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ELECTRODE ASSEMBLY AND CYLINDRICAL SECONDARY BATTERY INCLUDING THE ELECTRODE ASSEMBLY

Abstract

An electrode assembly includes a first electrode plate, a first separator in contact with the first electrode plate, a second separator in contact with the first separator, and a second electrode plate in contact with the second separator.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-

2024-0022893 filed in the Korean Intellectual Property Office on Feb. 16, 2024, the entire contents of which are incorporated herein by reference.

BACKGROUND

(a) Field

[0002] The present disclosure relates to an electrode assembly and a cylindrical secondary battery including the electrode assembly.

(b) Description of the Related Art

[0003] Unlike a primary battery that cannot be charged, a secondary battery can be charged and discharged. A low-capacity secondary battery having a single electrode assembly packaged in the form of a pack is used for a small-sized portable electronic device, such as a mobile phone or a camcorder. A high-capacity secondary battery having several tens of electrode assemblies connected to each other is widely used as a power source for motor driving, such as in an electric scooter, a hybrid vehicle, or an electric vehicle.

[0004] A secondary battery is manufactured in various shapes. Among these, a cylindrical secondary battery includes an electrode assembly, a cylindrical can that accommodates the electrode assembly and an electrolyte solution, and a cap assembly that is coupled to an upper-end opening portion of the can to seal the can, with the cap assembly allowing current generated from the electrode assembly to flow to an external device.

[0005] In a typical cylindrical secondary battery, a negative electrode repeatedly undergoes relatively large contraction and expansion. In the cylindrical secondary battery, a deformation force caused by the contractions and expansions is not resolved, resulting in deformation inside the electrode assembly.

SUMMARY OF THE DISCLOSURE

[0006] An aspect of the present disclosure is to provide an electrode assembly that can prevent deformation from occurring in the electrode assembly, and a cylindrical secondary battery including the electrode assembly.

[0007] An electrode assembly according to an embodiment of the present disclosure includes a first electrode plate, a first separator in contact with the first electrode plate, a second separator in contact with the first separator, and a second electrode plate in contact with the second separator.

[0008] The first separator and the second separator may be longer than the first electrode plate and the second electrode plate.

[0009] The lengths of the first separator and the second separator may be the same.

[0010] The lengths of first electrode plate and the second electrode plate may be the same.

[0011] A thickness of the first separator may be within a range from 4 μm to 8 μm .

[0012] A thickness of the second separator may be within a range from 4 μm to 8 μm .

[0013] The first electrode plate may be a negative electrode plate, and the second electrode plate may be a positive electrode plate.

[0014] The first electrode plate may be a positive electrode plate, and the second electrode plate may be a negative electrode plate.

[0015] An electrode assembly according to another embodiment of the present invention includes a first electrode plate, a second electrode plate positioned spaced apart from the first electrode plate, and a separator interposed between the first electrode plate and the second electrode plate, with the separator being in a folded state.

[0016] The first electrode plate, the separator, and the second electrode plate may be wound while overlapping each other, and a folded portion of the separator may be positioned on an innermost side in the wound state of the first electrode plate, the separator, and the second electrode plate.

[0017] The first electrode plate, the separator, and the second electrode plate may be wound while overlapping each other, and [0018] a folded portion of the separator may be positioned on an outermost side in the wound state of the first electrode plate, the third separator, and the second electrode plate.

[0019] The separator may be folded at a middle portion of the separator.

[0020] A length of the separator may be made to be two times longer than a relatively longer length of the first electrode plate and the second electrode plate.

[0021] The first electrode plate and the second electrode plate may have lengths that are the same.

[0022] A thickness of the separator may be within a range from 4 μm to 8 μm .

[0023] The first electrode plate may be a negative electrode plate, and the second electrode plate may be a positive electrode plate.

[0024] The first electrode plate may be a positive electrode plate, and the second electrode plate may be a negative electrode plate.

[0025] A cylindrical secondary battery according to an embodiment of the present disclosure includes an electrode assembly, a cylindrical can configured to accommodate the electrode assembly, and a cap assembly coupled to one side of the cylindrical can.

[0026] The electrode assembly according to an embodiment of the present disclosure includes the first separator and the second separator, so when contraction or expansion occurs inside the electrode assembly, slip may occur between the first separator and the second separator. Accordingly, the secondary battery including the electrode assembly can facilitate unwinding of the wound state, rewinding, and the like by contraction and expansion between the first electrode plate and the second electrode plate and prevent deformation from occurring in the electrode assembly by relieving the stress due to the contractions and expansions.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. 1 is a cross-sectional view showing a cylindrical secondary battery.

[0028] FIG. 2 is an exploded perspective view showing the cylindrical secondary battery of FIG. 1.

[0029] FIG. 3 is a cross-sectional view showing an inside of an electrode assembly according to an embodiment of the present disclosure.

[0030] FIG. 4 is a cross-sectional view showing the electrode assembly in a developed manner.

[0031] FIG. 5 is a cross-sectional view showing a state in which slip occurs between a first separator and a second separator of the electrode assembly.

[0032] FIG. 6 is a cross-sectional view showing an electrode assembly according to an embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0033] Hereinafter, preferred embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. The terms or words used throughout the specification and the claims should not be construed as being limited to their ordinary or dictionary meanings, but as having meanings and concepts consistent with the technical idea of the present disclosure, based on the principle that an inventor may properly define the concepts of the words or terms to best explain the disclosure. Therefore, the embodiments described herein and the configurations shown in the drawings are some most preferred embodiments of the present disclosure, but not intended to fully describe the technical aspects of the present disclosure, so it should be understood that a variety of other equivalents and variations could have been made thereto at the time of the filing of the application.

[0034] Additionally, the terms “comprise,” “include,” “comprising,” and/or “including,” when used in this specification, specify the presence of the stated features, integers, steps, operations, members, elements, and/or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, operations, members, elements, and/or groups thereof.

[0035] Additionally, in order to help the understanding of the disclosure, the accompanying drawings may illustrate some elements in exaggerated dimensions, not in actual scale. Furthermore,

the same element in different embodiments may be given the same reference numeral.

[0036] The statement that two comparison targets are equal refers to ‘substantially equal’.

Accordingly, substantially equal may include the deviation regarded as a low level in the art, for example, the deviation of 5% or less. In addition, a uniform parameter in a predetermined region may refer to uniform from the average point of view.

[0037] The terms “first”, “second” and the like are used to describe a variety of elements, but these elements are not limited by the terms. These terms are used to distinguish one element from another, and unless the context clearly indicates otherwise, a first element may be a second element.

[0038] Throughout the disclosure, each constitutional element may be singular or plural, unless the context clearly indicates otherwise.

[0039] It will be understood that when an element is referred to being “on (or below)” or “above (or under)” another element, it can be positioned in contact with an upper surface (or a lower surface) of the other element, but another element may be positioned between the element and the other element on (or below) the element.

[0040] It will be also understood that when an element is referred to as being “on”, “connected to” or “coupled to” another element, the elements can be directly connected or joined to each other, but intervening elements may be present between them or each element may be “connected”, “coupled” or “joined” to each other through another element.

[0041] As used herein, the term “and/or” includes any one more or all combinations of the associated listed items. Additionally, the use of “may” when describing embodiments of the present disclosure refers to “one or more embodiments of the present disclosure.”

[0042] Expressions such as “one or more” and “at least one” preceding a list of elements modify the entire list of elements and do not modify the individual elements of the list.

[0043] Throughout the disclosure, the phrase “A and/or B” as used herein can denote A, B or A and B, and the phrase “C to D” can denote C or greater and D or less, unless the context clearly indicates otherwise.

[0044] When a phrase such as “at least one of A, B and C”, “at least one of A, B or C”, “at least one selected from the group of A, B and C” and “at least one selected from A, B and C” is used to specify a list of elements A, B, and C, the phrase may refer to any and all suitable combinations.

[0045] As used herein, the term “use” may be considered synonymous with the term “utilize.”

[0046] As used herein, the term “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 deviations in measured or calculated values that would be recognized by those of ordinary skill in the art.

[0047] It will be understood that, although the terms “first,” “second,” “third,” and the like, 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 described below could be termed a second element, component, region, layer or section, without departing from the spirit and scope of the present disclosure.

[0048] Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper,” and the like, may be used herein for ease of explanation 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 in operation, in addition to the orientation depicted in the drawings. For example, if the device in the drawings is turned over, elements described as “below” or “beneath” other elements would then be understood “above” the other elements. Accordingly, the term “below” can encompass both orientations of above and below.

[0049] The terms used herein are for describing embodiments of the present disclosure and are not

intended to limit the present disclosure.

[0050] Hereinafter, before describing an electrode assembly according to an embodiment of the present disclosure with reference to the accompanying drawings, a cylindrical secondary battery to which the electrode assembly may be applied will be described in detail.

[0051] FIG. 1 is a cross-sectional view showing a cylindrical secondary battery, and FIG. 2 is an exploded perspective view showing the cylindrical secondary battery of FIG. 1.

[0052] As shown in FIGS. 1 and 2, a cylindrical secondary battery **100** includes a cylindrical can **110**, an electrode assembly **120**, and a cap assembly **140**.

[0053] The cylindrical can **110** may include a circular bottom portion **111** and a cylindrical side portion **112** extending upward from the bottom portion **111** for a predetermined length. During a manufacturing process of the cylindrical secondary battery **100**, a top portion of the cylindrical can **110** is open. Therefore, during an assembly process of the cylindrical secondary battery, the electrode assembly **120** may be inserted into the cylindrical can **110** together with an electrolyte solution.

[0054] The cylindrical can **110** may be made of steel, a steel alloy, aluminum, an aluminum alloy, or an equivalent thereof. The cylindrical can **110** may be provided with a beading portion **113** inwardly recessed around the cap assembly **140** and below the cap assembly to prevent the electrode assembly **120** and the cap assembly **140** from deviating toward outside of the cylindrical can **110**. An inwardly bent crimping portion **114** may be provided above the cap assembly.

[0055] The electrode assembly **120** may be accommodated inside the cylindrical can **110**. The electrode assembly **120** includes a first electrode plate **121**, a second electrode plate **122**, and a twofold separator **123** interposed between the first electrode plate **121** and the second electrode plate **122**. The electrode assembly **120** has an internal space on the innermost side as the first electrode plate **121**, the second electrode plate **122**, and the twofold separator **123** are wound.

[0056] The second electrode plate **121** may be a negative electrode plate. In such a case, the second electrode plate **122** may be a positive electrode plate. Conversely, the first electrode plate **121** may be a positive electrode plate, and the second electrode plate **122** may be a negative electrode plate. For convenience, the description below will be of configuration wherein the first electrode plate **121** is a negative electrode plate and the second electrode plate **122** is a positive electrode plate.

[0057] The negative electrode plate is coated with a negative electrode active material (for example, graphite, carbon, or the like). The positive electrode plate is coated with a positive electrode active material (for example, a transition metal oxide such as $\text{LiCoO}_{0.5}\text{Li}_{0.5}\text{O}$, $\text{LiNiO}_{0.5}\text{Li}_{0.5}\text{O}$, $\text{LiMn}_{0.5}\text{Li}_{0.5}\text{O}$, or the like).

[0058] The separator **123** is positioned between the negative electrode plate **121** and the positive electrode plate **122** to prevent a short circuit and allow migration of lithium ions. The separator **123** included in the electrode assembly **120** of the cylindrical secondary battery **100** according to an embodiment of the present disclosure has a folded structure, which will be described in detail below.

[0059] The negative electrode plate **121**, the positive electrode plate **122**, and the separator **123** may be wound in a substantially cylindrical shape. The negative electrode plate **121** may include a copper (Cu) or nickel (Ni) foil, the positive electrode plate **122** may include an aluminum (Al) foil, and the separator **123** may include polyethylene (PE) or polypropylene (PP).

[0060] A negative electrode tab **124** protruding and extending downwardly for a predetermined length may be welded to the negative electrode plate **121**, and a positive electrode tab **125** protruding upwardly for a predetermined length may be welded to the positive electrode plate **122**. However, the positions of the negative electrode tab **124** and the positive electrode tab **125** may be switched. The negative electrode tab **124** may include a copper or nickel material, and the positive electrode tab **125** may include an aluminum material.

[0061] The negative electrode tab **124** of the electrode assembly **120** may be welded to the bottom portion **111** of the cylindrical can **110**. Thus, the cylindrical can **110** may operate as a negative

electrode. Conversely, the positive electrode tab **125** may be welded to the bottom portion **111** of the cylindrical can **110**, and in such a case, the cylindrical can **110** may operate as a positive electrode.

[0062] A first insulating plate **126** may be interposed between the electrode assembly **120** and the bottom portion **111**. The first insulating plate **126** is coupled to the cylindrical can **110**, has a first hole **126a** formed at its center, and has a second hole **126b** formed on an outer side of the first hole. The first insulating plate **126** may prevent the electrode assembly **120** from being brought into electrical contact with the bottom portion **111** of the cylindrical can **110**.

[0063] More specifically, the first insulating plate **126** may prevent the positive electrode plate **122** of the electrode assembly **120** from being brought into electrical contact with the bottom portion **111**. The first hole **126a** may allow gas to rapidly move upward through a center pin **130** when gas is generated in large amounts due to an abnormality in the cylindrical secondary battery. The negative electrode tab **124** extend through the second hole **126b** and may be welded to the bottom portion **111**.

[0064] The second insulating plate **127** may be interposed between the electrode assembly **120** and the cap assembly **140**. The second insulating plate **127** is coupled to the cylindrical can **110**, and has a first hole **127a** formed at a center and a plurality of second holes **127b** formed on an outer side of the first hole.

[0065] The second insulating plate **127** may prevent the electrode assembly **120** from being brought into electrical contact with the cap assembly **140**. More specifically, the second insulating plate **127** may prevent the negative electrode plate **121** of the electrode assembly **120** from being brought into electrical contact with the cap assembly **140**.

[0066] The first hole **127a** may allow gas to rapidly move to the cap assembly **140** when the gas is generated in large amounts due to an abnormality in the cylindrical secondary battery. One of the second holes **127b** may allow the positive electrode tab **125** to pass therethrough so that the positive electrode tab **125** can be welded to the cap assembly **140**. In addition, the remaining second holes **127b** may allow an electrolyte solution to rapidly flow into the electrode assembly **120** during an electrolyte solution injection process.

[0067] Note that a diameter of each of the first hole **126a** of the first insulating plate **126** and the first hole **127a** of the second insulating plate **127** may be less than a diameter of the center pin **130**. Accordingly, the center pin **130** may not be brought into electrical contact with the bottom portion **111** of the cylindrical can **110** or the cap assembly **140** due if there is an external impact to the secondary battery **100**.

[0068] The center pin **130** has a hollow circular pipe shape and may be coupled to an approximate center of the electrode assembly **120**. The center pin **130** may be made of steel, a steel alloy, aluminum, an aluminum alloy, or polybutylene terephthalate.

[0069] The center pin **130** may suppress deformation of the electrode assembly **120** during charging and discharging of the battery. The center pin **130** also provides a path for moving gases generated inside the cylindrical secondary battery. In some cases, the center pin **130** may be omitted.

[0070] The cap assembly **140** may include an upper cap **141** with a plurality of through holes **141e** being formed therein, a safety vent **142** positioned below the upper cap **141**, a connecting ring **143** positioned below the safety vent **142**, and a lower cap **144** positioned below the safety vent **142** and the connecting ring **143**. The lower cap **144** may include a plurality of through holes **144a** and be electrically connected to the positive electrode tab **125**. The lower cap **144** is arranged on a side of the assembly **140** that is opposite to the upper cap **141** with the safety vent **142** interposed therebetween.

[0071] The cap assembly **140** may further include an insulating gasket **145**. The insulating gasket **145** insulates the upper cap **141**, the safety vent **142**, and the lower cap **144** from the side portion **112** of the cylindrical can **110**. The insulating gasket **145** may be substantially compressed between

the beading portion **113** and the crimping portion **114** that is formed substantially at the side portion **112** of the cylindrical can **110**.

[0072] The through holes **141e** of the upper cap **141** and the through holes **144a** of the lower cap **144** may serve to discharge internal gases to outside of the secondary battery **100** when an abnormal internal pressure is generated inside the cylindrical can **110**. The internal gases moving through the through holes **144a** invert the safety vent **142** upwardly so that the safety vent **142** is electrically disconnected from the lower cap **144** and is ruptured, and the internal gases may be discharged to outside of the secondary battery **100** through the through holes **141e** of the upper cap **141**.

[0073] An electrolyte solution (not shown in the drawing) may be injected into the cylindrical can **110**, which allows lithium ions generated by an electrochemical reaction taking place between the negative electrode plate **121** and the positive electrode plate **122** in the battery during charging and discharging to move. The electrolyte solution may be a non-aqueous, organic electrolyte solution that is a mixture of a lithium salt and a high-purity organic solvent. The electrolyte solution may include a polymeric electrolyte using a polymer or a solid electrolyte.

[0074] Note that the electrode assembly **120** according to an embodiment of the present disclosure is not limited to being applicable only to the above-described cylindrical secondary battery, and can also be applied to cylindrical secondary batteries in general.

[0075] Below, an electrode assembly according to an embodiment of the present disclosure will be described in detail with reference to the drawings.

[0076] FIG. **3** is a cross-sectional view showing an inside of an electrode assembly according to an embodiment of the present disclosure, FIG. **4** is a cross-sectional view showing the electrode assembly in a developed manner, and FIG. **5** is a cross-sectional view showing a state in which slip occurs between a first separator and a second separator of the electrode assembly.

[0077] Referring to FIGS. **3** to **5**, the electrode assembly **120** according to an embodiment of the present disclosure includes a first electrode plate **121**, a first separator **123A** in contact with the first electrode plate **121**, a second separator **123B** in contact with the first separator **123A**, and a second electrode plate **122** in contact with the second separator **123B**.

[0078] In the electrode assembly **120**, the first separator **123A** and the second separator **123B** are arranged in close contact with each other between the first electrode plate **121** and the second electrode plate **122**. In this state, the electrode assembly **120** may be wound in the form of a jelly roll. That is, the first separator **123A** and the second separator **123B** may be installed over an entire section of the electrode assembly **120**, not over a partial section.

[0079] Generally, a coefficient of friction between a separator and a positive electrode plate is 0.838, and a coefficient of friction between the separator and a negative electrode plate is 0.276. A coefficient of friction between the first separator and the second separator is 0.244. As such, the coefficient of friction between the two separators is relatively low.

[0080] The electrode assembly **120** according to an embodiment of the present disclosure includes the first separator **123A** and the second separator **123B**, so when contraction and expansion occurs inside the electrode assembly **120**, slip (S) may occur between the first separator **123A** and the second separator **123B** (see FIG. **5**). Accordingly, the cylindrical secondary battery **100** including the electrode assembly **120** according to an embodiment of the present disclosure can facilitate unwinding of the wound state, rewinding and the like by contraction and expansion between the first electrode plate **121** and the second electrode plate **122** and prevent deformation from occurring in the electrode assembly **120** by relieving the stress due to the contraction and expansion.

[0081] Here, the first separator **123A** and the second separator **123B** may be made to be longer than the first electrode plate **121** and the second electrode plate **122**. Accordingly, stable insulation is provided between the first electrode plate **121** and the second electrode plate **122**. In this case, the first separator **123A** and the second separator **123B** may have lengths corresponding to each other. That is, the overall lengths of the first separator **123A** and the second separator **123B** may be the

same.

[0082] Additionally, the first electrode plate **121** and the second electrode plate **122** may have lengths corresponding to each other. That is, the overall lengths of the first electrode plate **121** and the second electrode plate **122** may be the same.

[0083] Note that a thickness of a separator included in a cylindrical secondary battery of the related art that is a single separator may be about 14 μm . In the electrode assembly **120** according to an embodiment of the present disclosure, a thickness of the first separator **123A** may be within a range from 4 μm to 8 μm , and a thickness of the second separator **123B** may be within a range from 4 μm to 8 μm . Accordingly, even if the electrode assembly **120** includes the first separator **123A** and the second separator **123B**, a size of the electrode assembly **120** may not be increased compared to the size of an electrode assembly in a cylindrical secondary battery of the related art.

[0084] Note that, unlike the above description, in order to prevent deformation from occurring inside the electrode assembly, a method of reducing the coefficient of friction between the positive electrode plate and the negative electrode plate while using a single separator may also be used. To this end, a separately manufactured special separator may be used, but this method has a problem of increasing the manufacturing cost of the cylindrical secondary battery because the cost of the separator is higher than that of a general separator.

[0085] On the other hand, since a separately manufactured single separator is not used when manufacturing the electrode assembly **120** according to an embodiment of the present disclosure, an increased manufacturing cost prevented. In addition, by arranging the twofold separator (**123A**, **123B**) between the first electrode plate **121** and the second electrode plate **122** without performing an additional process in the manufacturing method, the manufacturing cost may be similar to the manufacturing cost of the cylindrical secondary battery of the related art.

[0086] In addition, when the cylindrical secondary battery **100** has been used and should be discarded, the electrode assembly **120** can be easily separated because the first separator **123A** and the second separator **123B** overlap each other. Accordingly, the work of recovering waste batteries can be carried out more easily.

[0087] FIG. **6** is a cross-sectional view showing an electrode assembly according to another embodiment.

[0088] Referring to FIG. **6**, an electrode assembly **220** according to an embodiment of the present disclosure includes a third separator **123C**. The third separator **123C** is interposed between the first electrode plate **121** and the second electrode plate **122** in a partially folded (twofold) state.

[0089] In the electrode assembly **120** described above (see FIG. **4**), the first separator **123A** and the second separator **123B**, which are separated from each other, are stacked. However, in the electrode assembly **220** according to this embodiment, the third separator **123C** is interposed between the first electrode plate **121** and the second electrode plate **122** in a state with a middle portion of the third separator being folded. Accordingly, the third separator **123C** may include a folded portion, in particular, the middle portion of the third separator **123C** may be folded.

[0090] As described above, the first electrode plate **121**, the third separator **123C**, and the second electrode plate **122** are wound in an overlapping state.

[0091] Although not shown in FIG. **6**, the folded portion of the third separator **123C** may be positioned on the innermost side in the wound state of the first electrode plate **121**, the third separator **123C**, and the second electrode plate **122**. That is, the folded portion of the third separator **123C** may be positioned on the innermost side of the electrode assembly **220**.

[0092] On the other hand, the folded portion of the third separator **123C** may be positioned on the outermost side in a wound state of the first electrode plate **121**, the third separator **123C**, and the second electrode plate **122**. That is, the folded portion of the third separator **123C** may be positioned on the outermost side of the electrode assembly **220**. Accordingly, the folded portion of the third separator **123C** may be positioned in a space between the cylindrical can and the electrode assembly **220**.

[0093] Note that a length of the third separator **123C** may be made to be two times longer than a longer length of the first electrode plate **121** and the second electrode plate **122**. Accordingly, even if the third separator **123C** is folded and the entire length thereof becomes $\frac{1}{2}$ of its unfolded length, the third separator may be longer than the first electrode plate **121** and/or the second electrode plate **122**.

[0094] Here, the first electrode plate **121** and the second electrode plate **122** may have lengths corresponding to each other. That is, as described above, the overall lengths of the first electrode plate **121** and the second electrode plate **122** may be the same.

[0095] Note that a thickness of the third separator **123C** may be within a range from 4 μm to 8 μm . Accordingly, the total thickness of the folded third separator **123C** may be 8 μm to 16 μm , which is similar to a thickness of a single separator included in a general electrode assembly. Thus, the size of the electrode assembly **220** according to this embodiment may not be increased compared to the cylindrical secondary battery of the related art in the same manner that the size of the electrode assembly **120** (see FIG. 4) described above is not increased compared to the related art.

[0096] As described above, in the electrode assembly **220** according to an embodiment of the present disclosure, the third separator **123C** is arranged between the first electrode plate **121** and the second electrode plate **122** in a folded (twofold) state. Therefore, unwinding of the wound state, rewinding, and the like by contraction and expansion between the first electrode plate **121** and the second electrode plate **122** can proceed smoothly, and deformation can be prevented from occurring in the electrode assembly **220** by relieving the stress due to the contraction and expansion.

[0097] Although the various embodiments of the present disclosure have been described, the drawings and the detailed description of the disclosure referenced so far are merely illustrative of the present disclosure, are used only for the purpose of describing the present disclosure, and are not intended to define the meanings thereof or to limit the scope of the present disclosure set forth in the claims. Therefore, one skilled in the art will understand that various variations and other equivalent embodiments are possible from the drawings and the detailed description. Consequently, the true technical protective scope of the present disclosure should be determined based on the technical spirit of the attached claims.

DESCRIPTION OF SYMBOLS

[0098] **100**: cylindrical secondary battery [0099] **110**: cylindrical can [0100] **120, 220**: electrode assembly [0101] **121**: first electrode plate [0102] **122**: second electrode plate [0103] **123**: separator [0104] **123A**: first separator [0105] **123B**: second separator [0106] **123C**: third separator [0107] **140**: cap assembly

Claims

1. An electrode assembly comprising: a first electrode plate; a first separator in contact with the first electrode plate; a second separator in contact with the first separator; and a second electrode plate in contact with the second separator.
2. The electrode assembly of claim 1, wherein the first separator and the second separator are longer than the first electrode plate and the second electrode plate.
3. The electrode assembly of claim 1, wherein lengths of the first separator and the second separator are the same.
4. The electrode assembly of claim 1, wherein lengths of the first electrode plate and the second electrode plate are the same.
5. The electrode assembly of claim 1, wherein a thickness of the first separator is within a range from 4 μm to 8 μm .
6. The electrode assembly of claim 1, wherein a thickness of the second separator is within a range from 4 μm to 8 μm .

- 7.** The electrode assembly of claim 1, wherein the first electrode plate is a negative electrode plate, and the second electrode plate is a positive electrode plate.
 - 8.** The electrode assembly of claim 1, wherein the first electrode plate is a positive electrode plate, and the second electrode plate is a negative electrode plate.
 - 9.** An electrode assembly comprising: a first electrode plate; a second electrode plate spaced apart from the first electrode plate; and a separator interposed between the first electrode plate and the second electrode plate, with the separator being in a folded state.
 - 10.** The electrode assembly of claim 9, wherein the first electrode plate, the separator, and the second electrode plate are wound while overlapping each other such a folded portion of the separator is positioned on an innermost side in the wound state of the first electrode plate, the separator, and the second electrode plate.
 - 11.** The electrode assembly of claim 9, wherein the first electrode plate, the separator, and the second electrode plate are wound while overlapping each other, and wherein a folded portion of the separator is positioned on an outermost side in the wound state of the first electrode plate, the third separator, and the second electrode plate.
 - 12.** The electrode assembly of claim 9, wherein the separator is folded at a middle portion of the separator.
 - 13.** The electrode assembly of claim 9, wherein a length of the separator is two times longer than a length of the first electrode plate and the second electrode plate.
 - 14.** The electrode assembly of claim 9, wherein lengths of the first electrode plate and the second electrode plate are the same.
 - 15.** The electrode assembly of claim 9, wherein a thickness of the separator is within a range from 4 μm to 8 μm .
 - 16.** The electrode assembly of claim 9, wherein the first electrode plate is a negative electrode plate, and the second electrode plate is a positive electrode plate.
 - 17.** The electrode assembly of claim 9, wherein the first electrode plate is a positive electrode plate, and the second electrode plate is a negative electrode plate.
 - 18.** A cylindrical secondary battery comprising: an electrode assembly according to claim 1; a cylindrical can accommodating the electrode assembly; and a cap assembly coupled to one side of the cylindrical can.
 - 19.** A cylindrical secondary battery comprising: an electrode assembly according to claim 9; a cylindrical can accommodating the electrode assembly; and a cap assembly coupled to one side of the cylindrical can.
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