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CYLINDRICAL SECONDARY BATTERY

Abstract

Disclosed is a cylindrical secondary battery in which an insulating member located between a rivet terminal and a can includes protrusions protruding therefrom upward and/or downward, thereby preventing rotation of the rivet terminal. The cylindrical secondary battery may include an electrode assembly including a positive electrode plate, a separator, and a negative electrode plate, a cylindrical can configured to accommodate the electrode assembly and to be electrically connected to the negative electrode plate and including an open lower end portion, a rivet terminal configured to be electrically connected to the positive electrode plate through an upper surface of the cylindrical can, an insulating member located between the cylindrical can and the rivet terminal, and a non-polar cap plate configured to seal the lower end portion of the cylindrical can. The insulating member may include protrusions formed on at least one surface thereof facing the cylindrical can or the rivet terminal.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to and the benefit under 35 U.S.C. § 119 (a)-(d) of Korean Patent Application No. 10-2024-0019860, filed on Feb. 8, 2024, at the Korean Intellectual Property Office, the entire contents of which are incorporated herein by reference.

FIELD

[0002] Embodiments relate to a cylindrical secondary battery.

BACKGROUND

[0003] Generally, a cylindrical secondary battery may include a cylindrical electrode assembly including a positive electrode plate, a separator, and a negative electrode plate, a cylindrical can accommodating the electrode assembly and an electrolyte, having an open lower end portion, and electrically connected to the negative electrode plate, a rivet terminal electrically connected to the positive electrode plate through an upper surface of the cylindrical can, and a cap assembly coupled to the lower end portion of the cylindrical can to seal the can and electrically connected to the electrode assembly to act as an electrical connection element between an external device and the electrode assembly.

[0004] The information disclosed in this section is provided only for enhancement of understanding of the background of the disclosure and therefore it may contain information that does not form the related art.

SUMMARY

[0005] Aspects of some embodiments provide a cylindrical secondary battery in which an insulating member located between a rivet terminal and a can includes protrusions protruding therefrom upward and downward, thereby preventing rotation of the rivet terminal.

[0006] A cylindrical secondary battery according to some embodiments includes an electrode assembly including a positive electrode plate, a separator, and a negative electrode plate, a cylindrical can configured to accommodate the electrode assembly and configured to be electrically connected to the negative electrode plate, wherein the cylindrical can includes an open portion, a rivet terminal configured to be electrically connected to the positive electrode plate through an upper surface of the cylindrical can, an insulating member located between the cylindrical can and the rivet terminal, and a non-polar cap plate configured to seal the open portion of the cylindrical can, wherein the insulating member includes protrusions formed on at least one surface of the insulating member facing the cylindrical can or the rivet terminal.

[0007] The insulating member may include a first terminal hole formed therein and configured to allow the rivet terminal to pass therethrough.

[0008] The protrusions may be formed symmetrically with respect to the first terminal hole.

[0009] The protrusions may be formed on a lower surface and an upper surface of the insulating member facing the cylindrical can and the rivet terminal.

[0010] The protrusions may be formed on the lower surface and the upper surface of the insulating member facing the cylindrical can and the rivet terminal so as to be misaligned from each other.

[0011] The protrusions may be formed on the lower surface and the upper surface of the insulating member at a predetermined angular interval.

[0012] The protrusions may be formed asymmetrically with respect to the first terminal hole.

[0013] The protrusions may be provided in different numbers in regions symmetrical with respect to the first terminal hole.
[0014] The protrusions may have a rectangular planar shape, a circular planar shape, or a triangular planar shape.
[0015] The rivet terminal may include an outer portion exposed above the cylindrical can and an insertion portion extending from the outer portion to within the cylindrical can.
[0016] The outer portion may include first protrusion recesses formed in a lower surface of the outer portion so as to allow the protrusions to be fitted into the first protrusion recesses, respectively.
[0017] The cylindrical can may include a second terminal hole formed in an upper surface of the cylindrical can configured to allow the rivet terminal to pass therethrough.
[0018] The cylindrical can may include second protrusion recesses formed in the upper surface of the cylindrical can so as to allow the protrusions to be fitted into the second protrusion recesses, respectively.
[0019] The second protrusion recesses may be formed symmetrically with respect to the second terminal hole.
[0020] A first gasket may be disposed between the rivet terminal and the second terminal hole.
[0021] The insulating member may be formed of at least one resin comprising perfluoroalkoxy (PFA), polypropylene (PP), or polybutylene terephthalate (PBT).
[0022] The planar shape of the protrusions may have a V-shape bent at a predetermined angle.
[0023] The planar shape of the protrusions may have a shape of an arc of a circle concentric with the first terminal hole.
[0024] A method of manufacturing a cylindrical secondary battery according to some embodiments includes providing a cylindrical can configured to accommodate an electrode assembly and configured to be electrically connected to a negative electrode plate of the electrode assembly, wherein the cylindrical can comprises an open portion; inserting the electrode assembly through the open portion of the cylindrical can; providing a rivet terminal configured to be electrically connected to a positive electrode plate of the electrode assembly through an upper surface of the cylindrical can; providing an insulating member between the cylindrical can and the rivet terminal, wherein the insulating member comprises protrusions formed on at least one surface of the insulating member facing the cylindrical can or the rivet terminal; and coupling to the cylindrical can a cap plate configured to seal the open portion of the cylindrical can.
[0025] The method may include fitting the protrusions into first protrusion recesses formed in a lower surface of an outer portion of the rivet terminal.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0026] The accompanying drawings, which are incorporated in this specification, illustrate exemplary embodiments and serve to further illustrate the technical ideas of the disclosure in conjunction with the detailed description of exemplary embodiments that follows, and the disclosure is not to be construed as limited to what is shown in such drawings. In the drawings:
[0027] FIG. **1** is a cross-sectional view of a cylindrical secondary battery according to some embodiments;
[0028] FIG. **2** is a perspective view showing an upper surface of a can of the cylindrical secondary battery shown in FIG. **1**;
[0029] FIGS. **3**A to **3**C are, respectively, a side view, a top perspective view, and a bottom perspective view of an insulating member of the cylindrical secondary battery shown in FIG. **1**;
[0030] FIG. **4** is a perspective view of a cylindrical secondary battery according to another

embodiment;

[0031] FIGS. **5**A and **5**B are, respectively, a top perspective view and a bottom perspective view showing an insulating member of the cylindrical secondary battery shown in FIG. **4**;

[0032] FIG. **6** is a perspective view of a cylindrical secondary battery according to another embodiment; and

[0033] FIGS. **7**A and **7**B are, respectively, a top perspective view and a bottom perspective view showing an insulating member of the cylindrical secondary battery shown in FIG. **6**.

DETAILED DESCRIPTION

[0034] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

[0035] Embodiments are provided to more fully illustrate the disclosure to a person having ordinary skill in the art, and the following embodiments may be modified in various other forms, and the scope of the disclosure is not limited to the following embodiments. The embodiments are provided to make the disclosure more complete and to convey the idea of the disclosure fully to those skilled in the art.

[0036] In the drawings, the thickness or size of each layer is exaggerated for convenience and clarity of description, and same reference numerals in the drawings refer to the same elements.

[0037] As used herein, the term “and/or” includes any one of the enumerated items and any combination of one or more thereof. As used herein, the term “connected” refers not only to direct connection between members A and B but also to indirect connection between members A and B with member C interposed therebetween.

[0038] The terms used in the specification are intended to describe example embodiments and are not intended to limit the disclosure. As used herein, singular forms may include plural forms, unless the context clearly indicates otherwise. As used herein, the terms “comprise” (or “include”) and/or “comprising” (or “including”) are intended to specify the presence of stated figures, numbers, steps, operations, members, elements, and/or groups thereof and do not exclude the presence or addition of one or more other figures, numbers, steps, operations, members, elements, and/or groups thereof.

[0039] While terms such as “first” and “second” are used herein to describe various members, parts, regions, layers, and/or portions, the members, the parts, the regions, the layers, and/or the portions are not to be limited by the terms. The terms are used only to distinguish one member, one part, one region, one layer, or one portion from another member, another part, another region, another layer, or another portion. Thus, a first member, a first part, a first region, a first layer, or a first portion hereinafter described may refer to a second member, a second part, a second region, a second layer, or a second portion without departing from the teachings of the disclosure.

[0040] Terms related to space, such as “beneath,” “below,” “lower,” “above,” and “upper,” may be utilized to facilitate understanding of one element or feature shown in the drawings as different from another element or feature. The terms related to space are intended to facilitate understanding of the disclosure in various states of process or use and are not intended to limit the disclosure. For example, if an element or feature in a figure is inverted, an element or feature described as “beneath” or “below” becomes “above” or “upper.” Thus, “beneath” is a concept that encompasses “above” or “below”.

[0041] Preferred embodiments will be described in detail with reference to the accompanying drawings so that those skilled in the art to which the disclosure pertains may easily carry out the embodiments.

[0042] Throughout the specification, elements having similar configurations and operations are denoted by the same reference numerals. When one element is referred to as being electrically coupled to another element, the element may be directly coupled to the other element or indirectly coupled to the other element via one or more intervening elements.

[0043] As described herein, a cylindrical secondary battery may include a cylindrical electrode assembly including a positive electrode plate, a separator, and a negative electrode plate, a cylindrical can accommodating the electrode assembly and an electrolyte, having an open lower end portion, and electrically connected to the negative electrode plate, a rivet terminal electrically connected to the positive electrode plate through an upper surface of the cylindrical can, and a cap assembly coupled to the lower end portion of the cylindrical can to seal the can and electrically connected to the electrode assembly to act as an electrical connection element between an external device and the electrode assembly.

[0044] The rivet terminal and an insulator may be assembled with the cylindrical can through compression molding. However, there can be a problem in that the rivet terminal rotates due to low pressure.

[0045] FIG. **1** is a cross-sectional view of a cylindrical secondary battery, according to some embodiments. FIG. **2** is a perspective view showing an upper surface of a can of the cylindrical secondary battery shown in FIG. **1**.

[0046] As shown in FIGS. **1** and **2**, the cylindrical secondary battery **100**, according to some embodiments, may include a cylindrical can **110**, an electrode assembly **120** accommodated in the cylindrical can **110**, a rivet terminal **150** coupled to a second terminal hole formed in one end of the cylindrical can **110**, an insulating member **170** located between the cylindrical can **110** and the rivet terminal **150**, and a cap plate **160** configured to seal an opening in the other end of the cylindrical can **110**.

[0047] The cylindrical can **110** may include a circular upper surface portion **111** and a side surface portion **112** extending a predetermined length downward from an edge of the upper surface portion **111**. The upper surface portion **111** and the side surface portion **112** may be integrally formed with each other.

[0048] As shown in FIG. **2**, the circular upper surface portion **111** may have a flat circular plate shape and may include a second terminal hole **111***a* formed through the central portion thereof. The rivet terminal **150** may be coupled to the upper surface portion **111** in a manner of being inserted into the second terminal hole **111***a*. The second terminal hole may be configured to allow the rivet terminal to pass therethrough. A first gasket **111***b*, such as for sealing and electrical insulation, may be further interposed and/or disposed between the second terminal hole **111***a* and the rivet terminal **150**. The first gasket **111***b* may electrically isolate the rivet terminal **150** and the cylindrical can **110** from each other by blocking contact therebetween. The second terminal hole **111***a* in the upper surface portion **111** of the cylindrical can **110** may be sealed by the first gasket **111***b*. The first gasket **111***b* may be made of resin, such as polyethylene (PE), polypropylene (PP), or polyethylene terephthalate (PET). The cylindrical can **110** may include second protrusion recesses **111***c* formed in the upper surface of the cylindrical can so as to allow protrusions (e.g., upper protrusion **172***a* and lower protrusion **172***b*) formed on the insulating member **170** to be fitted into the protrusion recesses (e.g., respectively). The second protrusion recesses **111***c* may be formed symmetrically with respect to the second terminal hole **111***a*.

[0049] During a process of manufacturing the cylindrical secondary battery **100**, the lower portion of the cylindrical can **110** may be open. Therefore, during a process of manufacturing the cylindrical secondary battery **100**, the electrode assembly **120** may be inserted into the cylindrical can **110** through the open lower portion of the cylindrical can **110** together with an electrolyte. In some embodiments, the electrolyte and the electrode assembly **120** may be inserted into the cylindrical can **110** with the open lower portion of the cylindrical can **110** oriented upward. After the electrolyte and the electrode assembly **120** are inserted into the cylindrical can **110**, the cap plate **160** may be coupled to the open lower portion of the cylindrical can **110** to seal the interior of the cylindrical can **110**. The electrolyte may serve to allow lithium ions to move between a positive electrode plate **121** and a negative electrode plate **122**, which constitute the electrode assembly **120**. The electrolyte may be a non-aqueous organic electrolyte that is a mixture of lithium salt and a high-purity organic solvent. In other embodiments, the electrolyte may be a polymer using a polymer electrolyte or may be a solid electrolyte. However, the type of electrolyte is not limited thereto.

[0050] The cylindrical can **110** may be formed of steel, a steel alloy, aluminum, an aluminum alloy, or an equivalent thereof. However, the material of the cylindrical can **110** is not limited thereto.

[0051] The electrode assembly **120** may include a positive electrode plate **121** coated with a positive electrode active material, a negative electrode plate **122** coated with a negative electrode active material, and a separator **123** interposed between the positive electrode plate **121** and the negative electrode plate **122** to prevent electrical short circuit between the positive electrode plate **121** and the negative electrode plate **122** while allowing lithium ions to move therebetween. After the positive electrode plate **121**, the negative electrode plate **122**, and the separator **123** are stacked, the electrode assembly **120** may be wound from a winding leading end to have a substantially cylindrical shape. Further, the electrode assembly **120** may include a positive electrode uncoated portion protruding upward from the positive electrode plate **121**, having no positive electrode active material coated thereon, and a negative electrode uncoated portion protruding downward from the negative electrode plate **122**, having no negative electrode active material coated thereon.

[0052] The positive electrode plate **121** may be configured such that a positive electrode active material, such as a transition metal oxide, is coated on at least one surface of the positive electrode plate, which may be a plate-shaped metal foil made of aluminum (Al). The positive electrode plate **121** may be provided with a positive electrode uncoated portion at the upper end portion thereof, on which the positive electrode active material is not coated. The positive electrode uncoated portion may protrude upward from the electrode assembly **120**. For example, the positive electrode uncoated portion of the positive electrode plate **121** may protrude upward further than the negative electrode plate **122** and the separator **123**.

[0053] The negative electrode plate **122** may be configured such that a negative electrode active material, such as graphite or carbon, is coated on at least one surface of a negative electrode plate, which may be a plate-shaped metal foil made of copper (Cu) or nickel (Ni). The negative electrode plate **122** may be provided with a negative electrode uncoated portion at the lower end portion thereof, on which the negative electrode active material is not coated. The negative electrode uncoated portion may protrude downward from the electrode assembly **120**. The negative electrode uncoated portion of the negative electrode plate **122** may protrude downward further than the positive electrode plate **121** and the separator **123**.

[0054] The separator **123** may be made of polyethylene (PE) or polypropylene (PP); however, the embodiments are not limited thereto. The separator **123** may prevent electrical short circuit between the positive electrode plate **121** and the negative electrode plate **122** while allowing lithium ions to move therebetween.

[0055] A positive electrode current collector **130** may be a circular metal plate shaped corresponding to the upper surface of the electrode assembly **120**. The planar size of the positive electrode current collector **130** may be equal to or smaller than the size of the upper surface of the electrode assembly **120**. The positive electrode current collector **130** may be made of aluminum (Al). The positive electrode current collector **130** may be fixed and electrically connected to the positive electrode plate **121**, which may be exposed at an upper portion of the electrode assembly **120**, through welding such that the lower surface of the positive electrode current collector **130** is in contact with the upper surface of the electrode assembly **120**. The positive electrode current collector **130** may be fixed and electrically connected to the rivet terminal **150** through welding such that the upper surface of the positive electrode current collector **130** is in contact with the lower surface of the rivet terminal **150**. The positive electrode current collector **130** may act as a passage for flow of current between the positive electrode plate **121** of the electrode assembly **120** and the rivet terminal **150**.

[0056] A negative electrode current collector **140** may include a circular flat portion corresponding to the lower surface of the electrode assembly **120** and an extension portion extending downward from the edge of the flat portion. The upper surface of the flat portion may be in contact with the lower surface of the electrode assembly **120**. The flat portion may be fixed and electrically connected to the negative electrode plate **122**, which may be exposed at a lower portion of the electrode assembly **120**, through welding such that the upper surface of the flat portion is in contact with the lower surface of the electrode assembly **120**. The extension portion may be bent and may extend downward from the edge of the flat portion. A beading portion **113** may be formed on the lower surface portion of the can **110**, and the negative electrode current collector **140** may be seated beneath the beading portion **113**. The negative electrode current collector **140** may be in contact with the inner surface of the beading portion **113**, and an end portion thereof may be located beneath the beading portion **113**. The negative electrode current collector **140** may be welded so as to be in contact with the lower inner surface of the beading portion **113** to be fixed and electrically connected to the cylindrical can **110**. In some embodiments, welding between the extension portion and the beading portion **113** may be performed in a direction from the extension portion toward the beading portion **113** in a state in which the negative electrode current collector **140** is seated beneath the beading portion **113** before a crimping portion of the cylindrical can **110** is formed. Therefore, the negative electrode current collector **140** may act as a passage for flow of current between the negative electrode plate **122** of the electrode assembly **120** and the cylindrical can **110**.

[0057] The rivet terminal **150** may be inserted into the second terminal hole **111***a* formed in the upper surface portion **111** of the cylindrical can **110** and may be electrically connected to the positive electrode current collector **130**. The rivet terminal **150** may be made of a material identical or similar to that of the positive electrode current collector **130** or the positive electrode plate **121**, such as including but not limited to aluminum (Al). The rivet terminal **150** may include an outer portion **151** exposed above the cylindrical can **110** and an insertion portion **152** extending from the outer portion **151** to being located in (e.g., within) the cylindrical can **110**. The rivet terminal **150** may be coupled to the second terminal hole **111***a* in the upper surface portion **111** of the cylindrical can **110** from the bottom to the top, and then the outer portion **151** of the rivet terminal **150** may be compression-deformed (e.g., compression-molded) through a processing method such as pressing or spinning, and thus, may come into close contact with the upper surface portion **111** of the cylindrical can **110**. In other embodiments, after the rivet terminal **150** is inserted into the second terminal hole **111***a* from the inside of the can **110**, the outer portion **151** thereof protruding outward may be deformed to have a larger diameter than the second terminal hole **111***a*, and thus, may be supported and fixed by the outer surface of the upper surface portion **111** of the can **110**. A first protrusion recess **151***a*, into which a protrusion formed on the insulating member **170** may be fitted, may be formed in the lower surface of the outer portion **151**. In some embodiments, a plurality of first protrusion recesses may be included. The first gasket **111***b* may be interposed and/or disposed between the rivet terminal **150** and the second terminal hole **111***a* to perform electrical insulation and sealing between the rivet terminal **150** and the cylindrical can **110**, in some embodiments. The rivet terminal **150** may be electrically connected to the positive electrode plate **121** of the electrode assembly **120** via the positive electrode current collector **130**.

[0058] FIG. **3**A illustrates a side view of the insulating member of the cylindrical secondary battery shown in FIG. **1**. FIG. **3**B illustrates a top perspective view of the insulating member of the cylindrical secondary battery shown in FIG. **1**. FIG. **3**C illustrates a bottom perspective view of the insulating member of the cylindrical secondary battery shown in FIG. **1**.

[0059] As shown in FIGS. **3**A to **3**C, the insulating member **170** may include a circular plate member **171** located between the cylindrical can **110** and the rivet terminal **150**, a first terminal hole **173** formed in the central region of the plate member **171**, and protrusions **172***a* and **172***b* formed on at least one surface of the plate member **171** that faces the cylindrical can **110** or the rivet terminal **150**. The protrusions may be formed both on the lower surface and on the upper surface of the insulating member **170** that face the cylindrical can **110** and the rivet terminal **150**. For example, the insulating member **170** may include the upper protrusion **172***a* and the lower protrusion **172***b* formed on the upper surface and the lower surface thereof, respectively, thereby fixing the rivet terminal **150** and the cylindrical can **110** coupled to the upper surface and the lower surface of the insulating member **170**. The upper protrusion **172***a* and the lower protrusion **172***b* may be formed on the upper surface and the lower surface of the insulating member **170**, which face the rivet terminal **150** and the cylindrical can **110**, and may be formed so as to be misaligned or offset from each other. In some embodiments, the upper protrusion **172***a* and the lower protrusion **172***b* may be disposed at a predetermined angular interval. Therefore, rotation of the rivet terminal **150** inserted into the cylindrical can **110** may be prevented, and thus, airtightness between parts and sealability of the interior of the cell may be improved. Further, separation between the positive electrode current collector **130** and the rivet terminal **150** welded thereto may be prevented.

[0060] The insulating member **170** may include a first terminal hole **173** through which the rivet terminal **150** passes. The upper protrusion **172***a* and the lower protrusion **172***b* may be formed symmetrically with respect to the first terminal hole **173**; however, the embodiments are not limited thereto. In some embodiments, the protrusions **172***a* and **172***b* may be formed asymmetrically with respect to the first terminal hole **173**. In other embodiments, the protrusions **172***a* and **172***b* may be provided in different numbers in regions that are symmetrical with respect to the first terminal hole **173**. The protrusions **172** may have a rectangular planar shape, a circular planar shape, or a triangular planar shape.

[0061] The insulating member **170** may be formed of at least one resin selected from among perfluoroalkoxy (PFA), polypropylene (PP), and polybutylene terephthalate (PBT).

[0062] Referring to FIG. **1**, the cap plate **160** may be a circular metal plate and may be coupled to the lower end portion of the cylindrical can **110**. The cap plate **160** may be coupled to the lower end portion of the cylindrical can **110** with a second gasket **180** interposed therebetween, and thus, may be prevented from being electrically connected to the cylindrical can **110**. In some embodiments, because the cap plate **160** is not electrically connected to the positive electrode or the negative electrode of the electrode assembly **120**, the cap plate **160** may be an electrically non-polar part.

[0063] The cap plate **160** may be fixed by forming a crimping portion at the lower end of the cylindrical can **110** such that the edge of the cap plate **160** is seated beneath the lower flat portion of the beading portion **113** of the cylindrical can **110**. The cap plate **160** may be seated on the beading portion **113** in a state in which the open lower portion of the cylindrical can **110** faces upward.

[0064] The cap plate **160** may include at least one protruding portion **161** protruding downward. For example, the protruding portion **161** of the cap plate **160** may be spaced apart from the central portion thereof and may protrude downward so as to have a ring shape when viewed in plan. In another example, the protruding portion **161** of the cap plate **160** may protrude downward so as to have multiple patterns. The protruding portion **161** of the cap plate **160** may serve to support internal pressure in the cylindrical can **110**. The lower surface of the protruding portion **161** of the cap plate **160** may be located at a higher position than the lower surface of the crimping portion of the cylindrical can **110**. For example, the crimping portion of the cylindrical can **110** may protrude downward farther than the protruding portion **161** of the cap plate **160**. Therefore, if the cylindrical secondary battery **100** is placed on a certain flat surface, the crimping portion of the cylindrical can **110** may contact the certain surface, and the protruding portion **161** of the cap plate **160** may be spaced apart from the certain surface. Because the crimping portion of the cylindrical can **110** protrudes downward farther than the protruding portion **161** of the cap plate **160**, it may be possible to prevent the cap plate **160** from contacting the certain surface even when the cap plate **160** expands due to the internal pressure in the cylindrical can **110**. Therefore, in some embodiments, even when the internal pressure in the cylindrical can **110** increases, the overall height of the cylindrical secondary battery **100** may be maintained.

[0065] The cap plate **160** may include a notch **162** formed therein in order to be opened at a predetermined pressure. If the internal pressure in the cylindrical can **110** reaches a rupture pressure or higher, the notch **162** may rupture, thereby preventing the cylindrical secondary battery **100** from exploding. For example, if excessive internal pressure occurs in the cylindrical can **110**, the notch **162** may rupture, thereby discharging the excessive internal pressure. The notch **162** in the cap plate **160** may be spaced apart from the central portion of the cap plate **160** and may be formed to have a ring shape when viewed in plan. In another example, the notch **162** may be formed to have multiple patterns. The embodiments are not limited to a specific shape of the notch **162**.

[0066] The notch **162** may be formed so as to be spaced apart from the protruding portion **161**. In some embodiments, the notch **162** may be formed in a concave portion of the cap plate **160**, which is concave toward the cylindrical can **110** with respect to the protruding portion **161**, rather than in the protruding portion **161** of the cap plate **160**. Because, in some embodiments, the cap plate **160** has a concave-convex structure due to the concave portion and the protruding portion **161**, the cap plate **160** may withstand the internal pressure in the cylindrical can **110** even when the internal pressure increases.

[0067] The second gasket **180** may be formed of resin such as polyethylene (PE), polypropylene (PP), or polyethylene terephthalate (PET). The second gasket **180** may perform pressing and sealing between the cylindrical can **110** and the cap plate **160** and may prevent the cap plate **160** from being separated from the cylindrical can **110**.

[0068] Although the cylindrical secondary battery has been described above as being structured such that the positive electrode (e.g., the positive electrode plate) is disposed on the upper surface thereof and the negative electrode (e.g., the negative electrode plate) is disposed on the lower surface thereof, the embodiments are not limited thereto. For example, the cylindrical secondary battery may be structured such that both the negative electrode and the positive electrode are disposed on the upper surface thereof. In embodiments in which both the negative electrode and the positive electrode are disposed on the upper surface of the cylindrical secondary battery **100**, if plural cylindrical secondary batteries are electrically connected to each other via busbars, connection using the busbars may be performed only on the upper surfaces of the cylindrical secondary batteries, thus simplifying the busbar connection structure.

[0069] Hereinafter, another example of the insulating member in a cylindrical secondary battery according to another embodiment will be described. The cylindrical secondary battery may include elements as described in relation to FIG. **1**.

[0070] FIG. **4** is a perspective view of a cylindrical secondary battery according to another embodiment. FIG. **5**A illustrates a top perspective view showing an insulating member of the cylindrical secondary battery shown in FIG. **4**. FIG. **5**B illustrates a bottom perspective view showing the insulating member of the cylindrical secondary battery shown in FIG. **4**.

[0071] Referring to FIGS. **5**A and **5**B together with FIG. **4**, the insulating member may be located between the cylindrical can **210** and the rivet terminal **150** (e.g., as described in relation to FIG. **1**) and may include a circular plate member **271**, a first terminal hole **173** (e.g., as described in relation to FIG. **3**B) formed in the central region of the plate member **271**, and protrusions **272***a* and **272***b* formed on at least one surface of the plate member **271** that faces the cylindrical can **210** or the rivet terminal **150**.

[0072] The protrusions **272***a* and **272***b* may be formed both on the upper surface and on the lower surface of the insulating member that face the rivet terminal **150** and the cylindrical can **210**. The upper protrusion **272***a* and the lower protrusion **272***b* may be formed on the upper surface and the lower surface of the insulating member, which face the rivet terminal **150** and the cylindrical can **210**, and may be formed so as to be misaligned or offset from each other. In some embodiments, the upper protrusion **272***a* and the lower protrusion **272***b* may be disposed at a predetermined angular interval.

[0073] Each of the upper protrusion **272***a* and the lower protrusion **272***b* may be provided in a pair symmetrically with respect to the first terminal hole **173**. The pair of upper protrusions **272***a* may be formed on the left and right of the first terminal hole **173** and may have a V-shape (e.g., the planar shape may have a V-shape). The V-shape of the upper protrusions **272***a* may be a shape that is bent at a predetermined angle in the middle. Similar to the pair of upper protrusions **272***a*, the pair of lower protrusions **272***b* may also have a V-shape and may be located so as to be misaligned or offset from the pair of upper protrusions **272***a*.

[0074] Due to the above-described shape of the protrusions, the upper protrusion **272***a* and the lower protrusion **272***b* may increase areas of contact with the rivet terminal **150** and the cylindrical can **210**. Therefore, if rotational force is applied to the rivet terminal **150**, the upper protrusion **272***a* and the lower protrusion **272***b* may effectively prevent rotation of the rivet terminal **150**, thereby improving airtightness between parts and sealability of the interior of the cell.

[0075] Hereinafter, another example of the insulating member in a cylindrical secondary battery according to another embodiment will be described. The cylindrical secondary battery may include elements as described in relation to FIG. **1**.

[0076] FIG. **6** is a perspective view of a cylindrical secondary battery according to another embodiment. FIG. **7**A illustrates a top perspective view showing an insulating member of the cylindrical secondary battery shown in FIG. **6**. FIG. **7**B illustrates a bottom perspective view showing an insulating member of the cylindrical secondary battery shown in FIG. **6**.

[0077] Referring to FIGS. **7**A and **7**B together with FIG. **6**, the insulating member may be located between the cylindrical can **310** and the rivet terminal **150** (e.g., as described in relation to FIG. **1**) and may include a circular plate member **371**, a first terminal hole **173** (e.g., as described in relation to FIG. **3**B) formed in the central region of the plate member **371**, and protrusions **372***a* and **372***b* formed on at least one surface of the plate member **371** that faces the cylindrical can **310** or the rivet terminal **150**. The upper protrusion **372***a* and the lower protrusion **372***b* may be formed on the upper surface and the lower surface of the insulating member, which face the rivet terminal **150** and the cylindrical can **310**, so as to be misaligned or offset from each other.

[0078] The upper protrusion **372***a* may be formed on each of the left and right of the first terminal hole **173** and may have an arc shape (e.g., the planar shape may have a shape of an arc). For example, the arc shape of the upper protrusions **372***a* may be a partial arc of a circle concentric with the circular first terminal hole **173**. Therefore, the upper protrusions **372***a* may also be formed in the shape of a circle concentric with the first terminal hole **173**. Similar to the upper protrusions **372***a*, the lower protrusions **372***b* may also be formed in the shape of a partial arc of a circle concentric with the circular first terminal hole **173** and may be located so as to be misaligned from the upper protrusions **372***a*.

[0079] Due to the above-described shape of the protrusions, the upper protrusion **372***a* and the lower protrusion **372***b* may increase areas of contact with the rivet terminal **150** and the cylindrical can **310** in a rotational direction. Therefore, if rotational force is applied to the rivet terminal **150**, the upper protrusion **372***a* and the lower protrusion **372***b* may effectively prevent rotation of the rivet terminal **150**, thereby improving airtightness between parts and sealability of the interior of the cell.

[0080] As is apparent from the above description, in a cylindrical secondary battery according to the embodiments, an insulating member located between a rivet terminal and a can may include protrusions protruding therefrom upward and downward, thereby preventing rotation of the rivet terminal.

[0081] According to the embodiments, because the rivet terminal may be fixed so as not to be rotated, airtightness between parts and sealability of the interior of a cell may be improved.

[0082] According to some embodiments, there is provided a method of manufacturing a cylindrical secondary battery, the method including: providing a cylindrical can configured to accommodate an electrode assembly and configured to be electrically connected to a negative electrode plate of the electrode assembly, wherein the cylindrical can comprises an open portion; inserting the electrode assembly through the open portion of the cylindrical can; providing a rivet terminal configured to

be electrically connected to a positive electrode plate of the electrode assembly through an upper surface of the cylindrical can; providing an insulating member between the cylindrical can and the rivet terminal, wherein the insulating member comprises protrusions formed on at least one surface of the insulating member facing the cylindrical can or the rivet terminal; and coupling to the cylindrical can a cap plate configured to seal the open portion of the cylindrical can.
[0083] According to some embodiments, the method may include fitting the protrusions into first protrusion recesses formed in a lower surface of an outer portion of the rivet terminal.
[0084] The above-mentioned embodiments are example embodiments for implementing an exemplary cylindrical secondary battery according to the disclosure; therefore, the disclosure is not limited to the above-mentioned embodiments, and it is to be understood by those skilled in the art that various modifications can be made without departing from the spirit and scope of the disclosure as claimed in the following claims.

Claims

1. A cylindrical secondary battery comprising: an electrode assembly comprising: a positive electrode plate, a separator, and a negative electrode plate; a cylindrical can configured to accommodate the electrode assembly and configured to be electrically connected to the negative electrode plate, wherein the cylindrical can comprises an open portion; a rivet terminal configured to be electrically connected to the positive electrode plate through an upper surface of the cylindrical can; an insulating member located between the cylindrical can and the rivet terminal; and a cap plate configured to seal the open portion of the cylindrical can, wherein the insulating member comprises protrusions formed on at least one surface of the insulating member facing the cylindrical can or the rivet terminal.
2. The cylindrical secondary battery as claimed in claim 1, wherein the insulating member comprises a first terminal hole formed therein and configured to allow the rivet terminal to pass therethrough.
3. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are formed symmetrically with respect to the first terminal hole.
4. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are formed on a lower surface and an upper surface of the insulating member facing the cylindrical can and the rivet terminal.
5. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are formed on a lower surface and an upper surface of the insulating member facing the cylindrical can and the rivet terminal so as to be misaligned from each other.
6. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are formed on a lower surface and an upper surface of the insulating member at a predetermined angular interval.
7. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are formed asymmetrically with respect to the first terminal hole.
8. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions are provided in different numbers in regions symmetrical with respect to the first terminal hole.
9. The cylindrical secondary battery as claimed in claim 2, wherein the protrusions have a rectangular planar shape, a circular planar shape, or a triangular planar shape.
10. The cylindrical secondary battery as claimed in claim 1, wherein the rivet terminal comprises: an outer portion exposed above the cylindrical can; and an insertion portion extending from the outer portion to within the cylindrical can.
11. The cylindrical secondary battery as claimed in claim 10, wherein the outer portion comprises first protrusion recesses formed in a lower surface of the outer portion so as to allow the protrusions to be fitted into the first protrusion recesses, respectively.
12. The cylindrical secondary battery as claimed in claim 10, wherein the cylindrical can comprises

a second terminal hole formed in an upper surface of the cylindrical can configured to allow the rivet terminal to pass therethrough.

13. The cylindrical secondary battery as claimed in claim 12, wherein the cylindrical can comprises second protrusion recesses formed in the upper surface of the cylindrical can so as to allow the protrusions to be fitted into the second protrusion recesses, respectively.

14. The cylindrical secondary battery as claimed in claim 13, wherein the second protrusion recesses are formed symmetrically with respect to the second terminal hole.

15. The cylindrical secondary battery as claimed in claim 12, comprising a first gasket disposed between the rivet terminal and the second terminal hole.

16. The cylindrical secondary battery as claimed in claim 1, wherein the insulating member is formed of at least one resin comprising perfluoroalkoxy (PFA), polypropylene (PP), or polybutylene terephthalate (PBT).

17. The cylindrical secondary battery as claimed in claim 1, wherein a planar shape of the protrusions has a V-shape bent at a predetermined angle.

18. The cylindrical secondary battery as claimed in claim 1, wherein a planar shape of the protrusions has a shape of an arc of a circle concentric with the first terminal hole.