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(12) Invention Patent Application

(10) Application Publication No.:CN 101714624 A

(43) Application Publication Date:May 26, 2010

(21) Application No.:200910192367.7

H01M 10/38 (2006.01)

(22) Filing Date: September 11, 2009

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(51) Int. Cl.

H01M 4/02 (2006.01)

H01M 2/26 (2006.01)

H01M 10/36 (2006.01)

Claims: 2 pages

Description: 5 pages

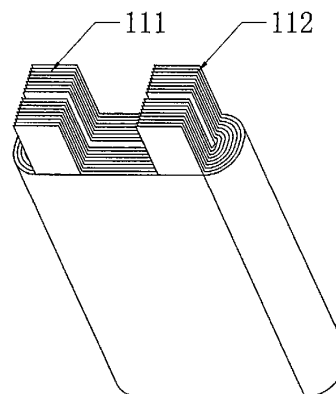
Drawings: 3 pages

(54) Title of Invention

Spiral Multi-Tab Lithium-Ion Battery and Method for Manufacturing the Same

(57) Abstract

A spiral multi-tab lithium-ion battery and a method for manufacturing the same are disclosed, both belonging to the field of batteries. The battery includes a positive electrode plate, a negative electrode plate, and a separator disposed therebetween. An active material is formulated into a mixed paste and applied onto a current collector; a blank region is reserved on the front surface along one longitudinal edge of the positive electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the positive electrode plate, and the remainder is fully coated with paste. An active material is formulated into a mixed paste and applied onto a current collector; a blank region is reserved on the front surface along one longitudinal edge of the negative electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the negative electrode plate, and the remainder is fully coated with paste. The invention is characterized in that spaced tabs are provided on the reserved blank region of the positive electrode plate, and spaced tabs are provided on the reserved blank region of the negative electrode plate. The present invention shortens the distance from the electrode plate to the electrode terminal, reduces internal resistance, decreases heat generation during discharge, improves safety, increases yield, and overcomes the difficulty that small batteries are unsuitable for stacking.



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1. A spiral multi-tab lithium-ion battery electrode plate, in which an active material, a conductive agent, and a binder are thoroughly mixed in a predetermined proportion to form a mixed paste that is applied onto a current collector, a blank region being reserved on the front surface along one longitudinal edge of the electrode plate, a blank region being reserved on the back surface along one longitudinal edge of the electrode plate, and the remainder being fully coated with paste, wherein a plurality of spaced tabs are provided on the reserved blank regions of the electrode plate.

2. The spiral multi-tab lithium-ion battery electrode plate of claim 1, wherein the spaced tabs are tabs of the same polarity which, after being formed, overlap upon winding, such that a neat stack of tabs is independently arranged at an end.

3. A spiral multi-tab lithium-ion battery, comprising a positive electrode plate, a negative electrode plate, and a separator disposed therebetween, in which an active material is formulated into a mixed paste and applied onto a current collector, a blank region being reserved on the front surface along one longitudinal edge of the positive electrode plate, a blank region being reserved on the back surface along one longitudinal edge of the positive electrode plate, and the remainder being fully coated with paste; and an active material is formulated into a mixed paste and applied onto a current collector, a blank region being reserved on the front surface along one longitudinal edge of the negative electrode plate, a blank region being reserved on the back surface along one longitudinal edge of the negative electrode plate, and the remainder being fully coated with paste, wherein a plurality of spaced tabs are provided on the reserved blank region of the positive electrode plate, and a plurality of spaced tabs are provided on the reserved blank region of the negative electrode plate.

4. The spiral multi-tab lithium-ion battery of claim 3, wherein the spaced tabs follow the polar coordinate equation $\rho = a\theta + P_0$,

where: a is the Archimedean spiral coefficient, in $\text{mm}/^\circ$, representing the increase (or decrease) in the polar radius per degree of rotation, with $a=L/360$;

θ is the polar angle, in degrees, representing the total number of degrees through which the Archimedean spiral rotates, θ being used to determine the forming positions of the tabs;

P_0 is the polar radius when $t = 0^\circ$, in mm; and

L = thickness of the positive electrode plate + thickness of the negative electrode plate + thickness of two separator layers, in mm.

5. The spiral multi-tab lithium-ion battery of claim 3, wherein the spaced tabs are tabs of the same polarity which, after being formed, overlap upon winding, such that a neat stack of tabs is independently arranged at an end.

6. A method for manufacturing a spiral multi-tab lithium-ion battery, comprising: fabricating a positive electrode plate by formulating an active material into a mixed paste, applying the paste onto a current collector, reserving a blank region on the front surface along one longitudinal edge of the positive electrode plate, reserving a blank region on the back surface along one longitudinal edge of the positive electrode plate, and fully coating the remainder with paste; fabricating a negative electrode plate by formulating an active material into a mixed paste, applying the paste onto a current collector, reserving a blank region on the front surface along one longitudinal edge of the negative electrode plate, reserving a blank region on the back surface along one longitudinal edge of the negative electrode plate, and fully coating the remainder with paste; placing the negative electrode plate on the separator by winding, winding the positive electrode plate, the separator, and the negative electrode plate into a cell, securing the cell with a finishing tape, and subjecting the cell having welded positive and negative electrodes to subsequent operations of packaging, vacuum drying, electrolyte injection, sealing, formation, capacity grading, and inspection to obtain a battery, wherein a plurality of spaced tabs are provided on the reserved blank region of the positive electrode plate, and a plurality of spaced tabs are provided on the reserved blank region of the negative electrode plate.

7. The method for manufacturing a spiral multi-tab lithium-ion battery of claim 6, wherein the spaced tabs follow the polar coordinate equation $\rho = a\theta + P_0$,

where: a is the Archimedean spiral coefficient, in $\text{mm}/^\circ$, with $a = L/360$;

θ is the polar angle, in degrees, used to determine the forming positions of the tabs;

P_0 is the polar radius when $t = 0^\circ$, in mm; and

L = thickness of the positive electrode plate + thickness of the negative electrode plate + thickness of two separator layers, in mm.

8. The method for manufacturing a spiral multi-tab lithium-ion battery of claim 6, wherein the tabs are formed by rotary cutting, die cutting, or laser cutting in accordance with a tab-forming template, the tab-forming template being obtained by winding the electrode plate into a cell, marking the tab positions on the wound cell, unwinding the electrode plate, measuring the dimensions of the marked points on the electrode plate, and thereby obtaining the multi-tab spacing

dimensions on the electrode plate to serve as the tab-forming template.

9. The method for manufacturing a spiral multi-tab lithium-ion battery of claim 6, wherein the spaced tabs are tabs of the same polarity which, after being formed, overlap upon winding, such that a neat stack of tabs is independently arranged at an end. The positive tabs and the negative tabs are arranged independently and neatly; the positive and negative tabs may be distributed at the same end of the cell, or at the two opposite ends of the cell respectively.

Spiral Multi-Tab Lithium-Ion Battery and Method for Manufacturing the Same

Technical Field

[0001] The present invention relates to a spiral multi-tab lithium-ion battery and a method for manufacturing the same, both belonging to the field of batteries, and in particular to the fabrication of a rechargeable secondary lithium-ion battery having high-rate discharge performance.

Background Art

[0002] Since the advent of lithium-ion batteries, cell assembly has consistently been the bottleneck in mass production and has also played a critical role in determining electrical performance. At present, cell forming for lithium-ion batteries is divided primarily into two categories—winding and stacking—each having its own advantages and disadvantages in production and battery performance. The advantages of the wound type are its simple structure, requiring only one positive electrode plate and one negative electrode plate, and its high specific energy; its disadvantages are that the electrode plates are long, the internal resistance is high—which is unfavorable for high-current charging and discharging—and the specific power is low. The advantages of the stacked type are that the electrode plates are short and the internal resistance is relatively low, which is favorable for high-current charging and discharging; its disadvantages are that the battery contains many electrode plates with numerous trimmed edges, making burr control at the trimmed edges difficult and generating substantial scrap, and that the stacking process requires aligning and stacking many plates one by one, resulting in extremely low production efficiency—only one-tenth that of wound batteries. In addition, welding multiple electrode plates is difficult, particularly for multiple negative electrodes, which use copper foil: the good electrical conductivity of copper foil is unfavorable for resistance welding, while the high melting point of copper foil is unfavorable for ultrasonic welding, potentially producing cold welds that are not firmly bonded. Over-welding may also occur, in which some electrode plates are welded through or partially welded through. Both cold welds and over-welds may render some negative electrodes inoperative, leading to low battery capacity; more seriously, a condition in which the positive electrode is operative but the negative electrode is inoperative may cause lithium plating during use and result in a safety incident. Existing wound and stacked lithium batteries each have drawbacks and are unfavorable for fast charging and high-current discharging. Even when the positive and negative electrode plates are coated very uniformly, an unsound electrode structure and cell design will exhibit non-uniform current density distribution during high-current charging and discharging, thereby compromising the battery's safety performance, fast-charging performance, and high-current charge-discharge cycle life.

[0003] The existing method for fabricating multi-tab batteries entails winding the electrode plates and then blanking the excess foil to obtain multiple tabs extending from both ends of the cell. This approach is suitable only for prismatic batteries having tabs at both ends and cannot achieve the fabrication of cylindrical multi-tab lithium-ion batteries or multi-tab lithium-ion batteries having tabs extending from a single end; moreover, blanking multiple layers of foil makes it difficult to ensure the integrity of the electrode plates.

Summary of the Invention

[0004] An object of the present invention is to overcome the deficiencies of the prior art by providing a high-rate-discharge multi-tab lithium-ion battery that has a simple structure, a high specific energy, a relatively low internal resistance, facilitates control of electrode-plate edge trimming, ensures the integrity of the electrode plates, and offers high production efficiency.

[0005] A further object of the present invention is to overcome the deficiencies of the prior art by providing a method for manufacturing a multi-tab lithium-ion battery that has a simple structure, a high specific energy, a relatively low internal resistance, facilitates control of electrode-plate edge trimming, ensures the integrity of the electrode plates, offers high production efficiency, exhibits high-rate discharge performance, and prevents the failure of individual electrode plates due to poor welding.

[0006] The objects of the present invention are achieved by the following measures. In a multi-tab lithium-ion battery electrode plate, an active material, a conductive agent, and a binder are thoroughly mixed in a predetermined proportion to form a mixed paste, which is applied onto a current collector; a blank region is reserved on the front surface along one longitudinal edge of the electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the electrode plate, and the remainder is fully coated with paste; and a plurality of spaced tabs are provided on the reserved blank regions of the electrode plate.

[0007] A multi-tab lithium-ion battery includes a positive electrode plate, a negative electrode plate, and a separator disposed therebetween. An active material is formulated into a mixed paste and applied onto a current collector; a blank region is reserved on the front surface along one longitudinal edge of the positive electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the positive electrode plate, and the remainder is fully coated with paste. An active material is formulated into a mixed paste and applied onto a current collector; a blank region is reserved on the front surface along one longitudinal edge of the negative electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the negative electrode plate, and the remainder is fully coated with paste. Spaced tabs are provided on the reserved blank region of

the positive electrode plate, and a plurality of spaced tabs are provided on the reserved blank region of the negative electrode plate.

[0008] A method for manufacturing a multi-tab lithium-ion battery includes: fabricating a positive electrode plate by formulating an active material into a mixed paste, applying the paste onto a current collector, reserving a blank region on the front surface along one longitudinal edge of the positive electrode plate, reserving a blank region on the back surface along one longitudinal edge of the positive electrode plate, and fully coating the remainder with paste; fabricating a negative electrode plate by formulating an active material into a mixed paste, applying the paste onto a current collector, reserving a blank region on the front surface along one longitudinal edge of the negative electrode plate, reserving a blank region on the back surface along one longitudinal edge of the negative electrode plate, and fully coating the remainder with paste; placing the negative electrode plate on the separator by winding, winding the positive electrode plate, the separator, and the negative electrode plate into a cell, securing the cell with a finishing tape, and subjecting the cell having welded positive and negative electrodes to subsequent operations of packaging, vacuum drying, electrolyte injection, sealing, formation, capacity grading, and inspection to obtain a battery; and providing a plurality of spaced tabs on the reserved blank region of the positive electrode plate and a plurality of spaced tabs on the reserved blank region of the negative electrode plate.

[0009] A lithium-ion battery includes a positive electrode plate, a negative electrode plate, and a separator disposed therebetween. Each of the positive and negative electrode plates includes a current collector and an electrode material. A conductive salt dissolved in an organic solution constitutes an electrolyte, which permeates into the layers of the positive electrode plate, the negative electrode plate, and the separator to activate the battery. The electrode plates are produced by thoroughly mixing an active material, a conductive agent, and a binder in a predetermined proportion to form a mixed paste, which is applied onto a current collector by methods such as roll coating, knife coating, or spray coating. The positive electrode plate is fabricated by thoroughly mixing an active material, a conductive agent, and a binder in a predetermined proportion to form a mixed paste, which is applied onto a current collector by methods such as roll coating, knife coating, or spray coating; a blank region is reserved on the front surface along one longitudinal edge of the positive electrode plate, and a blank region is reserved on the back surface along one longitudinal edge of the positive electrode plate for use as the tab welding site; a band of blank region is reserved on the back surface of the positive electrode, and the remainder is fully coated with paste. The negative electrode plate is fabricated by thoroughly mixing an active material, a conductive agent, and a binder in a predetermined proportion to form a mixed paste, which is applied onto a current collector by methods such as roll coating, knife coating, or spray coating; a blank region is reserved on the front surface along one longitudinal edge of the negative electrode plate, a blank region is reserved on the back surface along one longitudinal edge of the negative electrode plate, and the remainder is fully coated with paste. A plurality of spaced tabs are provided on the reserved blank region of the positive electrode plate, the spaced tabs being formed by rotary cutting, die cutting, or laser cutting. The width of the tabs may be determined by comprehensively considering the width of the cell and the current-carrying capacity. A plurality of spaced tabs are provided on the reserved blank region of the negative electrode plate, the spaced tabs being formed by rotary cutting, die cutting, or laser cutting. The width of the tabs may be determined by comprehensively considering the width of the cell and the current-carrying capacity. By winding, the negative electrode plate is placed on the separator and wrapped by the separator, with the blank tabs of the negative electrode plate extending from one side edge of the separator; after half a turn, the positive electrode plate is inserted between the winding needle and the separator, with the blank tabs of the positive electrode plate extending from the same side as, or the opposite side from, the blank tabs of the negative electrode plate; the positive electrode plate, the separator, and the negative electrode plate are wound into a cell, with the separator surrounding the outer periphery of the cell, and the cell is secured with a finishing tape, the separator being 2 to 3 mm wider than the negative electrode and the negative electrode being 1 to 2 mm wider than the positive electrode; on the cell, a neat stack of the blank tabs of the negative electrode plate and a neat stack of the blank tabs of the positive electrode plate are independently arranged, formed by a corresponding tab projecting from each layer of electrode plate of the cell; the tabs of the positive electrode plate are welded to the positive electrode of the battery, the positive electrode being an aluminum tab with tab tape of various thicknesses, or the cap of a steel-cased battery or the casing of an aluminum-cased battery; the tabs of the negative electrode plate are welded to the negative electrode of the battery, the negative electrode being a nickel, nickel-plated copper, or copper-nickel alloy tab with tab tape of various sizes, or the casing of a steel-cased battery or the cap of an aluminum-cased battery; and the cell having welded positive and negative electrodes is subjected to subsequent operations of packaging, vacuum drying, electrolyte injection, sealing, formation, capacity grading, and inspection to obtain a battery.

[0010] In the present invention, the plurality of spaced tabs are tabs of the same polarity which, after being formed, may overlap upon winding, such that a neat stack of tabs is independently arranged at an end; this is formed by a corresponding tab projecting from each layer of electrode plate.

[0011] In the present invention, the plurality of spaced tabs having a spiral distribution pattern follow the polar coordinate equation below:

[0012] $\rho = a\theta + P_0$

- [0013] where: a is the Archimedean spiral coefficient, in $\text{mm}/^\circ$, representing the increase (or decrease) in the polar radius per degree of rotation, that is, $a=L/360$;
- [0014] θ is the polar angle, in degrees, representing the total number of degrees through which the Archimedean spiral rotates;
- [0015] P_0 is the polar radius when $t = 0^\circ$, in mm.
- [0016] L = thickness of the positive electrode plate + thickness of the negative electrode plate + thickness of two separator layers, in mm.
- [0017] θ is used to determine the forming positions of the tabs; when the polar angle θ increases in integer multiples of π , it is ensured that the tabs of the same polarity, once formed, can overlap upon winding.
- [0018] In the present invention, the plurality of spaced tabs are formed by rotary cutting, die cutting, or laser cutting in accordance with a tab-forming template. The tab-forming template is obtained by winding the electrode plate into a cell, marking the tab positions on the wound cell, unwinding the electrode plate, measuring the dimensions of the marked points on the electrode plate, and thereby obtaining the multi-tab spacing dimensions on the electrode plate to serve as the tab-forming template.
- [0019] In the present invention, when a prismatic winding needle is used for winding, the tab positions on the wound prismatic cell are marked, the electrode plate is unwound, the dimensions of the marked points on the electrode plate are measured, and the spacing dimensions of the plurality of tabs on the electrode plate are obtained to serve as the tab-forming template for the prismatic cell.
- [0020] In the present invention, when an oval winding needle is used for winding, the tab positions on the wound oval cell are marked, the electrode plate is unwound, the dimensions of the marked points on the electrode plate are measured, and the spacing dimensions of the plurality of tabs on the electrode plate are obtained to serve as the tab-forming template for the oval cell.
- [0021] The present invention shortens the distance from the electrode plate to the electrode terminal, reduces internal resistance, and decreases heat generation during discharge, thereby improving safety; it reduces the voltage drop caused by internal resistance, thereby raising the discharge plateau; only one positive electrode plate and only one negative electrode plate are required, thereby improving the consistency of the electrode plates; the corners of the electrode plates and the burrs are reduced, so that, compared with stacked batteries, the number of defective products caused by internal short circuits and low voltage is reduced, the yield is increased, and the assembly efficiency is improved; meanwhile, the risk that breakage of an individual tab causes complete failure of an electrode plate is reduced; the invention is suitable for high-rate discharge, with uniform charge-discharge current distribution, so that lithium plating is unlikely to occur during high-current charging and discharging, giving the battery a long cycle life and high safety; the positive and negative electrode plates are each a continuous, integral piece, so that no low-capacity condition occurs and localized lithium plating leading to a safety incident is unlikely; and the invention overcomes the difficulty that small batteries are unsuitable for stacking.

Brief Description of the Drawings

- [0022] FIG. 1 is a front view of the coated positive electrode plate of the present invention.
- [0023] FIG. 2 is a back view of the coated positive electrode plate of the present invention.
- [0024] FIG. 3 is a cross-sectional view of the positive electrode plate of the present invention.
- [0025] FIG. 4 is a front view of the coated negative electrode plate of the present invention.
- [0026] FIG. 5 is a back view of the coated negative electrode plate of the present invention.
- [0027] FIG. 6 is a cross-sectional view of the negative electrode plate of the present invention.
- [0028] FIG. 7 is a front view of the positive electrode plate of the present invention after tab forming.
- [0029] FIG. 8 is a front view of the negative electrode plate of the present invention after tab forming.
- [0030] FIG. 9 is a schematic diagram showing the positions of the positive electrode, the negative electrode, and the separator during winding in the present invention.
- [0031] FIG. 10 is a schematic cross-sectional view taken along line Z-Z of FIG. 9 of the present invention.
- [0032] FIG. 11 is a schematic diagram of the wound cell of the present invention.
- [0033] FIG. 12 is a schematic diagram of the cell of the present invention after assembly and tab welding.

Detailed Description of the Embodiments

[0034] The present invention is further described below in conjunction with the drawings.

[0035] As shown in FIGS. 1, 2, and 3, in the present invention, an active material, a conductive agent, and a binder are thoroughly mixed in a predetermined proportion to form a mixed paste, which is applied onto a current collector by methods such as roll coating, knife coating, or spray coating; paste 12 is applied to the front surface of the positive electrode plate, a blank region 11 is reserved on the front surface along one longitudinal edge of the positive electrode plate, paste 22 is applied to the back surface of the positive electrode plate, and a blank region 21 is reserved on the back surface along one longitudinal edge of the positive electrode plate.

[0036] As shown in FIGS. 4, 5, and 6, in the present invention, the negative electrode plate has a blank region 41 reserved on the front surface along one longitudinal edge, with the remainder fully coated with paste 42, and a blank region 51 reserved on the back surface along the same longitudinal edge, with the remainder fully coated with paste 52. Because the negative electrode is designed to wrap the tail at the conclusion of winding, the back surface of the negative electrode plate, in addition to the blank region 51 reserved along one edge, further has a band of blank region 53 reserved on the back surface to reduce the weight of the battery, with the remainder fully coated.

[0037] As shown in FIG. 7, in the present invention, a plurality of spaced tabs 71 are provided on the reserved blank region of the positive electrode plate, the spaced tabs being formed by rotary cutting, die cutting, or laser cutting. The width of the tabs may be determined by comprehensively considering the width of the cell and the current-carrying capacity.

[0038] A plurality of spaced tabs 71 are provided on the reserved blank region of the positive electrode plate, the spaced tabs being formed by rotary cutting, die cutting, or laser cutting. The width of the tabs may be determined by comprehensively considering the width of the cell and the current-carrying capacity. The tab width having the spiral distribution pattern involved in this example is 6.5 mm, and the tab spacing varies with the number of winding turns of the electrode plate. By using a prismatic winding needle for winding in the present invention, the tab positions on the wound prismatic cell are marked, the electrode plate is unwound, the dimensions of the marked points on the electrode plate are measured, and the specific multi-tab spacing distribution on the electrode plate is obtained as: 1.5 mm, 30.5 mm, 6 mm, 31 mm, 6.5 mm, 32 mm, 7.5 mm, 33 mm, 8.5 mm, 34 mm, 9 mm, 35 mm, 9.5 mm, 36 mm, 10.5 mm.

[0039] As shown in FIG. 8, in the present invention, spaced tabs 81 are provided on the reserved blank region of the negative electrode plate, the spaced tabs being formed by rotary cutting, die cutting, or laser cutting. The width of the tabs may be determined by comprehensively considering the width of the cell and the current-carrying capacity. The tab width having the spiral distribution pattern involved in this example is 6.5 mm, and the tab spacing varies with the number of winding turns of the electrode plate. By using a prismatic winding needle for winding in the present invention, the tab positions on the wound prismatic cell are marked, the electrode plate is unwound, the dimensions of the marked points on the electrode plate are measured, and the specific multi-tab spacing distribution on the electrode plate is obtained as: 1.5 mm, 30.5 mm, 6 mm, 31 mm, 6.5 mm, 32 mm, 7.5 mm, 33 mm, 8.5 mm, 34 mm, 9 mm, 35 mm, 9.5 mm, 36 mm, 10.5 mm, 36.5 mm.

[0040] The spaced tabs follow the polar coordinate equation below:

[0041] $\rho = a\theta + P_0$

[0042] where:

[0043] a is the Archimedean spiral coefficient, in mm/°, representing the increase (or decrease) in the polar radius per degree of rotation, that is, $a=L/360$;

[0044] θ is the polar angle, in degrees, representing the total number of degrees through which the Archimedean spiral rotates;

[0045] P_0 is the polar radius when $t = 0^\circ$, mm.

[0046] L = thickness of the positive electrode plate + thickness of the negative electrode plate + thickness of two separator layers.

[0047] θ is used to determine the forming positions of the tabs; when the polar angle θ increases in integer multiples of π , it is ensured that the tabs of the same polarity, once formed, can overlap upon winding.

[0048] As shown in FIGS. 9 and 10, during winding in the present invention, the negative electrode plate 102 is placed on the separator 103 and entirely wrapped by the separator, with the negative electrode plate 102 inside the separator 103, the negative electrode tab 81 extending from one side edge of the separator, and the coated portion of the negative electrode plate positioned at the center of the separator. After half a turn, the positive electrode plate 101 is placed on the separator, with the positive electrode tab 71 extending from the same side of the separator as the negative electrode plate; the positive

electrode plate, the separator, and the negative electrode plate are then wound into a cell, with the separator wrapping the outermost turn, and the cell is secured with a finishing tape.

[0049] As shown in FIG. 11, in the present invention, a neat stack of negative electrode tabs 111 and a neat stack of positive electrode tabs 112 are formed at the top of the cell. First, a tab-forming template is produced by winding the electrode plate into a cell, marking the tab positions on the wound cell, unwinding the electrode plate, measuring the dimensions of the marked points on the electrode plate, and thereby obtaining the multi-tab spacing dimensions on the electrode plate to obtain the tab-forming template; the spaced tabs of the negative electrode plate are formed by rotary cutting, die cutting, or laser cutting in accordance with the tab-forming template. The spaced tabs of the positive electrode plate are formed by rotary cutting, die cutting, or laser cutting in accordance with the tab-forming template. By winding, the negative electrode plate is placed on the separator and wrapped by the separator, with the blank tabs of the negative electrode plate extending from one side edge of the separator; after half a turn, the positive electrode plate is inserted between the winding needle and the separator, with the blank tabs of the positive electrode plate extending from the same side as the blank tabs of the negative electrode plate; the positive electrode plate, the separator, and the negative electrode plate are wound into a cell, with the separator surrounding the outer periphery of the cell, and the cell is secured with a finishing tape, the separator being 2 to 3 mm wider than the negative electrode and the negative electrode being 1 to 2 mm wider than the positive electrode; on the cell, a neat stack of the blank tabs of the negative electrode plate and a neat stack of the blank tabs of the positive electrode plate are independently arranged, formed by a corresponding tab projecting from each layer of electrode plate of the cell.

[0050] As shown in FIG. 12, in the present invention, the neat stack of positive electrode tabs is welded and secured to an aluminum tab 121 with tab tape by ultrasonic welding, and likewise the neat stack of negative electrode tabs is welded and secured to a nickel tab 122 with tab tape by ultrasonic welding, thereby completing the assembly of the wound multi-tab cell having a spiral distribution pattern.

[0051] The cell having welded positive and negative electrodes is subjected to subsequent operations of packaging, vacuum drying, electrolyte injection, sealing, formation, capacity grading, and inspection to obtain a battery.

[0052] The methods of implementation are not limited to the above examples; any winding and assembly used to manufacture a lithium-ion battery in accordance with the essence of the present invention falls within the scope of protection of the present invention. For example, although the present invention preferably winds one positive electrode, one separator, and one negative electrode into a single cell, it is also possible to deliberately wind two or more positive electrodes, two or more separators, and two or more negative electrodes into two or more cells, which are then stacked and connected in parallel by welding to increase capacity; or to deliberately wind one or more additional turns of separator around the outside of the wound cell. As a further example, although the present invention preferably has the tabs extending from the same end of the cell, the tabs may instead extend from the two opposite ends of the cell. As yet a further example, although the present invention preferably employs a prismatic battery, it may also be fabricated as an oval or cylindrical battery.

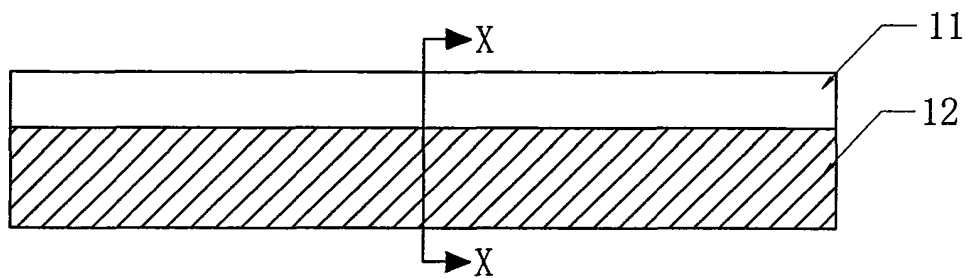


FIG. 1

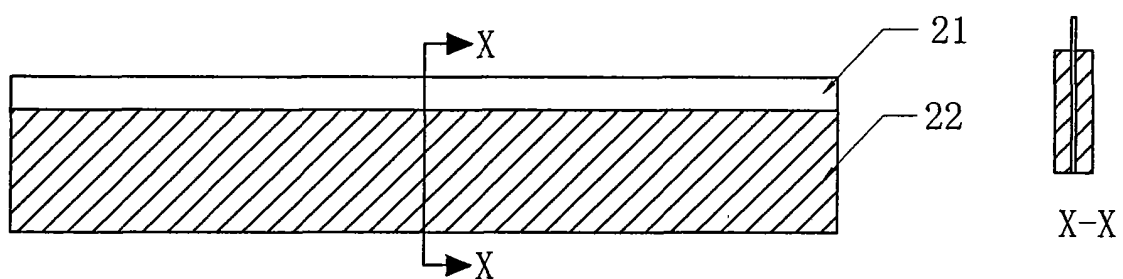


FIG. 3

FIG. 2

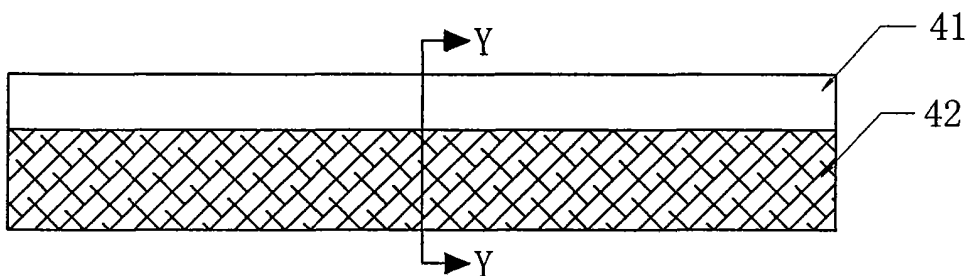


FIG. 4

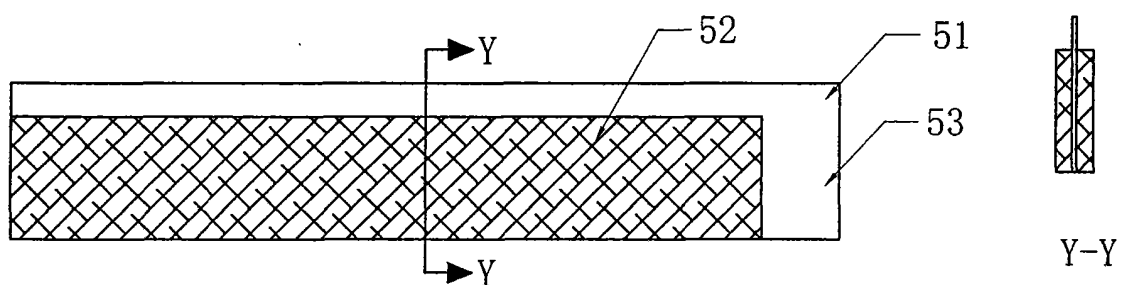


FIG. 6

FIG. 5

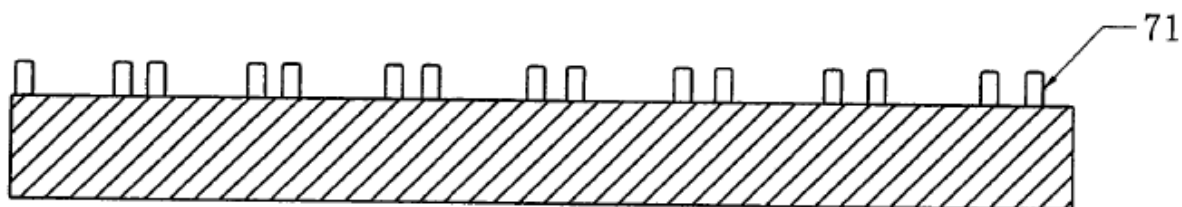


FIG. 7

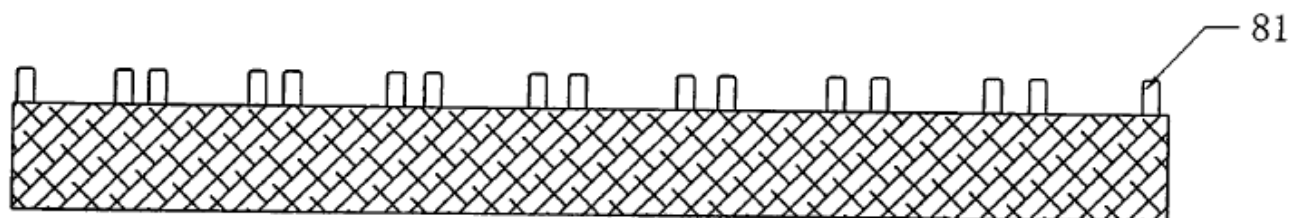


FIG. 8

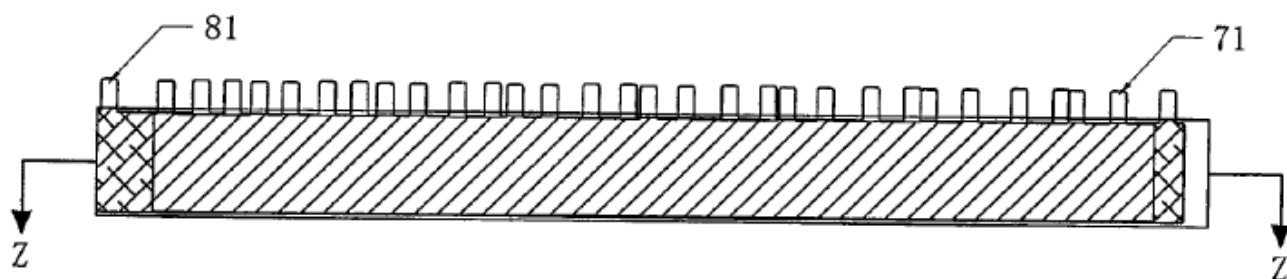


FIG. 9

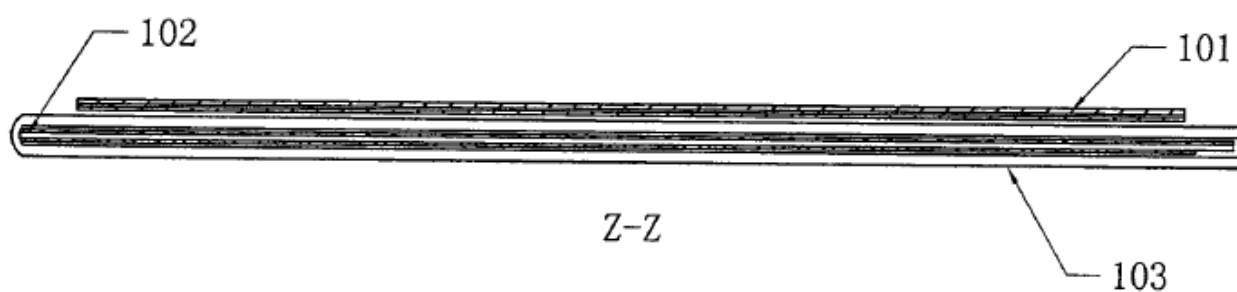


FIG. 10

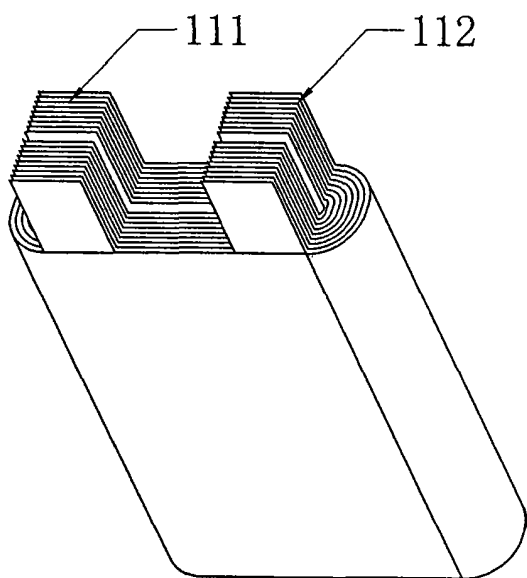


FIG. 11

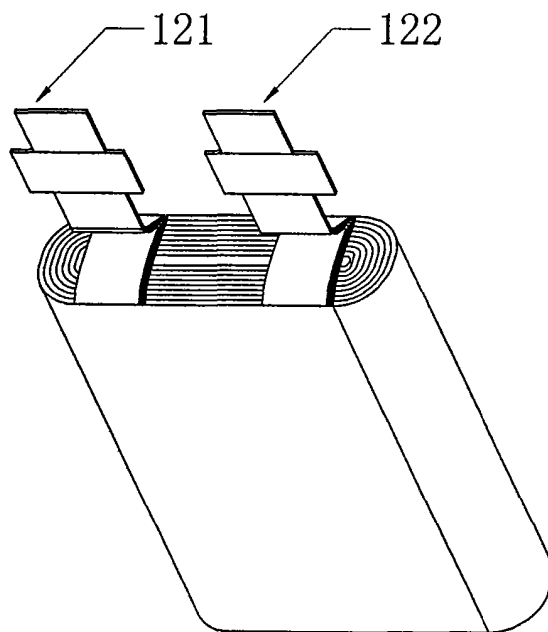


FIG. 12



DECLARATION OF TRANSLATOR

I, Chen Qing, hereby declare as follows:

1. I personally performed the attached translation from Chinese into English of [Foreign Patent / Application Publication No. CN 101714624 A], published/issued 2010.05.26, and entitled "[一种螺旋线多极耳锂离子电池及其制造方法]" ("Spiral Multi-Tab Lithium-Ion Battery and Method for Manufacturing the Same").
2. The attached translation is, to the best of my knowledge and belief, a true, full, and accurate English translation of the above-identified Chinese -language document.
3. I am competent to perform this translation because I hold a Test for English Majors-Band 8 (TEM-8) certificate, and have over 20 years of professional translation experience..
4. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct, and I further declare that I am aware that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of any patent or proceeding resulting therefrom.

Dated: June 11, 2026

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