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LAMINATED BATTERY MANUFACTURING METHOD AND LAMINATED BATTERY

Abstract

A method of manufacturing a laminated battery of the present disclosure is a method of manufacturing a laminated battery from an unfinished product. The unfinished product includes an electrode body and an exterior body formed of a laminate film covering the electrode body. The exterior body includes an accommodating portion for housing the electrode body, and an edge seal portion formed by welding end portions of the laminate film to each other. The edge seal portion includes a bent portion bent with respect to a main surface of the electrode body. The manufacturing method includes preparing the unfinished product, and filling an unsolidified material of the resin composition between the bent portion and the accommodating portion.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-020555 filed on Feb. 14, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to a laminated battery manufacturing method and a laminated battery.

2. Description of Related Art

[0003] In order to improve volume efficiency of a laminated battery, an edge seal portion of an exterior body made of a laminated film is bent. The edge seal portion is formed by welding end portions of the laminate film.

[0004] Japanese Unexamined Patent Application Publication No. 2019-200973 (JP 2019-200973 A) discloses a manufacturing method a secondary battery (hereinafter, also referred to as a "laminated battery"). The manufacturing method includes a first process and a second process. The first process and the second process are performed in this order. In the first process, a pressing plate is brought into contact with a base point of bending of an end portion (hereinafter, also referred to as an "edge seal portion") of an exterior body. In the second process, the pressing plate and a pushing plate disposed at a position facing the pressing plate are caused to slide with the edge seal portion sandwiched. Accordingly, the edge seal portion is bent around the base point, the edge seal portion is sandwiched between the pressing plate and the pushing plate, and the bent portion is thereby formed. A surface of the pushing plate that slides on the edge seal portion has a specific surface.

SUMMARY

[0005] However, there is a concern that the bent portion is opened by spring-back in the laminated battery disclosed in JP 2019-200973 A. "Spring-back" refers to a phenomenon in which at least a part of deformation caused by pressurization is about to return its original shape using, as a driving force, a residual stress generated by the deformation. The laminate film is soft and vulnerable. If the bent portion is opened, there is a concern that scratching (for example, a tear or the like) may occur in the bent portion (particularly, in the vicinity of the base point of the bending of the laminate film).

[0006] The present disclosure has been made in consideration of the circumstances. An object of an embodiment of the present disclosure is to provide a laminated battery manufacturing method enabling a laminated battery with reduced opening of a folded portion and with excellent reliability against scratching at the bent portion to be manufactured. An object of another embodiment of the present disclosure is to provide a laminated battery with reduced opening of a folded portion and with excellent reliability against scratching at the bent portion.

[0007] A mechanism that addresses the above object includes the following aspects.

[0008] <1> A laminated battery manufacturing method according to a first aspect is a manufacturing method of manufacturing a laminated battery from an unfinished product.

The unfinished product includes an electrode body and an exterior body configured of a laminate film covering the electrode body.

The exterior body includes an accommodating portion that accommodates the electrode body and an edge seal portion that is made by welding end portions of the laminate film.

The edge seal portion includes a bent portion that is bent with respect to a main surface of the electrode body.

The manufacturing method includes:
preparing the unfinished product; and
filling a part between the bent portion and the accommodating portion with an unsolidified material of a resin composition.
[0009] In the present disclosure, “laminate film” refers to a film having at least a metal layer, a first resin layer laminated on one main surface of the metal layer, and a second resin layer laminated on the other main surface of the metal layer.
[0010] The manufacturing method according to the first aspect includes the filling of the part between the bent portion and the accommodating portion with the unsolidified material of the resin composition. The obtained bent portion of the laminated battery is thus fixed by a solidified material (resin-filled portion) of the resin composition. As a result, according to the manufacturing method of the first aspect, it is possible to manufacture a laminated battery with reduced opening of the bent portion and with excellent reliability against scratching at the bent portion.
[0011] <2> A laminated battery manufacturing method according to a second aspect is a manufacturing method of manufacturing a laminated battery from an unfinished product.
The unfinished product includes an electrode body and an exterior body configured of a laminate film covering the electrode body.
The exterior body includes an accommodating portion that accommodates the electrode body and an edge seal portion that is made by welding end portions of the laminate film.
The edge seal portion includes a bent portion that is bent with respect to a main surface of the electrode body and a non-bent portion.
The manufacturing method includes:
preparing the unfinished product;
applying an unsolidified material of a resin composition to a surface of the bent portion on a side of the electrode body;
folding the bent portion to which the unsolidified material is applied to form a folded portion; and
folding the non-bent portion using a base line located closer to the side of the electrode body than a portion of the non-bent portion overlapping the folded portion as a bending line.
[0012] The manufacturing method according to the second aspect includes the folding of the bent portion to which the unsolidified material is applied to form the folded portion. The obtained folded portion of the laminated battery is thus fixed by a solidified material (resin-filled portion) of the resin composition. As a result, according to the manufacturing method of the second aspect, it is possible to manufacture a laminated battery with reduced opening of the bent portion and with excellent reliability against scratching at the bent portion.
[0013] <3> The laminated battery according to a third aspect includes:
an electrode body;
an exterior body that is configured of a laminate film covering the electrode body; and a resin-filled portion.
The exterior body includes an accommodating portion that accommodates the electrode body and an edge seal portion that is made by welding end portions of the laminate film.
The edge seal portion includes a bent portion that is bent with respect to a main surface of the electrode body.
The resin-filled portion includes a solidified material of a resin composition filled between the bent portion and the accommodating portion.
[0014] In the present disclosure, the “solidified product of the resin composition” indicates a resin composition that is in a solid state at an operating temperature (for example, 120° C. or lower) of the laminated battery.
[0015] In the third aspect, the resin-filled portion includes the solidified material of the resin composition filled between the bent portion and the accommodating portion. The bent portion of the laminated battery is thus fixed by the resin-filled portion. As a result, the laminated battery

according to the third aspect has reduced opening of the bent portion and has excellent reliability against scratching at the bent portion.
[0016] <4> A laminated battery according to a fourth aspect includes:
an electrode body;
an exterior body that is configured of a laminate film covering the electrode body; and
a resin-filled portion.
The exterior body includes an accommodating portion that accommodates the electrode body and an edge seal portion that is made by welding end portions of the laminate film.
The edge seal portion has a bent portion that is bent with respect to a main surface of the electrode body.
The bent portion has a folded portion and a non-folded portion.
The resin-filled portion includes a solidified material of a resin composition filled between the folded portion and the non-folded portion.
[0017] According to the manufacturing method of the fourth aspect, the resin-filled portion includes the solidified material of the resin composition filled between the folded portion and the non-folded portion. The folded portion of the laminated battery is thus fixed by the resin-filled portion. As a result, the laminated battery according to the fourth aspect has reduced opening of bent portion and has excellent reliability against scratching at the bent portion.
[0018] According to an embodiment of the present disclosure, there is provided a laminated battery manufacturing method enabling a laminated battery with reduced opening of a bent portion and with excellent reliability against scratching at the bent portion to be manufactured.
[0019] According to another embodiment of the present disclosure, there is provided a laminated battery with reduced opening of a bent portion and with excellent reliability against scratching at the bent portion.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0020] Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:
[0021] FIG. **1** is a perspective view of a laminated battery according to a first embodiment;
[0022] FIG. **2** shows a cross-sectional view of II-II of FIG. **1**;
[0023] FIG. **3** is a diagram schematically illustrating a configuration of a bending device used in the method of manufacturing a laminated battery according to the first embodiment;
[0024] FIG. **4** is a diagram for explaining a method of manufacturing a laminated battery according to the first embodiment;
[0025] FIG. **5** is a cross-sectional view of a laminated battery according to a second embodiment; and
[0026] FIG. **6** is a diagram for explaining a manufacturing method of the laminated battery according to the second embodiment.
DETAILED DESCRIPTION OF EMBODIMENTS
[0027] In the present disclosure, a numerical range indicated by using “to” means a range including numerical values described before and after “to” as a minimum value and a maximum value, respectively. In the numerical range described in the present disclosure in a stepwise manner, the upper limit value or the lower limit value described in a certain numerical range may be replaced with the upper limit value or the lower limit value of the numerical range described in another stepwise manner. In the present disclosure, a combination of two or more preferred embodiments is a more preferred embodiment. In the present disclosure, the term “step” is included in the term as

long as the intended purpose of the step is achieved, even if it is not clearly distinguishable from other steps as well as independent steps.

[0028] Hereinafter, a method of manufacturing a laminated battery of the present disclosure and an embodiment of a laminated battery of the present disclosure will be described with reference to the drawings. In the drawings, the same or corresponding parts are denoted by the same reference numerals, and description thereof will not be repeated.

(1) FIRST EMBODIMENT

[0029] A method of manufacturing a laminated battery according to the first embodiment is a method of manufacturing a laminated battery **1**A (hereinafter, also referred to as "battery A**1**") from an unfinished product **1***a*. The manufacturing process includes a preparation process, an application process, a consolidation process, and a finishing bend process. The preparation step, the coating step, the solidification step, and the finish bending step are performed in this order.

(1.1) Laminated battery

[0030] As shown in FIG. **1**, the battery **1**A includes an exterior body **10**A, a resin-filled portion **20**A, an electrode body **30**, and a pair of terminals **40**. One of the pair of terminals **40** is a positive electrode terminal. The other of the pair of terminals **40** is a negative electrode terminal. The electrode body **30** is a rectangular parallelepiped.

[0031] In the first embodiment, the longitudinal direction of the main surface S**30** of the electrode body **30** is defined as the X-axis direction, the Y-axis direction of the main surface S**30** of the electrode body **30** is defined as the Y-axis direction, and the thickness direction of the electrode body **30** is defined as the Z-axis direction. Each of the X-axis, the Y-axis, and the Z-axis is orthogonal to each other. Note that these orientations do not limit the orientation of the laminated battery of the present disclosure when used.

[0032] The pair of terminals **40** are disposed to face each other with the electrode body **30** interposed therebetween. Each of the pair of terminals **40** is electrically connected to the electrode body **30**. The exterior body **10**A covers the electrode body **30**. The electrode body **30** is sealed by a pair of terminals **40** and an exterior body **10**A.

(1.1.1) Exterior Body

[0033] The exterior body **10**A is composed of one laminated film. As shown in FIG. **2**, the exterior body **10**A has an accommodating portion R**10**A and an edge scaling portion R**10**B. The accommodating portion R**10**A accommodates the electrode body **30**. The edge scaling portion R**10**B is formed by welding end portions of the laminated films to each other. The edge scaling portion R**10**B has a bent portion R**10**B**1** and a non-bent portion R**10**B**2**. The bent portion R**10**B**1** is bent with respect to the main surface S**30** of the electrode body **30**. In the first embodiment, the angle θA (hereinafter, also referred to as "bending angle θA") of the bent portion R**10**B**1** with respect to the main surface S**30** (see FIG. **2**) is, for example, approximately 90°. The non-bent portion R**10**B**2** extends in the Y-axis positive direction from an end portion on the Z-axis negative direction side of the side surface on the Y-axis positive direction side of the accommodating portion R**10**A. The bent portion R**10**B**1** and the accommodating portion R**10**A face each other.

[0034] The laminate film is formed by laminating an outer insulating layer, a metal layer, and an inner insulating layer in this order. The thickness of the laminate film may be 70 μm to 220 μm. The outer insulating layer functions as a protective layer for the metal layer. Examples of the protective layers include polyethylene terephthalate (PET) and nylon. The metallic layers block the ingress and egress of gases (e.g., moisture, air, etc.) between the exterior of the battery **1**A and the interior of the battery **1**A. Examples of the material of the metal layer include aluminum, an aluminum alloy, and stainless steel. The inner insulating layer electrically insulates the pair of terminals **40** and the electrode body **30** from the metal layer. Examples of the inner insulating layers include polypropylene (PP) and polyethylene (PE).

(1.1.2) Resin-Filled Portion

[0035] The resin-filled portion **20**A fixes the bent portion R**10**B**1** of the exterior body **10**A. The

resin-filled portion **20**A includes a solidified material. The solidified material is filled in a gap R**1**A between the bent portion R**10**B**1** and the accommodating portion R**10**A. The resin composition may be a known resin composition (for example, a thermoplastic resin composition, a thermosetting resin composition, or a photocurable resin composition) as long as it is a resin composition that is in a solid-state at an operating temperature of the battery **1**A (for example, 120° C. or lower). The resin composition includes a known resin (for example, a thermoplastic resin, a thermosetting resin, a photocurable resin, or the like). The resin composition may further contain a polymerization initiator, a curing agent, or the like, if necessary.

(1.1.3) Electrode Body

[0036] The electrode body **30** functions as a power generation element of the battery **1**A. The electrode body **30** may be any known electrode body. The electrode body **30** may include a plurality of unit electrode bodies. The unit electrode body may include a so-called solid electrolyte (the content of the electrolyte as the electrolyte is less than 5% by mass based on the total amount of the electrolyte) using an inorganic solid electrolyte as the electrolyte. The structure of the unit electrode body may be a structure in which a positive electrode current collector, a positive electrode layer, a solid electrolyte layer, a negative electrode layer, and a negative electrode current collector are stacked in this order along the Z-axis direction.

(1.1.4) Terminal

[0037] The terminal **40** is a rectangular parallelepiped. The shape of the terminal **40** as viewed in the Z-axis direction is a U-shape. Examples of the material of the terminal **40** include metallic materials (for example, SUS and the like).

(1.2) Unfinished Product

[0038] The unfinished product **1***a* is similar to the battery **1**A except that the unfinished product **1***a* does not include the resin-filled portion **20**A and that the bending angle θA is an acute angle.

(1.3) Bending Device

[0039] In the first embodiment, the bending device **100** is used in the preparation step, the coating step, and the finish bending step. The bending device **100** bends the edge sealing portion R**10**B and applies an unsolidified material. As illustrated in FIG. **3**, the bending device **100** includes a conveyance unit **110**, an upstream roller group **120**, a dispenser **130**, and a downstream roller group **140**. The upstream roller group **120**, the dispenser **130**, and the downstream roller group **140** are arranged in this order along the conveying direction D.

[0040] The conveyance unit **110** is configured to convey the unfinished product **1***a* in the conveying direction D.

[0041] The upstream roller group **120** bends the edge sealing portion R**10**B so that the bending angle θA is from 0° to the third angle (for example, 85°). The baseline L**1** (see FIGS. **2** and **4**) is a fold line. The upstream roller group **120** includes a pair of rollers **121**, a pair of rollers **122**, and a pair of rollers **123**. The pair of rollers **121**, the pair of rollers **122**, and the pair of rollers **123** are arranged in this order along the conveying direction D.

The pair of rollers **121** bends the bent portion R**10**B**1** so that the bending angle θA is from 0° to the first angle (for example, 30°). The pair of rollers **121** includes a back-up roller **121**A and a folding roller **121**B. The folding roller **121**B has an inclined surface S**121** (see FIG. **4**).

The edge sealing portion R**10**B is sandwiched between the pair of rollers **121** and is bent along the inclined surface S**121**.

The pair of rollers **122** bends the bent portion R**10**B**1** so that the bending angle θA is the second angle (for example, 60°) from the first angle. The pair of rollers **122** includes a back-up roller **122**A and a folding roller **122**B. The folding roller **122**B has a first inclined surface. The bent portion R**10**B**1** is sandwiched between the pair of rollers **122** and is bent along the first inclined surface.

The pair of rollers **123** bends the bent portion R**10**B**1** so that the bending angle θA is the third angle (for example, 85°) from the second angle. The pair of rollers **123** includes a back-up roller **123**A and a folding roller **123**B. The folding roller **123**B has a second inclined surface. The bent portion

R**10**B**1** is sandwiched between the pair of rollers **123** and is bent along the second inclined surface.
[0042] The dispenser **130** applies an unsolidified resin-composition to the gap R**1**A. The dispenser **130** may be a known dispenser.
[0043] The downstream roller group **140** bends the bent portion R**10**B**1** such that the bending angle θA is approximately 90° from the third angle. The downstream roller group **140** includes an inclined roller **140**A and a bending roller **140**B. The rotational axis direction of the inclined roller **140**A is inclined with respect to the Y axis direction. The rotational axis direction of the inclined roller **140**A with respect to the Y-axis direction is, for example, 5°. The surface layer of the bending roller **140**B is formed of an elastic material. The bending roller **140**B is biased in the Y-axis direction (a direction perpendicular to the conveying direction D) by a biasing unit (for example, a spring or the like).
(1.4) Preparation Process
[0044] In the preparation step, an unfinished product **1***a* is prepared. Specifically, in the first embodiment, the edge sealing portion R**10**B of the unfolded product **1***au* (see FIG. **4**) is sandwiched between the upstream roller groups **120** of the bending device **100** to form the unfinished product **1***a*. The unfolded product **1***au* is similar to the unfinished product **1***a* except that the edge sealing portion R**10**B is unfolded. Methods for preparing unfolded product **1***au* are known methods.
(1.5) Coating Process
[0045] In the coating step, as shown in FIG. **4**, an unsolidified resin-composition is filled between the bent portion R**10**B**1** and the accommodating portion R**10**A. Specifically, in the first embodiment, an unsolidified resin-composition is applied to a gap R**1**A of an unfinished product **1***a* to form a coating **20**AU.
(1.6) Finishing Bending Process
[0046] In the finishing bending step, as shown in FIG. **4**, the bent portion R**10**B**1** is bent so that the bending angle θA is approximately 90°. Specifically, in the first embodiment, the unfinished product **1***a* on which the coating material **20**AU is formed is sandwiched by the downstream roller group **140** of the bending device **100** to bend the bent portion R**10**B**1**.
(1.7) Solidification Process
[0047] In the solidification step, the coating **20**AU is solidified to form a resin-filled portion **20**A. Thereby, a battery **1**A is obtained.
[0048] The solidification method is appropriately selected according to the type of the resin composition and the like. When the resin composition is a thermoplastic resin composition or a thermosetting resin composition, the coating **20**AU may be solidified by being cooled. The cooling method is not particularly limited, and examples thereof include a method of leaving at room temperature (25° C.), a method of blowing cooling air, and the like. When the resin composition is a photocurable resin composition, the coating **20**AU may be solidified by irradiating with active energy rays (for example, visible light, ultraviolet rays, X-rays, or electron beams).
(1.8) Action and Effect
[0049] As described with reference to FIGS. **1** to **3**, the manufacturing method of the first embodiment includes a preparation step and a coating step. Thus, the bent portion R**10**B**1** of the obtained battery **1**A is fixed by the solidified material (resin-filled portion **20**A) of the resin composition. Consequently, in the manufacturing process of the first embodiment, it is possible to manufacture a laminated battery **1**A in which the opening of the bent portion R**10**B**1** is suppressed and the reliability against the flaw of the bent portion R**10**B**1** is excellent.
[0050] As described with reference to FIGS. **1** to **3**, the battery **1**A includes an electrode body **30**, an exterior body **10**A, and a resin-filled portion **20**A. The exterior body **10**A has an accommodating portion R**10**A and an edge sealing portion R**10**B. The edge sealing portion R**10**B includes a bent portion R**10**B**1**. The resin-filled portion **20**A includes a solidified material of the resin-composition filled between the bent portion R**10**B**1** and the accommodating portion R**10**A. Thus, the bent

portion R**10**B**1** of the battery **1**A is fixed by the resin-filled portion **20**A. Consequently, in the battery **1**A, the opening of the bent portion R**10**B**1** is suppressed, and the reliability against the flaw of the bent portion R**10**B**1** is excellent.

(2) SECOND EMBODIMENT

[0051] A method of manufacturing a laminated battery according to the second embodiment is a method of manufacturing a laminated battery **1**B (hereinafter, also referred to as "battery **1**B") from an unfinished product **1***b*. The manufacturing method includes a preparation step, a coating step, a folding step, a solidifying step, and a folding step. The preparation, application, folding, consolidation, and folding steps are performed in this order.

(2.1) Laminated Battery

[0052] The battery **1**B is similar to the battery **1**A except that the edge seal portion bends and the resin-filled portion mainly differs. The battery **1**B includes an exterior body **10**B, a resin-filled portion **20**B, an electrode body **30**, and a pair of terminals **40**.

(2.1.1) Exterior Body

[0053] The exterior body **10**B is similar to the exterior body **10**A except that the bending of the edge sealing portion R**10**B differs. The exterior body **10**A has an accommodating portion R**10**A and an edge sealing portion R**10**B. The edge scaling portion R**10**B has a bent portion R**10**B**10** and a non-bent portion R**10**B**20**. The bent portion R**10**B**10** has a folded portion R**10**B**11** and a non-folded portion R**10**B**12**. The bent portion R**10**B**10** is bent with respect to the main surface S**30** of the electrode body **30**. In the second embodiment, the angle θB (hereinafter, also referred to as "bending angle θB") of the bent portion R**10**B**10** with respect to the main surface S**30** (see FIG. **5**) is, for example, approximately 90°. The non-bent portion R**10**B**20** extends in the Y-axis positive direction from an end portion on the Z-axis negative direction side of the side surface on the Y-axis positive direction side of the accommodating portion R**10**A. The folded portion R**10**B**11** and the unfolded portion R**10**B**12** face each other.

(2.1.2) Resin-Filled Portion

[0054] The resin-filled portion **20**B fixes the folded portion R**10**B**11** of the exterior body **10**B. The resin-filled portion **20**B includes a solidified material. The solidified material is filled between the folded portion R**10**B**11** and the unfolded portion R**10**B**12**. Examples of the resin composition on the resin-filled portion **20**B include the same as those exemplified as the resin composition on the resin-filled portion **20**A.

(2.2) Unfinished Product

[0055] The unfinished product **1***b* is similar to the battery **1**B except that the unfinished product **1***b* does not include the resin-filled portion **20**B and that the bent portion R**10**B**10** is not formed.

(2.3) Bending Device

[0056] In the second embodiment, a folding device (not shown) is used for the preparation step, the coating step, and the folding step. The bending device bends the edge sealing portion R**10**B and applies an unsolidified material. The bending device is the same as the bending device **100** except that the configurations of the upstream roller group and the downstream roller group are different from each other. The bending device includes a conveyance unit **110**, an upstream roller group, a dispenser **130**, and a downstream roller group. The upstream roller group, the dispenser **130**, and the downstream roller group are arranged in this order along the conveying direction D.

[0057] The upstream roller group bends the edge sealing portion R**10**B such that the angle θC of the portion R**10**B**110** corresponding to the folded portion R**10**B**11** of the battery **1**B with respect to the main surface S**30** is approximately 90° from 0° (see FIG. **6**). The portion R**10**B**110** is hereinafter also referred to as "bent portion R**10**B**110**". The angle θC is hereinafter also referred to as a "bending angle θC". The baseline L**2** (see FIGS. **5** and **6**) is a fold line. The upstream roller group includes a pair of first rollers **151** (see FIG. **6**), a pair of second rollers, and a pair of third rollers. The pair of first rollers **151**, the pair of second rollers, and the pair of third rollers are arranged in this order along the conveying direction D.

The pair of first rollers **151** bends the bent portion R**10**B**110** so that the bending angle θC is from 0° to the fourth angle (for example, 30°). The pair of first rollers **151** includes a first backup roller **151**A and a first folding roller **151**B. The first folding roller **151**B has a third inclined surface S**151** (see FIG. **6**). The edge sealing portion R**10**B is sandwiched between the pair of first rollers **151** and is bent along the third inclined surface S**151** of the first bending roller **151**B.

The pair of second rollers bends the bent portion R**10**B**110** so that the bending angle θC is the fifth angle (for example, 60°) from the fourth angle. The pair of second rollers includes a second backup roller and a second folding roller. The second bending roller has a fourth inclined surface. The bent portion R**10**B **110** is sandwiched between the pair of second rollers and is bent along the fourth inclined surface of the second bending roller.

The pair of third rollers bends the bent portion R**10**B**110** such that the bending angle θC is approximately 90° from the fifth angle. The pair of third rollers includes a third backup roller and a third folding roller. The third bending roller has a fifth inclined surface. The bent portion R**10**B**110** is sandwiched between a pair of third rollers, and is bent along the fifth inclined surface of the third bending roller.

[0058] The downstream-side roller group bends the bent portion R**10**B**110** such that the bending angle θC is approximately 0° from the third angle. That is, the bent portion R**10**B**110** is folded to become the folded portion R**10**B**11**. The upstream roller group includes a pair of fourth rollers, a pair of fifth rollers, and a pair of sixth rollers. The pair of fourth rollers, the pair of fifth rollers, and the pair of sixth rollers are arranged in this order along the conveying direction D.

The pair of fourth rollers bends the bent portion R**10**B**110** such that the bending angle θC is approximately 90° to a sixth angle (e.g., 120°). The pair of fourth rollers includes a first contact roller and a first opposing roller. The first contact roller has a first large-diameter portion, a first small-diameter portion, and a first planar portion connecting the first large-diameter portion and the first small-diameter portion. The first opposing roller has a second large-diameter portion, a second small-diameter portion, and a first inclined surface portion connecting the second large-diameter portion and the second small-diameter portion. The bent portion R**10**B**110** is sandwiched between the pair of fourth rollers and is bent along the first inclined surface portion of the first opposing roller.

The pair of fifth rollers bends the bent portion R**10**B**110** so that the bending angle θC is a seventh angle (for example, 150°) from the sixth angle. The pair of fifth rollers includes a second contact roller and a second opposing roller. The second contact roller has a third large-diameter portion, a third small-diameter portion, and a second planar portion connecting the third large-diameter portion and the third small-diameter portion. The second opposing roller has a fourth large-diameter portion, a fourth small-diameter portion, and a second inclined surface portion connecting the fourth large-diameter portion and the fourth small-diameter portion. The bent portion R**10**B**110** is sandwiched between the pair of fifth rollers and is bent along the second inclined surface portion of the second opposing roller. The pair of sixth rollers bends the bent portion R**10**B**110** such that the bending angle θC is approximately 0° from the seventh angle. The pair of sixth rollers includes a third contact roller and a third opposing roller. The third contact roller has a fifth large-diameter portion, a fifth small-diameter portion, and a third planar portion connecting the fifth large-diameter portion and the fifth small-diameter portion. The third opposing roller has a sixth large-diameter portion, a sixth small-diameter portion, and a third inclined surface portion connecting the sixth large-diameter portion and the sixth small-diameter portion. The bent portion R**10**B**110** is sandwiched between the pair of sixth rollers and is bent along the third inclined surface portion of the third opposing roller.

(2.4) Preparation Process

[0059] In the preparation step, an unfinished product **1***b* is prepared. Specifically, in the second embodiment, an unfinished product **1***b* is formed by sandwiching the edge sealing portion R**10**B of the unfolded product **1***bu* (see FIG. **6**) between the upstream rollers of the bending device. The

unfolded product **1***bu* is similar to the unfinished product **1***b* except that the edge sealing portion R**10**B is unfolded. Methods for preparing unfolded product **1***bu* are known methods.

(2.5) Coating Process

[0060] In the coating step, as shown in FIG. **6**, an unsolidified material is applied to the surface of the bent portion R**10**B**110** on the electrode body **30**. Specifically, in the second embodiment, an unsolidified resin-composition is applied to the surface SR**10**B**110** (see FIG. **6**) of the bent portion R**10**B**110** on the electrode body **30** to form a coating **20**BU.

(2.6) Folding Process

[0061] In the folding step, as shown in FIG. **6**, a bent portion R**10**B**110** to which an unsolidified material is applied is folded to form a folded portion R**10**B**11**. Specifically, in the second embodiment, the folded portion R**10**B**11** is formed by sandwiching the bent portion R**10**B**110** to which the unsolidified material is applied between the downstream-side roller groups of the bending device.

(2.7) Solidification Process

[0062] In the solidification step, the coating **20**BU is solidified to form a resin-filled portion **20**B. The solidification method of the second embodiment is the same as that exemplified as the solidification method of the first embodiment.

(2.8) Folding Process

[0063] In the folding step, as shown in FIG. **6**, the non-bent portion R**10**B**120** is folded using, as a folding line, a baseline L**3** located closer to the electrode body **30** with respect to a portion overlapping with the folded portion R**10**B**11** in the non-bent portion R**10**B**120**. Thereby, a battery **1**B is obtained.

[0064] The folding method is not particularly limited, and may be a known method.

(2.9) Action and Effect

[0065] As described in FIG. **5** and FIG. **6**, the manufacturing method of the second embodiment includes a preparation process, an application process, a folding process, and a folding process. Thus, the folded portion R**10**B**11** of the obtained battery **1**B is fixed by the resin-filled portion **20**B. As a consequence, in the manufacturing process of the second embodiment, it is possible to manufacture a laminated battery **1**B in which the opening of the bent portion R**10**B**10** is suppressed and the reliability against the flaw of the bent portion R**10**B**10** is excellent.

[0066] As described with reference to FIGS. **5** and **6**, the battery **1**B includes an electrode body **30**, an exterior body **10**B, and a resin-filled portion **20**B. The exterior body **10**B has an accommodating portion R**10**A and an edge sealing portion R**10**B. The edge sealing portion R**10**B has a bent portion R**10**B**10**. The bent portion R**10**B**10** has a folded portion R**10**B**11** and a non-folded portion R**10**B**12**. The resin-filled portion **20**B includes a solidified material of the resin composition filled between the folded portion R**10**B**11** and the non-folded portion R**10**B**12**. Thus, the folded portion R**10**B**11** of the battery **1**B is fixed by the resin-filled portion **20**B. As a consequence, the laminated battery **1**B is excellent in reliability against scratches on the bent portion R**10**B **10** and is suppressed in opening of the bent portion R**10**B**10**.

(3) MODIFICATION

[0067] The method of manufacturing the laminated battery according to the first embodiment includes a solidification step and a finish bending step, but the present disclosure is not limited thereto. The method for manufacturing a laminated battery according to the first embodiment may not include a solidification step and a finish bending step.

[0068] The method of manufacturing the laminated battery according to the second embodiment includes a solidification step, but the present disclosure is not limited thereto. The method for manufacturing a laminated battery according to the second embodiment may not include a solidification step.

[0069] In the second embodiment, the resin-composition solidified material is not filled between the accommodating portion R**10**A and the bent portion R**10**B**10**. In the second embodiment, a

solidified material may be filled between the accommodating portion R**10**A and the bent portion R**10**B**10**.

Claims

1. A manufacturing method of manufacturing a laminated battery from an unfinished product, the unfinished product including an electrode body and an exterior body configured of a laminate film covering the electrode body, the exterior body including an accommodating portion that accommodates the electrode body and an edge seal portion made by welding end portions of the laminate film, and the edge seal portion including a bent portion that is bent with respect to a main surface of the electrode body, wherein the manufacturing method includes: preparing the unfinished product; and filling a part between the bent portion and the accommodating portion with an unsolidified material of a resin composition.

2. A manufacturing method of manufacturing a laminated battery from an unfinished product, the unfinished product including an electrode body and an exterior body configured of a laminate film covering the electrode body, the exterior body including an accommodating portion that accommodates the electrode body and an edge seal portion made by welding end portions of the laminate film, and the edge seal portion including a bent portion that is bent with respect to a main surface of the electrode body and a non-bent portion, wherein the manufacturing method includes: preparing the unfinished product; applying an unsolidified material of a resin composition to a surface of the bent portion on a side of the electrode body; folding the bent portion to which the unsolidified material is applied to form a folded portion; and folding the non-bent portion using a base line located closer to the side of the electrode body than a portion of the non-bent portion overlapping the folded portion as a bending line.

3. A laminated battery comprising: an electrode body; an exterior body that is configured of a laminate film covering the electrode body; and a resin-filled portion, wherein the exterior body has an accommodating portion that accommodates the electrode body and an edge seal portion made by welding end portions of the laminate film, the edge seal portion includes a bent portion that is bent with respect to a main surface of the electrode body, and the resin-filled portion includes a solidified material of a resin composition filled between the bent portion and the accommodating portion.