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Inventor(s)

KIM; Jihwan et al.

CAP ASSEMBLY AND SECONDARY BATTERY INCLUDING A CAP ASSEMBLY

Abstract

A secondary battery includes an electrode assembly, a subplate connected to the electrode assembly, a current collector including a planar portion coupled to the subplate. A protruding portion protrudes from the planar portion, and a tab portion is provided on a side surface of the protruding portion. A terminal plate configured to includes a recessed portion in a shape that corresponds to the tab portion.

Inventors: KIM; Jihwan (Yongin-si, KR), YONG; Jun Sun (Yongin-si, KR), BAE; Kwangsoo (Yongin-si, KR), LEE; Junhyung (Yongin-si, KR), ROH; Heyoungcheoul (Yongin-si, KR), BAE; Chaeun (Yongin-si, KR), LEE; Jungwoo (Yongin-si, KR)

Applicant: SAMSUNG SDI CO., LTD. (Yongin-si, KR)

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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. 10-2024-0023744, 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 cap sub assembly and a secondary battery including a cap sub assembly.

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, laptops, and tablets), electric vehicles, solar power generation, and emergency power supplies. In particular, 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 the can is sealed by welding a cap plate. However, when there is a poor 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 include information that does not constitute related (or prior) art.

SUMMARY

[0006] An aspect of the present disclosure is to provide a cap assembly and a secondary battery configured to solve at least one of the above-described problems.

[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 subplate connected to the electrode assembly, a current collector including a planar portion coupled to the subplate, a protruding portion protruding from the planar portion, and a tab portion provided on a side surface of the protruding portion, and a terminal plate including a recessed portion in shape that corresponds to a shape of the tab portion.

[0009] In some embodiments, wherein the tab portion and the recessed portion are fitted to each other.

[0010] In some embodiments, an upper surface of the protruding portion is in contact with the terminal plate.

[0011] In some embodiments, an upper surface of the terminal plate comprises an area welded with the protruding portion.

[0012] In some embodiments, the protruding portion has a cylindrical shape, the tab portion has a ring shape, and a diameter of the protruding portion is less than a diameter of the tab portion.

[0013] In some embodiments, the terminal plate covers an upper surface of the protruding portion.

[0014] In some embodiments, a hole is formed in the terminal plate, and a portion of an upper surface of the protruding portion is exposed through the hole.

[0015] In some embodiments, the secondary battery further comprises a case accommodating the electrode assembly, the case including an open first side and an open second side opposite the first side, a first cap plate covering the first side of the case, and a second cap plate covering the second side of the case, wherein a through-hole is formed in the first cap plate, and the protruding portion extends through the through-hole.

[0016] In some embodiments, the case comprises, a first long sidewall and a second long sidewall facing and spaced apart from each other, a first short sidewall and a second short sidewall facing and spaced apart from each other, areas of the first and second short sidewalls are less than areas of the first and second long sidewalls.

[0017] According to some embodiments of the present disclosure, a secondary battery comprises, an electrode assembly, a case accommodating the electrode assembly, the case including an open first side and an open second side opposite the first side, a first subplate assembly and a second subplate assembly electrically connected to opposite sides of the electrode assembly, a first cap assembly covering the first side of the case and coupled to the first subplate assembly, and a second cap assembly covering the second side and coupled to the second subplate assembly, wherein the first cap assembly comprises a first cap plate and a first terminal plate coupled to the first cap plate, the first terminal plate including a first recessed portion, the first subplate assembly comprises a first subplate and a first current collector coupled to a surface of the first subplate, and the first current collector comprises a first protruding portion and a first tab portion provided on the first protruding portion, and wherein the protruding portion is coupled to the recessed portion.

[0018] In some embodiments, the second cap assembly comprises a second cap plate and a second terminal plate coupled to the second cap plate, the second terminal plate including a second recessed portion, the second subplate assembly comprises a second subplate and a second current collector coupled to a surface of the second subplate, and the second current collector comprises a second protruding portion and a second tab portion, and wherein the second tab portion is coupled to the second recessed portion.

[0019] In some embodiments, the second terminal plate comprises an upper terminal plate and a lower terminal plate, and the upper terminal plate and the lower terminal plate comprise different materials.

[0020] In some embodiments, the second terminal plate comprises an upper terminal plate and a lower terminal plate, and the second recessed portion is provided inside the upper terminal plate.

[0021] In some embodiments, the second terminal plate comprises an upper terminal plate and a lower terminal plate, and the second protruding portion extends through the lower terminal plate.

[0022] In some embodiments, the first cap assembly further comprises a sealing member disposed between the first cap plate and the first terminal plate.

[0023] In some embodiments, the first terminal plate and the first protruding portion are coupled to each other by welding.

[0024] In some embodiments, the case comprises, a first long sidewall and a second long sidewall facing each other and spaced apart from each other, and a first short sidewall and a second short sidewall facing each other and spaced apart from each other, wherein areas of the first and second short sidewalls are less than areas of the first and second long sidewalls.

[0025] In some embodiments, the secondary battery further comprises a vent provided on a surface of the case.

[0026] According to some embodiments of the present disclosure, a cap assembly configured to be coupled to a current collector that includes a tab portion, the cap assembly comprises, a cap plate, a sealing member coupled to the cap plate, and a terminal plate coupled to the sealing member, wherein the terminal plate comprises a recessed portion in a shape that corresponds to a shape of the tab portion.

[0027] In some embodiments, the terminal plate comprises an upper terminal plate and a lower terminal plate, and the upper terminal plate and the lower terminal plate comprise different materials.

[0028] According to embodiments of the present disclosure, the fit between the current collector and the terminal plate may be improved and the reliability of the secondary battery may be improved by using the current collector having a tab portion and the terminal plate having a recessed portion.

[0029] According to embodiments of the present disclosure, the capacitor and the terminal plate may be fixed, and the electrical characteristics of the secondary battery may be stably maintained by fitting the current collector having a tab portion and the terminal plate having an recessed portion to each other.

[0030] According to embodiments of the present disclosure, whether the collector and the terminal plate are tightly fitted to each other may be checked using the hole of the terminal plate, thereby reducing defects in the manufacturing process.

[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 cross-sectional diagram showing the secondary battery according to some embodiments of the present disclosure;

[0035] FIG. 3 illustrates a perspective diagram showing a case according to some embodiments of the present disclosure;

[0036] FIG. 4 illustrates an enlarged diagram showing a region R1 in FIG. 2;

[0037] FIG. 5 illustrates a diagram in which the first cap assembly and the first subplate assembly in FIG. 4 are separated from each other

[0038] FIG. 6 illustrates an enlarged diagram showing a region R2 in FIG. 2;

[0039] FIG. 7 illustrates a diagram in which the second cap assembly and the second subplate in FIG. 7 are separated from each other;

[0040] FIG. 8 illustrates the secondary battery according to some embodiments of the present disclosure;

[0041] FIG. 9 illustrates the secondary battery according to some embodiments of the present disclosure;

[0042] FIG. 10 illustrates a perspective diagram showing a secondary battery according to some embodiments of the present disclosure;

[0043] FIG. 11 illustrates a cross-sectional diagram showing the secondary battery according to some embodiments of the present disclosure.

[0044] FIGS. 12 and 13 illustrate a method of manufacturing a secondary battery according to some embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] 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.

[0051] 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.

[0052] 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).

[0053] 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.

[0054] Throughout the specification, unless otherwise stated, each element may be singular or plural.

[0055] 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.

[0056] 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”.

[0057] 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.

[0058] FIG. 1 illustrates a perspective diagram showing a secondary battery according to some embodiments of the present disclosure. FIG. 2 illustrates a cross-sectional diagram showing the secondary battery according to some embodiments of the present disclosure.

[0059] Referring to FIGS. 1 and 2, the secondary battery may include an electrode assembly **100**, a case **200** including 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**.

[0060] The first subplate assembly **310** may be coupled to a first side of the electrode assembly **100** and may be electrically connected to a first electrode plate (e.g., a 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**.

[0061] The second subplate assembly **410** may be coupled to a second side of the electrode assembly **100** and may be electrically connected to a second electrode plate (e.g., a negative

electrode plate) of the electrode assembly **100**. The second subplate assembly **410** may include a second subplate **420** and a second current collector **430**.

[0062] 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 of which may be formed as a thin plate or film. When 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. In addition, 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 as a Z stack. One or more electrode assemblies **100** may be stacked so that the long sides thereof are adjacent to each other so as to be received in the case **200**. 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.

[0063] 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 such as, for example, copper (Cu), a Cu alloy, nickel (Ni), or a Ni alloy. The first electrode plate may include a first electrode tab (or a first uncoated portion), which is a region to which the first electrode active material is not applied. The first electrode tab may form 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 tab may protrude further from the first side than the separator without additional cutting.

[0064] 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 such as, for example, Al or an Al alloy, and may include a second electrode tab (or a second uncoated portion), which is a region to which the second electrode active material is not applied. The second electrode tab form 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 tab may protrude further from the second side than the separator without additional cutting.

[0065] 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 reference to the secondary battery illustrated in FIG. 2, and the positions may change as the secondary battery is rotated left and right or up and down.

[0066] 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 illustrated as being provided on the first cap plate **360**, but the present disclosure is not limited to such a configuration. After the electrolyte injection is complete, the electrolyte inlet **130** may be sealed using a sealing means such as a stopper.

[0067] In some embodiments, a vent **110** may be provided on a first side of the case **200**. For example, the vent **110** may be provided on a lower surface of the case **200**. Herein, the lower surface may refer to a surface facing downward in a case where the secondary battery is installed. The vent **110** may prevent the secondary battery from exploding or prevent a chain exothermic reaction of secondary batteries arranged in close proximity. For 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 another example, the vent **110** may be configured to be open when the internal temperature exceeds a predetermined critical temperature.

[0068] In FIG. **1**, the vent **110** is illustrated as being a single vent provided at the center of one surface of the case **200**, but the present disclosure is not limited to such a configuration. Any number of vents **110** may be provided at any positions in a first surface of the case **200**. For example, two or more vents **110** may be provided on one surface of the case **200**.

[0069] FIG. **3** illustrates a perspective diagram showing a case according to some embodiments of the present disclosure.

[0070] Referring to FIGS. **2** and **3**, the case **200** may include long sidewalls **230** facing each other, short sidewalls **240** facing each other, an open first side **210**, and an open second side **220**.

[0071] As shown in the figures, 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 respectively orthogonal to the first direction X and the second direction Y. The third direction Z may refer to the Z-axis direction.

[0072] The long sidewalls **230** may include a first long sidewall portion and a second long sidewall portion. The first long sidewall portion and the second long sidewall portion may face each other. More specifically, the first long sidewall portion and the second long sidewall portion may face each other while being spaced apart from each other in the second direction Y.

[0073] The short sidewalls **240** may include a first short sidewall portion and a second short sidewall portion. The first short sidewall portion and the second short sidewall portion may face each other. More specifically, the first short sidewall portion and the second short sidewall portion may face each other while being spaced apart from each other in the third direction Z. The area of each of the first short sidewall portion and the second short sidewall portion may be less than the area of each of the first long sidewall portion and the second long sidewall portion.

[0074] The open first side **210** and the open second side **220** may be formed on the opposite sides of the case **200**. The open second side **220** may face the open first side **210**. More specifically, the open second side **220** and the open first side **210** may face each other while being spaced apart from each other in the first direction X. Each of the open first and second sides **210** and **220** may refer to an open area.

[0075] The case **200** may be formed of a conductive metal, such as Al, an Al alloy, or Ni-plated steel.

[0076] The first cap plate **360** may cover the open first side **210** and be coupled to the case **200**. A second cap plate **460** may cover the open second side **220** and be coupled to the case **200**. In particular, each of the first cap plate **360** and the second cap plate **460** may be coupled to the case **200** by welding. The first cap plate **360** and the second cap plate **460** may seal the case **200**.

[0077] FIG. **4** illustrates an enlarged diagram showing a region R1 in FIG. **2**. FIG. **5** illustrates a diagram in which the first cap assembly and the first subplate assembly in FIG. **4** are separated from each other.

[0078] Referring to FIG. **4**, the first subplate assembly **310** and the first cap assembly **350** may be coupled to a first side of the electrode assembly **100**.

[0079] 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 the first subplate **320** and the first current collector **330**.

[0080] 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 coupled to the first subplate **320** by welding. The first subplate **320** may be connected to the first electrode tab and electrically connected to the first electrode plate.

[0081] 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 coupled to each other by welding. The

first current collector **330** and the first subplate **320** may be electrically connected to each other.

[0082] A first insulation member **340** may be positioned between the first subplate assembly **310** and the first cap assembly **350**. The first insulation member **340** may prevent the first subplate **320** and the first cap plate **360** from contacting each other.

[0083] Referring to FIG. 5, the first current collector **330** may include a first planar portion **330_PL**, a first protruding portion **330_PR**, and a first tab portion **330_EM**. The first planar portion **330_PL** may be coupled to the first subplate **320** by welding. The first protruding portion **330_PR** may protrude from the first planar portion **330_PL**. The first protruding portion **320_PR** may have the shape of a cylinder.

[0084] The first tab portion **330_EM** may be formed on a side of the first protruding portion **330_PR**. The first tab portion **330_EM** may have the shape of a ring. For example, the first tab portion **330_EM** may be a ring-shaped portion protruding from the side of the first protruding portion **330_PR**. The diameter of the first protruding portion **330_PR** may be less than the diameter of the first tab portion **330_EM**.

[0085] In some embodiments, the first tab portion **330_EM** may be provided on a first end of the first protruding portion **330_PR**. For example, the first tab portion **330_EM** may be provided on top of a side of the first protruding portion **330_PR**. However, the present disclosure is not limited to such a configuration.

[0086] The first cap assembly **350** may include a first cap plate **360**, a first sealing member **370**, and a first terminal plate **380**.

[0087] The first cap plate **360** may include a first through-hole TH1. The first sealing member **370** may be coupled to the first cap plate **360**. In particular, 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 such that the first sealing member **370** may insulate the first cap plate **360** and the first terminal plate **380** from each other.

[0088] The first terminal plate **380** may be coupled to the first sealing member **370**. The first terminal plate **380** may be a positive electrode terminal of a secondary battery. A busbar may be welded onto the first terminal plate **380** and be electrically connected to another secondary battery.

[0089] The first terminal plate **380** may include a first recess portion **380_EG**. The first recessed portion **380_EG** may be in a shape of recess that corresponds to the first tab portion **330_EM**.

[0090] The first current collector **330** may be coupled to the first terminal plate **380**. Specifically, the first protruding portion **330_PR** may extend through a first through-hole TH1, and the first tab portion **330_EM** and the first recessed portion **380_EG** may be coupled to each other. For example, the first tab portion **330_EM** may be fitted into the first recessed portion **380_EG**. Because the first recessed portion **380_EG** has a groove shape corresponding to the first tab portion **330_EM**, the first current collector **330** and the first terminal plate **380** may be fixedly coupled to each other.

[0091] As shown in FIG. 4, in a case where the first subplate assembly **310** and the first cap assembly **350** are coupled to each other, the upper surface of the first protruding portion **330_PR** may contact the first terminal plate **380**. The first terminal plate **380** may cover the upper surface of the first protruding portion **330_PR**. The first terminal plate **380** may completely cover the upper surface of the first protruding portion **330_PR**. The first protruding portion **330_PR** and the first terminal plate **380** may be welded. For example, a weld area may be formed on the upper surface of the first terminal plate **380**. A welding process may be performed in the welding area, thereby coupling the first terminal plate **380** and the first current collector **330** to each other. Accordingly, the first current collector **330** and the first terminal plate **380** may be electrically connected. A welding bead or the like may be formed on the welding area as a result of the welding process.

[0092] Secondary batteries may be manufactured by inserting an electrode assembly into a case and welding a cap plate to opposite sides of the case. In such a secondary battery manufacturing process, a defect in which the terminal plate and the current collector are not tightly fitted to each other may occur. When the terminal plate and current collector are welded without a tight fit, the

electrical characteristics of the secondary battery may be reduced. Accordingly, the reliability of the secondary battery may be reduced.

[0093] In some embodiments of the present disclosure, the first terminal plate **380** includes the first recessed portion **380_EG**, and the first current collector **330** includes the first tab portion **330_EM**. Because the first tab portion **330_EM** is fitted into the first recessed portion **380_EG**, the first terminal plate **380** and the first current collector **330** are in close contact. That is, the upper surface of the first current collector **330** may contact the first terminal plate **380**. Accordingly, the electrical characteristics of the secondary cell may be maintained, and the reliability of the secondary cell may be improved.

[0094] FIG. **6** illustrates an enlarged diagram showing a region R2 in FIG. **2**. FIG. **7** illustrates a diagram in which the second cap assembly and the second subplate in FIG. **6** are separated from each other.

[0095] 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**. 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**.

[0096] 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 coupled to the second subplate **420** by welding. The second subplate **420** may be connected to the second electrode tab, and may be electrically connected to the second electrode plate.

[0097] 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** can be coupled to each other by welding. The second current collector **430** may be electrically connected to the second first subplate **420**. A second insulation member **440** may be positioned between the second subplate assembly **410** and the second cap assembly **450**. The second insulation member **440** may prevent the second subplate **420** and the second cap plate **460** from contacting each other.

[0098] Referring to FIG. **7**, the second current collector **430** may include a second planar portion **430_PL**, a second protruding portion **430_PR**, and a second tab portion **430_EM**. The second planar portion **430_PL** may be coupled to the second first subplate **420** by welding. The second protruding portion **430_PR** may protrude from the second planar portion **430_PL**. The second protruding portion **430_PR** may have the shape of a cylinder.

[0099] The second tab portion **430_EM** may be provided on a side of the second protruding portion **430_PR**. The second tab portion **430_EM** may have the shape of a ring. For example, the second tab portion **430_EM** may be a ring-shaped portion protruding from the side of the second protruding portion **430_PR**. The diameter of the second protruding portion **430_PR** may be less than the diameter of the second tab portion **430_EM**.

[0100] In some embodiments, the second tab portion **430_EM** may be provided on a first end of the second protruding portion **430_PR**. For example, the second tab portion **430_EM** may be provided on top of a side of the second protruding portion **430_PR**. However, the present disclosure is not limited to such a configuration.

[0101] The second cap assembly **450** may include the second cap plate **460**, a second sealing member **470**, and a second terminal plate **480**.

[0102] The second cap plate **460** may include a second through-hole TH2. The second sealing member **470** may be coupled to the second cap plate **460**. 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 such that the second sealing member **470** may insulate the second cap plate **460** and the second terminal plate **480** from each other.

[0103] The second terminal plate **480** may be coupled to the second sealing member **470**. The

second terminal plate **480** may be a negative electrode terminal of the secondary battery. A busbar may be welded onto the second terminal plate **480** to be electrically connected to another secondary battery.

[0104] The second terminal plate **480** may include an 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**.

[0105] The upper terminal plate **480_UT** and the lower terminal plate **480_LT** may be formed from different materials. For example, the lower terminal plate **480_LT** may include copper (Cu) and the upper terminal plate **480_UT** may include aluminum (Al). However, the present disclosure is not limited thereto. The upper terminal plate **480_UT** and the lower terminal plate **480_LT** may include other conductive metals.

[0106] The second terminal plate **480** may include a second recessed portion **480_EG**. The second recessed portion **480_EG** may be formed inside the upper terminal plate **480_UT**. The second recessed portion **480_EG** may be in a shape that corresponds to the second tab portion **430_EM**.

[0107] The second current collector **430** may be coupled to the second terminal plate **480**. Specifically, the second protruding portion **430_PR** may extend through each of the second through-hole TH2 and the lower terminal plate **480_LT**, and the second tab portion **430_EM** and the second recessed portion **480_EG** may be coupled to each other. For example, the second tab portion **430_EM** may be fitted into the second recessed portion **480_EG**. Because the second recessed portion **480_EG** has a groove shape corresponding to the second tab portion **430_EM**, the second current collector **430** and the second terminal plate **480** may be fixedly coupled to each other.

[0108] When the second first subplate and assembly **410** and the second cap assembly **450** are coupled to each other as in FIG. 6, the upper surface of the second protruding portion **430_PR** may contact the upper terminal plate **480_UT**. The upper terminal plate **480_UT** may cover the upper surface of the second protruding portion **430_PR**. The upper terminal plate **480_UT** may completely cover the upper surface of the second protruding portion **430_PR**. The second protruding portion **430_PR** and the upper terminal plate **480_UT** may be welded. For example, a weld area may be formed on the upper surface of the upper terminal plate **480_UT**. The upper surface of the upper terminal plate **480_UT** may be the upper surface of the second terminal plate **480**. A welding process may be performed in the welding area, such that the second terminal plate **480** and the second current collector **430** may be coupled to each other. Accordingly, the second current collector **430** and the second terminal plate **480** may be electrically connected. A welding bead or the like may be formed on the welding area as a result of the welding process.

[0109] According to some embodiments of the present disclosure, the second terminal plate **480** includes a second recessed portion **480_EG** and the second current collector **430** includes a second tab portion **430_EM**. Because the second tab portion **430_EM** is fitted into the second recessed portion **480_EG**, the second terminal plate **480** and the second current collector **430** are in close contact. That is, the upper surface of the second current collector **430** may contact the second terminal plate **480**. Accordingly, the electrical characteristics of the secondary cell may be stably maintained, and the reliability of the secondary battery may be improved.

[0110] FIG. 8 illustrates the secondary battery according to some embodiments of the present disclosure. For reference, FIG. 8 illustrates an enlarged diagram showing the region R1 in FIG. 2. For ease of description, the following description will focus on features other than those described above with reference to FIG. 4.

[0111] Referring to FIG. 8, the first terminal plate **380** may include a hole **390**. A portion of the upper surface of the first current collector **330** is exposed through the hole **390**. The hole **390** may be formed in a portion where the first terminal plate **380** and the first current collector **330** overlap

in a first direction X. For example, the hole **390** may be formed at the center of the portion where the first terminal plate **380** and the first current collector **330** overlap in the first direction X.

[0112] The first current collector **330** and the first terminal plate **380** may be welded. For example, a welding area may be formed on the upper surface of the first terminal plate **380**. The welding area may be formed around the hole **390**. A welding process may be performed on the welding area to join 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 to each other. A welding bead or the like may be formed on the welding area as a result of the welding process.

[0113] For ease of illustration, only the first terminal plate **380** is shown, but a hole may be similarly formed in the second terminal plate (**480** in FIG. 6).

[0114] In the secondary battery manufacturing process, a defect in which the cap plate and current collector do not tightly fit may occur. According to some embodiments of the present disclosure, the first terminal plate **380** may include a hole **390**, and through the hole **390** the fit between the cap plate and current collector may be checked. Accordingly, defects may be reduced in the process of manufacturing a secondary battery.

[0115] FIG. 9 illustrates the secondary battery according to some embodiments of the present disclosure. For ease of description, the following description will focus on features other than those described above with reference to FIG. 5.

[0116] Referring to FIG. 9, a third cap assembly **550** may include a third cap plate **560**, a third sealing member **570**, and a third terminal plate **580**. A third subplate assembly **510** may include a third subplate **520** and a third current collector **530**. Descriptions of the third cap assembly **550** and the third current collector **530** may be similar to the descriptions of the first cap assembly **350** and the first current collector **330**, respectively, in FIG. 5. Accordingly, the following description will focus on differences from the descriptions above.

[0117] The third current collector **530** may include a third planar portion **530_PL**, a third protruding portion **530_PR**, and a third tab portion **530_EM**. The third planar portion **530_PL** may be coupled to the third subplate **520** by welding. The third protruding portion **530_PR** may protrude from the third planar portion **530_PL**. The third protruding portion **530_PR** may have a cylindrical shape.

[0118] The third tab portion **530_EM** may be provided on a side of the third protruding portion **530_PR**. The third tab portion **530_EM** may have a ring shape. For example, the third tab portion **530_EM** may be a ring-shaped portion protruding from a side of the third protruding portion **530_PR**. The diameter of the third protruding portion **530_PR** may be less than the diameter of the third tab portion **530_EM**.

[0119] The third tab portion **530_EM** may be provided on a portion spaced apart from a first side of the third protruding portion **530_PR**. For example, the third tab portion **530_EM** may be provided on a portion spaced apart from the upper surface of the third protruding portion **530_PR**.

[0120] The third terminal plate **580** may include a third recessed portion **580_EG**. The third recessed portion **580_EG** may be shaped to correspond to the shape of the third tab portion **530_EM**.

[0121] A third current collector **530** may be coupled to a third terminal plate **580**. Specifically, the third protruding portion **530_PR** may extend through a third through-hole TH3, and the third tab portion **530_EM** and the third recessed portion **580_EG** may be coupled to each other. For example, the third tab portion **530_EM** may be fitted into the third recessed portion **580_EG**. Because the third recessed portion **580_EG** is shaped to correspond to the shape of the third recessed portion **530_EM**, the third current collector **530** and the third terminal plate **580** may be fixedly coupled to each other.

[0122] FIG. 10 illustrates a perspective diagram showing a secondary battery according to some embodiments of the present disclosure. FIG. 11 illustrates a cross-sectional diagram showing the secondary battery according to some embodiments of the present disclosure.

[0123] Referring to FIGS. **10** and **11**, the secondary battery may include an electrode assembly **100**, a case **200** accommodating the electrode assembly, a third cap plate **260**, a first subplate assembly **310**, a second subplate assembly **410**, a first terminal plate **380**, and a second terminal plate **480**.

[0124] The electrode assembly **100** may be accommodated within the case **200**. The electrode assembly **100** may include a first electrode plate, a separator, and a second electrode plate. The first electrode plate may include a first electrode tab. The second electrode plate may include a second electrode tab. In some embodiments, each of the first electrode tab and the second electrode tab are positioned on an upper side of the electrode assembly. The term “upper side” is used herein for ease of description with reference to the secondary battery shown in FIG. **10**, but the position thereof may change when the secondary battery is rotated left and right or up and down.

[0125] The electrolyte inlet **130** may be provided on the third cap plate **260**. Electrolyte may be injected into the case **200** through the electrolyte inlet **130**. After the electrolyte injection is complete, the electrolyte inlet **130** may be sealed using a sealing means, such as a stopper or the like.

[0126] In some embodiments, the vent **110** may be provided on the third cap plate **260**, but the present disclosure is not limited to such a configuration. For example, the vent **110** may be provided on the lower surface of the case **200**. Herein, the lower surface of the case **200** may be a side opposite the third cap plate **260** in the third direction Z. The vent **110** may prevent the secondary battery from exploding or prevent a chain exothermic reaction of secondary batteries arranged in close proximity.

[0127] The case **200** may include a third side that is open in the third direction Z. The third cap plate **260** may be coupled to the surface of the case **200** at the open third side to seal the secondary battery.

[0128] The first subplate assembly **310** may be coupled to the surface of the first electrode tab of the electrode assembly **100**. The first subplate assembly **310** may include the first subplate **320** and the first current collector **330**. The first subplate **320** may be coupled to the first electrode tab by welding, and the first current collector **330** may be coupled to the first subplate **320** by welding. The first current collector **330** may include a first planar portion, a first protruding portion, and a first tab portion. Descriptions of the first subplate **320** and the first current collector **330** may be the same as those described with reference to FIGS. **4** and **5**.

[0129] The second subplate assembly **410** may be coupled to the surface of the second electrode tab of the electrode assembly **100**. The second subplate assembly **410** may include the second subplate **420** and the second current collector **430**. The second subplate **420** may be coupled to the second electrode tab by welding, and the second current collector **430** may be coupled to the second subplate **420** by welding. The second current collector **430** may include a second planar portion, a second protruding portion, and a second tab portion. Descriptions of the second first subplate **420** and the second current collector **430** may be the same as those described with reference to FIGS. **6** and **7**.

[0130] The third cap plate **260** may be coupled to the surfaces of the first subplate assembly **310** and second subplate assembly **410**. The first sealing member **370** may be coupled to the surface of the third cap plate **260**, and the first terminal plate **380** may be coupled to the surface of the first sealing member **370**. The first terminal plate **380** may include a first recessed portion. The first terminal plate **380** may be electrically connected to the first current collector **330**. Descriptions of the first sealing member **370** and the first terminal plate **380** may be the same as those described above with reference to FIGS. **4** and **5**.

[0131] The second sealing member **470** may be coupled to the surface of the third cap plate **260**, and the second terminal plate **480** may be coupled to the surface of the second sealing member **470**. The second terminal plate **480** may include a second recessed portion. The second terminal plate **480** may be electrically connected to the second current collector **430**. Descriptions of the second sealing member **470** and the second terminal plate **480** may be the same as those described above

with reference to FIGS. 4 and 5.

[0132] FIGS. 12 and 13 illustrate a method of manufacturing a secondary battery according to some embodiments of the present disclosure.

[0133] Referring to FIG. 12, the electrode assembly 100 may be inserted into the case 200.

[0134] The electrode assembly 100 including the first subplate assembly 310 and the first insulation member 340 may be coupled to a first side and the second subplate assembly (not shown) and the second insulation member (not shown) may be coupled on a second side. The case 200 may include the vent 110, the open first side 210, and the open second side 220. The electrode assembly 100 may be inserted through the open second side 220 in the first direction X and received in the case 200.

[0135] Referring to FIG. 13, the first cap assembly 350 may be coupled to the surface of the first subplate assembly 310, and the second cap assembly 450 may be coupled to the surface of the second subplate assembly 410.

[0136] Specifically, as described above with reference to FIG. 5, the first current collector 330 and the first terminal plate 380 may be fitted to each other. Subsequently, the first current collector 330 and the first terminal plate 380 may be welded, and the case 200 and the first cap plate 360 may be welded. However, the welding sequence is not limited.

[0137] As described above with reference to FIG. 7, the second current collector 430 and the second terminal plate 480 may be fitted to each other. Subsequently, the second current collector 430 and the second terminal plate 480 may be welded, and the case 200 and the second cap plate 460 may be welded. However, the welding sequence is not limited.

[0138] It has been described above that the first cap assembly 350 is coupled to the first subplate assembly 310 and the second cap assembly 450 is coupled to the second first subplate assembly 410, but the present disclosure is not limited in this regard. For example, the order may be changed, and the first cap assembly 350 and the second cap assembly 450 may be coupled at substantially the same time.

[0139] 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 310: first subplate assembly 320: first subplate 330: first current collector 330_PL: first planar portion 330_PR: first protruding portion 330_EM: first tab portion 340: first insulation member 350: first cap assembly 360: first cap plate 370: first sealing member 380: first terminal plate 380_EG: first recessed portion 410: second first subplate assembly 420: second first subplate 430: second current collector 430_PL: second planar portion 430_PR: second protruding portion 430_EM: second tab portion 440: second insulation member 450: second cap assembly 460: second cap plate 470: second sealing member 480: second terminal plate 480_EG: second recessed portion

Claims

1. A secondary battery comprising: an electrode assembly; a subplate connected to the electrode assembly; a current collector including a planar portion coupled to the subplate, a protruding portion protruding from the planar portion, and a tab portion provided on a side surface of the protruding portion; and a terminal plate including a recessed portion that is shaped to correspond to a shape of the tab portion.
2. The secondary battery as recited in claim 1, wherein the tab portion and the recessed portion are fitted to each other.
3. The secondary battery as recited in claim 1, wherein an upper surface of the protruding portion is

in contact with the terminal plate.

4. The secondary battery as recited in claim 1, wherein an upper surface of the terminal plate comprises an area welded with the protruding portion.

5. The secondary battery as recited in claim 1, wherein the protruding portion has a cylindrical shape, the tab portion has a ring shape, and wherein a diameter of the protruding portion is less than a diameter of the tab portion.

6. The secondary battery as recited in claim 1, wherein the terminal plate covers an upper surface of the protruding portion.

7. The secondary battery as recited in claim 1, wherein a hole is formed in the terminal plate, and a portion of an upper surface of the protruding portion is exposed through the hole.

8. The secondary battery as recited in claim 1, further comprising: a case accommodating the electrode assembly, the case including an open first side and an open second side opposite the first side; a first cap plate covering the first side of the case; and a second cap plate covering the second side, wherein a through-hole is formed the first cap plate and wherein the protruding portion extends through the through-hole.

9. The secondary battery as recited in claim 8, wherein the case comprises: a first long sidewall and a second long sidewall facing each other and spaced apart from each other; a first short sidewall and a second short sidewall facing each other and spaced apart from each other, wherein areas of the first and second short sidewalls are less than areas of the first and second long sidewalls.

10. A secondary battery comprising: an electrode assembly; a case accommodating the electrode assembly, the case including an open first side and an open second side opposite the first side; a first subplate assembly and a second subplate assembly electrically connected to opposite sides of the electrode assembly; a first cap assembly covering the first side of the case and coupled to the first subplate assembly; and a second cap assembly covering the second side and coupled to the second subplate assembly, wherein the first cap assembly comprises a cap plate and a terminal plate coupled to the cap plate, the terminal plate including a recessed portion, wherein the first subplate assembly comprises a subplate and a current collector coupled to a surface of the subplate, wherein the current collector comprises a protruding portion and a tab portion provided on the protruding portion, and wherein the protruding portion is coupled to the recessed portion.

11. The secondary battery as recited in claim 10, wherein the cap plate is a first cap plate, the terminal plate is a first terminal plate, the recessed portion is a first recessed portion, the subplate is a first subplate, the current collector is a first current collector, the protruding portion is a first protruding portion, and the tab portion is a first tab portion, wherein the second cap assembly comprises a second cap plate and a second terminal plate coupled to the second cap plate, the second terminal plate including a second recessed portion, wherein the second subplate assembly comprises a second subplate and a second current collector coupled to a surface of the second subplate, wherein the second current collector comprises a second protruding portion and a second tab portion, and wherein the second tab portion is coupled to the second recessed portion.

12. The secondary battery as recited in claim 11, wherein the second terminal plate comprises an upper terminal plate and a lower terminal plate, and wherein the upper terminal plate and the lower terminal plate comprise different materials.

13. The secondary battery as recited in claim 11, wherein the second terminal plate comprises an upper terminal plate and a lower terminal plate, and wherein the second recessed portion is provided inside the upper terminal plate.

14. The secondary battery as recited in claim 11, wherein the second terminal plate comprises an upper terminal plate and a lower terminal plate, and wherein the second protruding portion extends through the lower terminal plate.

15. The secondary battery as recited in claim 10, wherein the cap assembly further comprises a sealing member disposed between the cap plate and the terminal plate.

16. The secondary battery as recited in claim 10, wherein the terminal plate and the protruding

portion are coupled to each other by welding.

17. The secondary battery as recited in claim 10, wherein the case comprises: a first long sidewall and a second long sidewall facing each other and spaced apart from each other; and a first short sidewall and a second short sidewall configured facing each other and spaced apart from each other, wherein areas of the first and second short sidewalls are less than areas of the first and second long sidewalls.

18. The secondary battery as recited in claim 10, further comprising a vent provided on a surface of the case.

19. A cap assembly configured to be coupled to a current collector that includes a tab portion, the cap assembly comprising: a cap plate; a sealing member coupled to the cap plate; and a terminal plate coupled to the sealing member, wherein the terminal plate comprises a recessed portion that is shaped to correspond to a shape of the tab portion.

20. The cap assembly as recited in claim 19, wherein the terminal plate comprises an upper terminal plate and a lower terminal plate, and wherein the upper terminal plate and the lower terminal plate comprise different materials.
