electrode assembly, respectively.
[0147] In step **1320**, first cap assembly may be coupled to the first subplate assembly and a second cap assembly may be coupled to the second subplate assembly to form a cap-subplate electrode assembly.
[0148] However, the manufacturing method according to the present disclosure is not limited to the above-described order. In some embodiments, the first subplate assembly and the first cap assembly may be coupled to a first side of the electrode assembly, and the second subplate assembly and the second cap assembly may be coupled to a second side of the electrode assembly to form the cap-subplate electrode assembly.

[0149] The cap-subplate electrode assembly may be inserted into the case body in step **1330**. The case body may include a first open area, a second open area, and a third open area. The first cap assembly may be positioned in the first open area. The second cap assembly may be positioned in the second open area.
[0150] The first cap assembly in the first open area may be coupled to the case body, and the second cap assembly in the second open area may be coupled to the case body in step **1340**.
[0151] Thereafter, the cover in the third open area and the case body may be joined together in step **1350**. Specifically, a secondary battery may be manufactured by joining the cover to the side portions of the case body, the first cap assembly, and the second cap assembly by welding.
[0152] 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.
DESCRIPTION OF REFERENCE SYMBOLS
TABLE-US-00001 100: electrode assembly 200: case 200B: case body 210: first open area 220: second open area 230: third open area 250: bottom portion 260: side portion 265: second bend 270: cover 275: first bend 310: first subplate assembly 350: first cap assembly 360: first cap plate 410: second subplate assembly 450: second cap assembly 460: second cap plate CWR1: first weld region CWR2: second weld region

Claims

1. A secondary battery comprising: an electrode assembly; a case in which the electrode assembly is accommodated; a subplate assembly coupled to a first side of the electrode assembly; and a cap assembly coupled to the subplate assembly, wherein the subplate assembly comprises a subplate connected to the electrode assembly and a current collector coupled to the subplate, wherein the case comprises a bottom portion, a side portion connected to the bottom portion, and a cover facing the bottom portion, and wherein the cover is welded to the side portion.
2. The secondary battery as recited in claim 1, wherein the current collector comprises a planar portion and a protruding portion, with the planar portion and the protruding portion being integral.
3. The secondary battery as recited in claim 1, wherein the case further comprises a first open area and a second open area facing the first open area, and wherein the cap assembly comprises a cap plate covering at least one of the first open area or the second open area, a terminal plate coupled to the cap plate, and a sealing member disposed between the cap plate and the terminal plate.
4. The secondary battery as recited in claim 1, further comprising a vent provided in the cover.
5. The secondary battery as recited in claim 1, further comprising a vent provided in the bottom portion.
6. The secondary battery as recited in claim 1, wherein the cover comprises a bend, and the cover is welded to the side portion in a region where the bend and the side portion overlap.
7. The secondary battery as recited in claim 1, wherein the bend is a first bend, wherein the side portion comprises a second bend, and the cover and the side portion are welded in a region where the first bend and the cover overlap and a region where the second bend and the cover overlap.
8. The secondary battery as recited in claim 1, wherein the cover comprises a stepped portion overlapping a portion of the side portion, and the stepped portion is welded to the side portion.
9. The secondary battery as recited in claim 1, wherein an area of the bottom portion is less than an area of the side portion.
10. A secondary battery comprising: an electrode assembly; a case in which the electrode assembly is accommodated; a subplate assembly coupled to a first side of the electrode assembly; and a cap assembly coupled to the subplate assembly, wherein the cap assembly comprises a terminal plate, the terminal plate is welded to the subplate assembly, wherein the case comprises a bottom portion,

a side portion connected to the bottom portion, and a cover facing the bottom portion, and wherein the cover is welded to the side portion.

11. The secondary battery as recited in claim 10, wherein the side portion comprises a stepped portion that overlaps a portion of the cover, and wherein the stepped portion is welded to the cover.

12. The secondary battery as recited in claim 10, wherein the terminal plate comprises an upper terminal plate and a lower terminal plate, wherein the upper terminal plate and the lower terminal plate are formed of different materials.

13. A method of manufacturing a secondary battery, the method comprising: coupling a first subplate assembly and a second subplate assembly to opposite sides of an electrode assembly; forming a cap-subplate electrode assembly by coupling a first cap assembly to the first subplate assembly and a second cap assembly to the second subplate assembly; inserting the cap-subplate electrode assembly into a case, wherein the case comprises a first open area, a second open area facing the first open area in a first direction, and a third open area open in a second direction that is orthogonal to the first direction; and welding a cover positioned in the third open area to the case.

14. The method as recited in claim 13, further comprising, before welding the cover to the case: welding the first cap assembly positioned in the first open area to the case; and welding the second cap assembly positioned in the second open area to the case.

15. The method as recited in claim 14, further comprising welding the cover to the first cap assembly and welding the cover to the second cap assembly.

16. The method as recited in claim 13, further comprising: welding the first cap assembly positioned in the first open area to the case; and welding the second cap assembly positioned in the second open area to the case.

17. The method as recited in claim 13, wherein the first subplate assembly comprises a current collector comprising a protruding portion, and the first cap assembly comprises a terminal plate, and wherein the method further comprising welding the protruding portion to the terminal plate.

18. The method as recited in claim 13, wherein the cover comprises a vent.

19. The method as recited in claim 13, wherein the cover comprises a bend, and wherein the welding of the cover to the case comprises welding an overlapping portion of the bend to a side portion of the case.

20. The method as claimed in claim 19, wherein the bend is a first bend, wherein the cover comprises a second bend, and the welding of the cover to the case comprises welding an overlapping portion of the second bend to the cover.