

(19) China National Intellectual Property Administration



(12) Invention Patent Application

(10) Application Publication No.: CN 104157914 A

(43) Application Publication Date: Nov 19, 2014

(21) Application No.: 201410443798.7

(22) Application Date: Sep 2, 2014

(71) Applicant: Shandong Qixing New Energy
Technology Limited Liability Company

Address: 697 Huixian No. 2 Road, Chengdong
Economic Development Zone, Zouping County,
Binzhou City, Shandong, 256200

(72) Inventors: WANG Yanfei HUANG Lei
LIU Yaming ZHANG Yan GUO Dali

(74) Patent Agency: Jinan Jindi Intellectual Property
Agency Co., Ltd. 37219

Agent: YANG Lei

(51) Int.Cl.

H01M10/0587(2010.01)

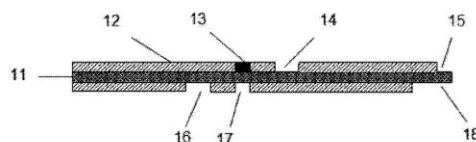
Claims: 3 pages Description: 13 pages Drawings: 2 pages

(54) Name of Invention

HIGH-POWER SOFT PACK LITHIUM-ION BATTERY AND MANUFACTURING TECHNIQUE THEREOF

(57) Abstract

The present invention relates to a high-power soft pack lithium-ion battery and a manufacturing technique thereof. The single cell comprises a negative electrode, a positive electrode, a first separator, and a second separator and is made by winding the first separator, the negative electrode, the second separator, and the positive electrode stacked in that sequence with the positive electrode being the innermost layer. In the present invention, a positive electrode first island area and a positive electrode second island area that are not coated with any active materials are disposed at certain distances on two sides from the positive electrode tab of the lithium-ion battery; when wound, the positive electrode second island area and the positive electrode first island area correspond to and cover the negative electrode tab and its back side, thereby preventing lithium plating caused by a positive electrode active material facing the negative electrode tab. In the manufacturing method, hot or cold pressing of the battery before formation squeezes excess electrolyte solution in the battery into a gas bag to increase the battery's hardness, tighten the contact between various separators, the positive electrode, and the negative electrode, and reduce the interfacial impedance of the battery, thereby reducing the internal resistance of the battery and improving the power density of the lithium-ion battery.



1. A wound single cell, wherein the single cell comprises a negative electrode, a positive electrode, a first separator, and a second separator and is made by winding the first separator, the negative electrode, the second separator, and the positive electrode stacked in that sequence with the positive electrode being the innermost layer;

wherein when the single cell is unwound, the positive electrode comprises a positive electrode strip, a positive electrode active material being disposed on two sides of the positive electrode strip, a positive electrode tab, a positive electrode first island area, and a positive electrode first uncoated area being disposed on one side of the positive electrode strip, a positive electrode second island area, a positive electrode second uncoated area, and a positive electrode third uncoated area being disposed on the other side of the positive electrode strip; the positive electrode tab and the positive electrode second uncoated area are located in a middle area of the positive electrode strip and are disposed opposite each other, and the positive electrode first island area and the positive electrode second island area are respectively located on two lateral sides of the positive electrode tab; the positive electrode first uncoated area and the positive electrode third uncoated area are located on two sides of the positive electrode strip and are disposed at an end of the positive electrode strip; and

wherein the negative electrode comprises a negative electrode strip, a negative electrode active material being disposed on two sides of the negative electrode strip, and a negative electrode tab and a negative electrode uncoated area being disposed opposite each other on two sides and in a middle area of the negative electrode strip.

2. The wound single cell of claim 1, wherein the distance between the positive electrode first island area and the positive electrode tab is 0-270 mm, and the distance between the positive electrode second island area and the positive electrode second uncoated area is 0-270 mm.

3. The wound single cell of claim 1, wherein the widths of the positive electrode tab and the negative electrode tab are both 5-70 mm, and their thicknesses are both 0.1-0.2 mm;

wherein the widths of the positive electrode first island area and the positive electrode second island area are both 13-80 mm;

wherein the width of the positive electrode first uncoated area is 0-220 mm, and the width of the positive electrode third uncoated area is 15-620 mm; and wherein the widths of the positive electrode second uncoated area and the negative electrode uncoated area are both 6-75 mm.

4. The wound single cell of claim 1, wherein the material of the positive electrode strip is aluminum foil, and the material of the negative electrode strip is copper foil; and

wherein the material of the positive electrode tab is aluminum, and the material of the negative electrode tab is nickel, copper, or nickel-plated copper.

5. The wound single cell of claim 1, wherein polyethylene terephthalate insulation tapes are disposed at the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, the thickness of the insulation tapes is 0.02-0.04 mm, the widths of the insulation tapes are greater by 0.5-1 mm than the widths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, and the lengths of the insulation tapes are greater by 2-8 mm than the lengths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area; a polyethylene terephthalate insulation tape is disposed at the positive electrode second uncoated area, the thickness of the insulation tape is 0.02-0.04 mm, the length of the insulation tape is greater by 2-8 mm than the positive electrode second uncoated area, and the width of the insulation tape is greater by 2.5-6.5 mm than the width of the positive electrode second uncoated area; and

wherein a polyimide acrylic insulation tape is disposed at the negative electrode uncoated area, the thickness of the insulation tape is 0.055-0.065 mm, the length of the insulation tape is greater by 2-8 mm

than the length of the negative electrode uncoated area, and the width of the insulation tape is greater by 1.5-5.5 mm than the width of the negative electrode uncoated area.

6. The wound single cell of claim 1, wherein the positive electrode tab and the negative electrode tab have externally exposed portions of 10-20 mm, tab tapes are disposed respectively at the externally exposed portions, and the distance between the tab tapes and an edge of the positive electrode strip or an edge of the negative electrode strip is 1.5-2.5 mm; and the tab tapes are yellow tapes, white tapes, or black tapes.

7. A high-power soft pack lithium-ion battery, the inside of the battery comprising at least one of the wound single cell of any of claims 1-6.

8. A high-power soft pack lithium-ion battery manufacturing method, comprising the following steps:

(1) mixing evenly lithium manganese oxide, conductive agent carbon black, and binder polyvinylidene fluoride in a mass ratio of (90-100) : (2-4) : (1-3) into a slurry to obtain a positive electrode active material; and

mixing evenly artificial graphite, conductive agent carbon black, binder sodium carboxymethyl cellulose, and thickener styrene-butadiene rubber in a mass ratio of (94-97) : (0.5-2) : (1-2) : (1-3) into a slurry to obtain a negative electrode active material;

(2) coating the positive electrode active material and the negative electrode active material onto the surfaces of a positive electrode strip and a negative electrode strip, respectively, wherein an area of a positive electrode tab, a positive electrode first island area, a positive electrode first uncoated area, a positive electrode second island area, a positive electrode second uncoated area, and a positive electrode third uncoated area are not coated with the positive electrode active material; wherein an area of a negative electrode tab and a negative electrode uncoated area are not coated with the negative electrode active material; and

wherein the coating density of the positive electrode active material is 160-210g/m²,

and the coating density of the negative electrode active material is 60-100g/m²; and

then welding tabs with tab tapes, or welding tabs without tab tapes for making a combined lithium-ion cell, at the area of the positive electrode tab and the area of the negative electrode tab, after drying, calendaring, and slitting, to obtain a positive electrode and a negative electrode;

(3) winding the negative electrode and the positive electrode made in Step (2) and a first separator and a second separator, stacked in the sequence of the first separator, the negative electrode, the second separator, and the positive electrode with the positive electrode being the innermost layer, the positive electrode strip and the negative electrode strip being wound with the surfaces on which tabs are welded facing up, into a wound cell;

wherein the first separator and the second separator are polypropylene separators, polyethylene separators, ceramic coated polypropylene separators, ceramic coated polyethylene separators, polyvinylidene fluoride coated polypropylene separators, polyvinylidene fluoride coated polyethylene separator, or polypropylene-polyethylene-polypropylene three-layer separators, and a wound single cell is obtained upon completion of the winding;

or, welding and connecting in parallel at least two of the aforementioned wound single cells and securing them with insulation tapes to obtain a combined lithium-ion cell; and

(4) completing the process by packaging the wound single cell or the combined lithium-ion cell from Step (3), vacuum baking, liquid injection, hot or cold pressing, and formation;

wherein parameters of the hot pressing and cold pressing are as follows:

hot pressing: surface pressure 1-6kgf/cm², quantity of cells pressed each time 2-16 pieces, hot pressing temperature 60-80 °C, hot pressing time 20-180S;

cold pressing: surface pressure 1-6kgf/cm², quantity of cells pressed each time 2-16 pieces, cold

pressing temperature 25-30 °C, cold pressing time 20-180S.

9. The high-power soft pack lithium-ion battery manufacturing method of claim 8, wherein after coating the surfaces of the positive electrode strip and the surfaces of the negative electrode strip with active materials in Step (2), polyethylene terephthalate insulation tapes are applied at the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, the thickness of the insulation tapes is 0.02-0.04 mm, the widths of the insulation tapes are greater by 0.5-1 mm than the widths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, and the lengths of the insulation tapes are greater by 2-8 mm than the lengths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area; wherein a polyethylene terephthalate insulation tape is applied at the positive electrode second uncoated area, the thickness of the insulation tape is 0.02-0.04 mm, the length of the insulation tape is greater by 2-8 mm than the positive electrode second uncoated area, and the width of the insulation tape is greater by 2.5-6.5 mm than the width of the positive electrode second uncoated area; and

wherein a polyimide acrylic insulation tape is applied at the negative electrode uncoated area, the thickness of the insulation tape is 0.055-0.065 mm, the length of the insulation tape is greater by 2-8 mm than the length of the negative electrode uncoated area, and the width of the insulation tape is greater by 1.5-5.5 mm than the width of the negative electrode uncoated area.

10. The high-power soft pack lithium-ion battery manufacturing method of claim 8, wherein the solvent of the electrolyte solution in Step (4) is a mixture of ethylene carbonate, diethyl carbonate, and methyl ethyl carbonate, the electrolyte is lithium hexafluorophosphate, 1,2-vinylene carbonate is added as an additive, and the liquid injection amount is 4.0g/Ah±0.1g.

TECHNICAL FIELD

[0001] The present invention belongs to the field of lithium-ion batteries; it relates to a lithium-ion battery and a manufacturing technique thereof and more particularly to a high-power soft pack lithium-ion battery and a manufacturing technique thereof.

BACKGROUND

[0002] To meet market demand for large-capacity soft pack lithium-ion power batteries, the length of electrodes needs to be extended while strictly controlling the surface density of electrodes. However, for wound lithium-ion power batteries, excessive length of the electrodes will lead to unnecessary trouble for the manufacturing process and result in a higher defective rate; additionally, batteries using long electrodes have a higher internal resistance, which is detrimental to high-current charging and discharging of the batteries and severely hinders improvement in their power density.

[0003] In Chinese patent literature, CN203119046U describes a tab structure in which a positive electrode tab is placed in a middle area of a positive electrode to reduce the internal resistance of lithium-ion batteries and resolve the problems of poor cycling performance and consistency in lithium-ion batteries. However, this method does not employ a structure in which a tab is placed in a middle area of a negative electrode and does not reduce the internal resistance of batteries to a large extent. Chinese patent CN202905842U describes a tab structure in which a positive electrode tab and a negative electrode tab are both welded in middle areas of electrodes to further reduce the internal resistance of batteries and improve the charge and discharge efficiency and service life of batteries. In these two patents, no uncoated foil area that is not coated with any active material, which is referred to as an “island area” in the art, is disposed at a certain distance from the right end of the positive electrode tab or at a certain distance from the left end on the back surface of the weld area of the positive electrode tab to prevent the negative electrode tab, when wound, to face a positive electrode material area when wound; such an electrode structure will result in lithium plating once the battery is charged and thereby causing a series of thermal runaway and lowering the battery’s safety performance. Therefore, it is necessary to configure an island area at such an area to improve the battery’s safety performance.

[0004] The positive and negative electrodes and separator of a soft pack lithium-ion battery all have porous membrane structures and liquid absorption capacity. Once the battery is injected with liquid and let standing for a period of time, layers separate as a result of swelling due to liquid absorption. This means that the contact between the separator and electrodes are not tight enough, which increases the interfacial impedance and results in uneven interfacial reaction during formation. This is detrimental to the forming of a dense solid electrolyte interphase film (SEI film) at a surface of the negative electrode. Additionally, gassing in the formation process exacerbates this detrimental reaction. When the formation voltage exceeds 3.95 V, lithium plating occurs on the negative electrode surface where the SEI film is loose, thus creating a safety hazard to the power battery and increasing its internal resistance. Furthermore, cell deformation of soft pack lithium-ion batteries at 3.9-4.1 V is more prominent compared with aluminum/steel-case lithium-ion batteries because the case of the soft pack lithium-ion battery is a relatively soft aluminum laminated film; after formation, hot fixture shaping of the cell within this voltage range needs to be performed to relieve the batteries’ internal stress and eliminate cell deformation. However, lowering the formation voltage to 3.95 V for the prevention of lithium plating during formation

is not beneficial to the hot fixture shaping outcome of the battery. Therefore, it is necessary to tighten looser contact between layers inside the battery by a certain means before the formation of the soft pack lithium-ion battery to reduce the internal resistance of large capacity soft pack lithium-ion power batteries, increase their power density, and address cell deformation.

SUMMARY

[0005] In response to defects and insufficiencies in the aforementioned currently available technology, the present invention provides a high power density soft pack lithium-ion battery and a manufacturing technique thereof.

[0006] Explanation of terminology:

[0007] Island area: in the present invention, island area is a widely known term in the art and refers to an uncoated foil area that is not coated with any positive electrode active material on a positive electrode strip facing the front and back surfaces of a weld area of a negative electrode tab once a cell is wound.

[0008] Coating line: in the present invention, coating line is a widely known term in the art and refers to an edge area of an island area or uncoated area, i.e., a boundary area between an active material and an electrode strip.

[0009] The technical solution of the present invention is as follows:

[0010] A wound single cell, the single cell comprising a negative electrode, a positive electrode, a first separator, and a second separator and the single cell made by winding the first separator, the negative electrode, the second separator, and the positive electrode stacked in that sequence with the positive electrode being the innermost layer;

[0011] wherein when the single cell is unwound, the positive electrode comprises a positive electrode strip, a positive electrode active material being disposed on two sides of the positive electrode strip, a positive electrode tab, a positive electrode first island area, and a positive electrode first uncoated area being disposed on one side of the positive electrode strip, a positive electrode second island area, a positive electrode second uncoated area, and a positive electrode third uncoated area being disposed on the other side of the positive electrode strip; the positive electrode tab and the positive electrode second uncoated area are located in a middle area of the positive electrode strip and are disposed opposite each other, and the positive electrode first island area and the positive electrode second island area are respectively located on two lateral sides of the positive electrode tab; the positive electrode first uncoated area and the positive electrode third uncoated area are located on two sides of the positive electrode strip and are disposed at an end of the positive electrode strip; and

[0012] wherein the negative electrode comprises a negative electrode strip, a negative electrode active material being disposed on two sides of the negative electrode strip, and a negative electrode tab and a negative electrode uncoated area being disposed opposite each other on two sides and in a middle area of the negative electrode strip.

[0013] According to the present invention, preferably, the distance between the positive electrode first

island area and the positive electrode tab is 0-270 mm, and the distance between the positive electrode second island area and the positive electrode second uncoated area is 0-270 mm.

[0014] According to the present invention, preferably, the widths of the positive electrode tab and the negative electrode tab are both 5-70 mm, and their thicknesses are both 0.1-0.2 mm.

[0015] According to the present invention, preferably, the widths of the positive electrode first island area and the positive electrode second island area are both 13-80 mm.

[0016] According to the present invention, preferably, the width of the positive electrode first uncoated area is 0-220 mm, and the width of the positive electrode third uncoated area is 15-620 mm.

[0017] According to the present invention, preferably, the widths of the positive electrode second uncoated area and the negative electrode uncoated area are both 6-75 mm.

[0018] According to the present invention, preferably, the material of the positive electrode strip is aluminum foil, and the material of the negative electrode strip is copper foil.

[0019] According to the present invention, preferably, the material of the positive electrode tab is aluminum, the material of the negative electrode tab is nickel, copper, or nickel-plated copper.

[0020] According to the present invention, preferably, polyethylene terephthalate insulation tapes are disposed at the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, the thickness of the insulation tapes is 0.02-0.04 mm, the widths of the insulation tapes are greater by 0.5-1 mm than the widths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, and the lengths of the insulation tapes are greater by 2-8 mm than the lengths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area; and a polyethylene terephthalate insulation tape is disposed at the positive electrode second uncoated area, the thickness of the insulation tape is 0.02-0.04 mm, the length of the insulation tape is greater by 2-8 mm than the positive electrode second uncoated area, and the width of the insulation tape is greater by 2.5-6.5 mm than the width of the positive electrode second uncoated area.

[0021] According to the present invention, preferably, polyethylene terephthalate insulation tapes are only disposed at a coating line area of the positive electrode first island area, a coating line area of the positive electrode first uncoated area, a coating line area of the positive electrode second island area, and a coating line area of the positive electrode third uncoated area, and the insulation tapes cover 2-8 mm on two sides of the coating lines.

[0022] According to the present invention, preferably, a polyimide acrylic insulation tape is disposed at the negative electrode uncoated area, the thickness of the insulation tape is 0.055-0.065 mm, the width of the insulation tape is greater by 2-8 mm than the width of the negative electrode uncoated area, and the length of the insulation tape is greater by 1.5-5.5 mm than the length of the negative electrode uncoated area.

[0023] According to the present invention, preferably, the positive electrode tab and the negative electrode tab have externally exposed portions of 10-20 mm, tab tapes are disposed respectively at the

externally exposed portions, and the distance between the tab tapes and an edge of the positive electrode strip or an edge of the negative electrode strip is 1.5-2.5 mm; and the tab tapes are yellow tapes, white tapes, or black tapes.

[0024] According to the present invention, the positive electrode active material and the negative electrode active material use common ingredients in the art; preferably, the positive electrode active material is an evenly mixed slurry of lithium manganese oxide, a conductive agent, and a binder, and the negative electrode active material is an evenly mixed slurry of artificial graphite, a conductive agent, and a binder.

[0025] According to the present invention, a high-power soft pack lithium-ion battery, and the inside of the battery comprises at least one of the aforementioned wound single cell; preferably, the quantity of the wound single cell is 2, and they are connected in parallel to form a double-wound-cell battery. The wound single cell can be pressed to obtain a square lithium-ion battery.

[0026] According to the present invention, a high-power soft pack lithium-ion battery manufacturing method, comprising the following steps:

[0027] (1) mixing evenly lithium manganese oxide, conductive agent carbon black (SP), and binder polyvinylidene fluoride (PVDF) in a mass ratio of (90-100) : (2-4) : (1-3) into a slurry to obtain a positive electrode active material;

[0028] mixing evenly artificial graphite, conductive agent carbon black (SP), binder sodium carboxymethyl cellulose (CMC), and thickener styrene-butadiene rubber (SBR) in a mass ratio of (94-97) : (0.5-2) : (1-2) : (1-3) into a slurry to obtain a negative electrode active material;

[0029] (2) coating the positive electrode active material and the negative electrode active material onto the surfaces of a positive electrode strip and a negative electrode strip, respectively, wherein an area of a positive electrode tab, a positive electrode first island area, a positive electrode first uncoated area, a positive electrode second island area, a positive electrode second uncoated area, and a positive electrode third uncoated area are not coated with the positive electrode active material; wherein an area of a negative electrode tab and a negative electrode uncoated area are not coated with the negative electrode active material; and

[0030] wherein the coating density of the positive electrode active material is 160-210g/m²,

[0031] and the coating density of the negative electrode active material is 60-100g/m²; and

[0032] then welding tabs with tab tapes, or welding tabs without tab tapes for making a combined lithium-ion cell, at the area of the positive electrode tab and the area of the negative electrode tab, after drying, calendaring, and slitting, to obtain a positive electrode and a negative electrode;

[0033] (3) winding the negative electrode and the positive electrode made in Step (2) and a first separator and a second separator, stacked in the sequence of the first separator, the negative electrode, the second separator, and the positive electrode with the positive electrode being the innermost layer, the positive electrode strip and the negative electrode strip being wound with the surfaces on which tabs are welded facing up, into a wound cell;

[0034] wherein the first separator and the second separator are polypropylene separators, polyethylene separators, ceramic coated polypropylene separators, polyvinylidene fluoride (PVDF) coated polypropylene separators, or polypropylene-polyethylene-polypropylene three-layer separators, and a wound single cell is obtained upon completion of the winding;

[0035] or, welding and connecting in parallel at least two of the aforementioned wound single cells and securing them with insulation tapes to obtain a combined lithium-ion cell; and

[0036] (4) completing the process by packaging the wound single cell or the combined lithium-ion cell from Step (3), vacuum baking, liquid injection, hot or cold pressing, and formation;

[0037] wherein parameters of the hot pressing and cold pressing are as follows:

[0038] hot pressing; surface pressure $1\text{-}6\text{kgf/cm}^2$, quantity of cells pressed each time 2-16 pieces, hot pressing temperature $60\text{-}80\text{ }^{\circ}\text{C}$, hot pressing time 20-180S;

[0039] cold pressing; surface pressure $1\text{-}6\text{kgf/cm}^2$, quantity of cells pressed each time 2-16 pieces, cold pressing temperature $25\text{-}30\text{ }^{\circ}\text{C}$, cold pressing time 20-180S.

[0040] According to the present invention, preferably, in Step (2), the coating density of the positive electrode active material is $180\text{-}185\text{g/m}^2$, and the coating density of the negative electrode active material is $65\text{-}70\text{g/m}^2$.

[0041] According to the present invention, preferably, after coating the surfaces of the positive electrode strip and the surfaces of the negative electrode strip with active materials in Step (2), polyethylene terephthalate insulation tapes are applied at the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, the thickness of the insulation tapes is $0.02\text{-}0.04\text{ mm}$, the widths of the insulation tapes are greater by $0.5\text{-}1\text{ mm}$ than the widths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area, and the lengths of the insulation tapes are greater by $2\text{-}8\text{ mm}$ than the lengths of the positive electrode first island area, the positive electrode first uncoated area, the positive electrode second island area, and the positive electrode third uncoated area; a polyethylene terephthalate insulation tape is applied at the positive electrode second uncoated area, the thickness of the insulation tape is $0.02\text{-}0.04\text{ mm}$, the length of the insulation tape is greater by $2\text{-}8\text{ mm}$ than the positive electrode second uncoated area, and the width of the insulation tape is greater by $2.5\text{-}6.5\text{ mm}$ than the width of the positive electrode second uncoated area; and

[0042] a polyimide acrylic insulation tape is applied at the negative electrode uncoated area, the thickness of the insulation tape is $0.055\text{-}0.065\text{ mm}$, the length of the insulation tape is greater by $2\text{-}8\text{ mm}$ than the length of the negative electrode uncoated area, and the width of the insulation tape is greater by $1.5\text{-}5.5\text{ mm}$ than the width of the negative electrode uncoated area.

[0043] According to the present invention, preferably, in Step (3), the at least two of the wound single cells are connected in parallel by ultrasound welding. In the winding, the positive electrode is the innermost layer, and the winding ends with the positive electrode; once the winding is completed, the third uncoated area of the positive electrode strip is exposed as the outermost layer of the wound cell.

[0044] According to the present invention, the electrolyte solution is a common electrolyte solution used

in the art; preferably, the solvent of the electrolyte solution in Step (4) is a mixture of ethylene carbonate (EC), diethyl carbonate (DEC), and methyl ethyl carbonate (EMC), the electrolyte is lithium hexafluorophosphate (LiPF_6), 1,2-vinylene carbonate (VC) is added as an additive, and the liquid injection amount is $4.0\text{g}/\text{Ah} \pm 0.1\text{g}$.

[0045] More preferably, steps after formation comprise repackaging and capacity grading.

[0046] The high-power soft pack lithium-ion battery of the present invention comprises, inside the battery, at least one wound single cell, each wound single cell having a positive electrode tab and a negative electrode tab disposed at a middle area of a positive electrode strip and a middle area of a negative electrode strip, respectively; here, the positive electrode strip has a positive electrode first island area and a positive electrode second island area; the invention is capable of effectively lowering the internal resistance of the battery and improving its safety performance while maintaining the battery's capacity.

[0047] The present invention provides the following benefits:

[0048] 1. The lithium-ion battery of the present invention comprises, inside the battery, at least one wound single cell, each wound single cell having a positive electrode tab and a negative electrode tab disposed, respectively; here, tabs of the same electrode type of the single cells are welded together by ultrasound welding to form a combined cell; the battery has low internal resistance and high power density.

[0049] 2. In the present invention, a positive electrode first island area and a positive electrode second island area that are not coated with any active materials are disposed at certain distances on two sides from the positive electrode tab of the lithium-ion battery; when wound, the positive electrode second island area and the positive electrode first island area correspond to and cover the negative electrode tab and its back side, respectively, thereby preventing lithium plating caused by a positive electrode active material facing the negative electrode tab.

[0050] 3. In the high-power soft pack lithium-ion battery manufacturing method of the present invention, hot or cold pressing of the battery before formation squeezes excess electrolyte solution in the battery into a gas bag to increase the battery's hardness, tighten the contact between various separators, the positive electrode, and the negative electrode, and reduce the interfacial impedance of the battery, thereby reducing the internal resistance of the battery and improving the power density of the lithium-ion battery.

[0051] 4. In the present invention, the positive electrode tab and the negative electrode tab are disposed in a middle area of a positive electrode strip and a middle area of a negative electrode strip, respectively, and two island areas are disposed at two different areas of the positive electrode strip; therefore, while ensuring the capacity of the soft pack lithium-ion battery remains the same, the invention is capable of not only effectively lowering the internal resistance of the battery and reducing the amount of heat generated when the battery discharges, but also improving the rate performance of the battery and increasing its safety performance by preventing lithium plating in the battery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0052] FIG. 1 is a cutaway view of a positive electrode, in its unwound state, of a wound single cell

according to Embodiment 1 of the present invention.

[0053] FIG. 2 is a cutaway view of a negative electrode, in its unwound state, of a wound single cell according to Embodiment 1 of the present invention.

[0054] FIG. 3 is a perspective view of the structure of a combined lithium-ion cell according to Embodiment 2 of the present invention.

[0055] FIG. 4 shows 3C discharge curves of batteries of Embodiment 5 of the present invention, Comparison Case 1, and Comparison Case 2.

[0056] In the figures: 11 – positive electrode strip, 12 – positive electrode active material, 13 – positive electrode tab, 14 – positive electrode first island area, 15 – positive electrode first uncoated area, 16 – positive electrode second island area, 17 – positive electrode second uncoated area, 18 – positive electrode third uncoated area;

[0057] 21 – negative electrode strip, 22 – negative electrode active material, 23 – negative electrode tab, 24 – negative electrode uncoated area;

[0058] 31 – single cell, 32 – insulation tape, 33 – combined lithium-ion cell positive electrode tab, 34 – combined lithium-ion cell negative electrode tab, 35 – tab tape, 36 – weld area.

DETAILED DESCRIPTION

[0059] Specific examples are provided below to describe in detail the technical solution of the present invention for the purpose of facilitating understanding of the present invention; however, the present invention is not limited thereby.

[0060] In the embodiments, the positive electrode active material 12 is a slurry of lithium manganese oxide, conductive agent SP, and binder PVDF mixed evenly in a ratio of 95 : 3 : 2; the negative electrode active material 22 is a slurry of artificial graphite, conductive agent SP, binder CMC, and thickener SBR mixed evenly in a ratio of 95.4 : 1 : 1.6 : 2; and the capacity of the wound single cell is 5 Ah.

[0061] The solvent of the electrolyte solution is a mixture of ethylene carbonate (EC), diethyl carbonate (DEC), and methyl ethyl carbonate (EMC); the electrolyte is lithium hexafluorophosphate (LiPF_6); and 1,2-vinylene carbonate (VC) is added as an additive.

[0062] Embodiment 1: wound single cell

[0063] A wound single cell, the single cell comprising a negative electrode, a positive electrode, a first separator, and a second separator and the single cell made by winding the first separator, the negative electrode, the second separator, and the positive electrode stacked in that sequence with the positive electrode being the innermost layer;

[0064] when the single cell is unwound, the positive electrode comprises a positive electrode strip 11, a positive electrode active material 12 being evenly disposed on two sides of the positive electrode strip 11, a positive electrode tab 13, a positive electrode first island area 14, and a positive electrode first uncoated

area 15 being disposed on one side of the positive electrode strip 11; a positive electrode second island area 16, a positive electrode second uncoated area 17, and a positive electrode third uncoated area 18 being disposed on the other side of the positive electrode strip 11; the positive electrode tab 13 and the positive electrode second uncoated area 17 are located in a middle area of the positive electrode strip 11 and are disposed opposite each other, and the positive electrode first island area 14 and the positive electrode second island area 16 are respectively located on two lateral sides of the positive electrode tab 13; the positive electrode first uncoated area 15 and the positive electrode third uncoated area 18 are located on two sides of the positive electrode strip 11 and are disposed at an end of the positive electrode strip 11; and

[0065] the negative electrode comprises a negative electrode strip 21, a negative electrode active material 22 being evenly disposed on two sides of the negative electrode strip 21, and a negative electrode tab 23 and a negative electrode uncoated area 24 being disposed opposite each other on two sides and in a middle area of the negative electrode strip 21.

[0066] In this embodiment, the distance between the positive electrode first island area 14 and the positive electrode tab 13 is 32 mm, the distance between the positive electrode second island area 16 and the positive electrode second uncoated area 17 is 32 mm;

[0067] the widths of the positive electrode tab 13 and the negative electrode tab 23 are both 15 mm, and their thicknesses are both 0.2 mm;

[0068] the widths of the positive electrode first island area 14 and the positive electrode second island area 16 are both 35 mm;

[0069] the width of the positive electrode first uncoated area 15 is 58 mm, the width of the positive electrode third uncoated area 18 is 180 mm;

[0070] the widths of the positive electrode second uncoated area 17 and the negative electrode uncoated area 24 are both 24 mm;

[0071] the material of the positive electrode strip 11 is aluminum foil, and the material of the negative electrode strip 21 is copper foil;

[0072] the material of the positive electrode tab 13 is aluminum, and the material of the negative electrode tab 23 is nickel-plated copper;

[0073] polyethylene terephthalate (PET) insulation tapes are disposed at a coating line area of the positive electrode first island area 14, a coating line area of the positive electrode first uncoated area 15, a coating line area of the positive electrode second island area 16, and a coating line area of the positive electrode third uncoated area 18; the thickness of the insulation tapes is 0.02 mm, the insulation tapes cover 5 mm on two sides of the coating lines, and the widths of the insulation tapes are greater by 1 mm than the widths of the positive electrode first island area 14, the positive electrode first uncoated area 15, the positive electrode second island area 16, and the positive electrode third uncoated area 18; a PET insulation tape is disposed at the positive electrode second uncoated area 17; the thickness of the insulation tape is 0.02-0.04 mm, the length of the insulation tape is greater by 6 mm than the positive electrode second uncoated area 17, and the width of the insulation tape is greater by 2.5 mm than the width of the positive electrode second uncoated area 17;

[0074] a polyimide acrylic insulation tape is disposed at the negative electrode uncoated area 24; the thickness of the insulation tape is 0.055 mm, the length of the insulation tape is greater by 6 mm than the length of the negative electrode uncoated area 24, and the width of the insulation tape is greater by 1.5 mm than the width of the negative electrode uncoated area 24;

[0075] the positive electrode tab 13 and the negative electrode tab 23 have externally exposed portions of 20 mm, and tab tapes are disposed respectively at the externally exposed portions. The distance between the tab tapes and an edge of the positive electrode strip 11 or an edge of the negative electrode strip 21 is 2 mm; the tab tapes are yellow tapes;

[0076] the surface coating density of the positive electrode active material 12 on the positive electrode strip 11 is 185 mg/cm², and the surface coating density of the negative electrode active material 22 on the negative electrode strip 21 is 76 mg/cm².

[0077] Embodiment 2: combined lithium-ion cell

[0078] The cell of this embodiment is obtained by connecting in parallel two of the wound single cells of Embodiment 1; in the parallel connection, the tabs are placed in the sequence of “left positive, right negative,” and the capacity after the parallel connection is 10 Ah.

[0079] Embodiment 3: wound single cell

[0080] The wound single cell of Embodiment 1 except that:

[0081] the distance between the positive electrode first island area 14 and the positive electrode tab 13 is 270 mm, and the distance between the positive electrode second island area 16 and the positive electrode second uncoated area 17 is 270 mm;

[0082] the widths of the positive electrode tab 13 and the negative electrode tab 23 are both 70 mm, and their thicknesses are both 0.2 mm;

[0083] the widths of the positive electrode first island area 14 and the positive electrode second island area 16 are both 80 mm;

[0084] the width of the positive electrode first uncoated area 15 is 220 mm, and the width of the positive electrode third uncoated area 18 is 620 mm;

[0085] the widths of the positive electrode second uncoated area 17 and the negative electrode uncoated area 24 are both 75 mm;

[0086] the material of the negative electrode tab 23 is copper; and

[0087] the surface coating density of the positive electrode active material 12 on the positive electrode strip 11 is 210 mg/cm², and the surface coating density of the negative electrode active material 22 on the negative electrode strip 21 is 100 mg/cm².

[0088] Embodiment 4: wound single cell

[0089] The wound single cell of Embodiment 1 except that:

[0090] the distance between the positive electrode first island area 14 and the positive electrode tab 13 is 10 mm, and the distance between the positive electrode second island area 16 and the positive electrode second uncoated area 17 is 10 mm;

[0091] the widths of the positive electrode tab 13 and the negative electrode tab 23 are both 5 mm, and their thicknesses are both 0.1 mm;

[0092] the widths of the positive electrode first island area 14 and the positive electrode second island area 16 are both 13 mm;

[0093] the width of the positive electrode first uncoated area 15 is 10 mm, and the width of the positive electrode third uncoated area 18 is 15 mm;

[0094] the widths of the positive electrode second uncoated area 17 and the negative electrode uncoated area 24 are both 6 mm;

[0095] the material of the negative electrode tab 23 is nickel; and

[0096] the surface coating density of the positive electrode active material 12 on the positive electrode strip 11 is 160 mg/cm², and the surface coating density of the negative electrode active material 22 on the negative electrode strip 21 is 60 mg/cm².

[0097] Embodiment 5

[0098] A high-power soft pack lithium-ion battery manufacturing method comprising using the combined lithium-ion cell of Embodiment 2; the steps are as follows:

[0099] (1) mixing evenly lithium manganese oxide, conductive agent SP, and binder PVDF in a ratio of 95 : 3 : 2 into a slurry to obtain a positive electrode active material 12;

[0100] mixing evenly artificial graphite, conductive agent SP, binder CMC, and thickener SBR in a ratio of 95.4 : 1 : 1.6 : 2 into a slurry to obtain a negative electrode active material 22;

[0101] (2) coating the positive electrode active material 12 and the negative electrode active material 22 onto the surfaces of a positive electrode strip 11 and a negative electrode strip 21, respectively; here, an area of a positive electrode tab 13, a positive electrode first island area 14, a positive electrode first uncoated area 15, a positive electrode second island area 16, a positive electrode second uncoated area 17, and a positive electrode third uncoated area 18 are not coated with the positive electrode active material 12; and an area of a negative electrode tab 23 and a negative electrode uncoated area 24 are not coated with the negative electrode active material 22;

[0102] after the surfaces of the positive electrode strip 11 and the surfaces of the negative electrode strip 21 are coated with the active materials, polyethylene terephthalate (PET) insulation tapes are disposed at a coating line area of the positive electrode first island area 14, a coating line area of the positive electrode first uncoated area 15, a coating line area of the positive electrode second island area 16, and a coating line area of the positive electrode third uncoated area 18; the thickness of the insulation tapes is 0.02 mm, the insulation tapes cover 5 mm on two sides of the coating line areas, and the widths of the insulation tapes are greater by 1 mm than the widths of the positive electrode first island area 14, the positive

electrode first uncoated area 15, the positive electrode second island area 16, and the positive electrode third uncoated area 18; a PET insulation tape is disposed at the positive electrode second uncoated area 17; the thickness of the insulation tape is 0.02-0.04 mm, the length of the insulation tape is greater by 6 mm than the positive electrode second uncoated area 17, and the width of the insulation tape is greater by 2.5 mm than the width of the positive electrode second uncoated area 17;

[0103] a polyimide acrylic insulation tape is disposed at the negative electrode uncoated area 24; the thickness of the insulation tape is 0.055 mm, the length of the insulation tape is greater by 6 mm than the length of the negative electrode uncoated area 24, and the width of the insulation tape is greater by 1.5 mm than the width of the negative electrode uncoated area 24;

[0104] the coating density of the positive electrode active material 12 is 185g/m^2 , and

[0105] the coating density of the negative electrode active material 22 is 76g/m^2 ; and

[0106] then welding tabs without tab tapes, for making a combined lithium-ion cell, at the area of the positive electrode tab 13 and the area of the negative electrode tab 23, after drying, calendaring, and slitting, to obtain a positive electrode and a negative electrode;

[0107] (3) winding the negative electrode and the positive electrode made in Step (2) and a first separator and a second separator, stacked in the sequence of the first separator, the negative electrode, the second separator, and the positive electrode with the positive electrode being the innermost layer, the positive electrode strip 11 and the negative electrode strip 21 being wound with the surfaces on which tabs are welded facing up, into a wound cell, the winding ending with the positive electrode, and, once the winding is completed, the third uncoated area 18 of the positive electrode strip 11 being exposed as the outermost layer of the wound cell;

[0108] the material of the separator is polypropylene, and a wound single cell is obtained once the winding is completed;

[0109] two of the wound single cells obtained from Step (3) are connected in parallel by ultrasound welding and secured by insulation tapes, thus obtaining a combined lithium-ion cell;

[0110] as illustrated in FIG. 3: when welding, a positive electrode tab 33 of the combined lithium-ion cell and a negative electrode tab 34 of the combined lithium-ion cell are placed head-down, the distance between upper edges of tab tapes 35 and upper edges of the separators is $1\pm 0.5\text{ mm}$; upon completion of welding for connecting in parallel the tabs, the positive electrode tab 33 of the combined lithium-ion cell and the negative electrode tab 34 of the combined lithium-ion cell are bent upward, and weld areas 36 are cut by scissors to remove excess tabs so that the weld areas 36 align exactly with the outermost edge of the cell 31; insulation tapes 32 are applied at lower ends of the weld areas, the insulation tapes 32 are 1-2 mm wider than the weld areas 36 and secure the weld areas 36 to an upper end of the wound cell; and

[0111] (4) completing the process by packaging the combined wound single cell from Step (3), vacuum baking at $80\text{ }^{\circ}\text{C}$, liquid injection, hot or cold pressing, formation, repackaging, and capacity grading;

[0112] the liquid injection amount is 39.9~40.1g

[0113] parameters of the hot pressing and cold pressing are shown in Table 1:

[0114] Table 1

[0115]

Cell pressing method	Pressure (kgf)	Temperature (°C)	Time (S)	Quantity of cells pressed (PCS)
Hot pressing	663	75	40	2
Cold pressing	663	25	70	2

[0116] Comparison Case 1

[0117] The high-power soft pack lithium-ion battery manufacturing method of Embodiment 5 except that no hot or cold pressing is performed in Step (5).

[0118] Comparison Case 2

[0119] The wound single cell of Embodiment 1 except that the positive electrode tab 13 and the negative electrode tab 23 are disposed at an end of the positive electrode strip 11 and an end of the negative electrode strip 21, respectively.

[0120] Steps of Embodiment 5 are taken in this comparison case to make the wound single cell into a soft pack lithium-ion battery.

[0121] Experiment Case

[0122] Electrical performance testing is performed on the soft pack lithium-ion batteries of Embodiment 5, Comparison Case 1, and Comparison Case 2, and the result is shown in Table 2 and FIG. 4.

[0123] Table 2 Electrical performance data of batteries of the three embodiments, average values

[0124]

Embodiment	1C discharge capacity (mAh)	1C discharge median voltage (V)	Internal resistance (mΩ)	Power density (Wh/Kg)
Embodiment 5	11798	3.722	6.2	175.64
Comparison Case 1	11631	3.643	7.8	168.14
Comparison Case 2	11700	3.602	13.5	165.91

[0125] It can be learned from comparing the data in Table 2 that the soft pack lithium-ion battery of the present invention has lower internal resistance and higher power density.

[0126] It can be learned from the 3C discharge curves of the different batteries in FIG. 4 that the high-power power density soft pack lithium-ion battery of the present invention has better rate performance for

high-current discharge.

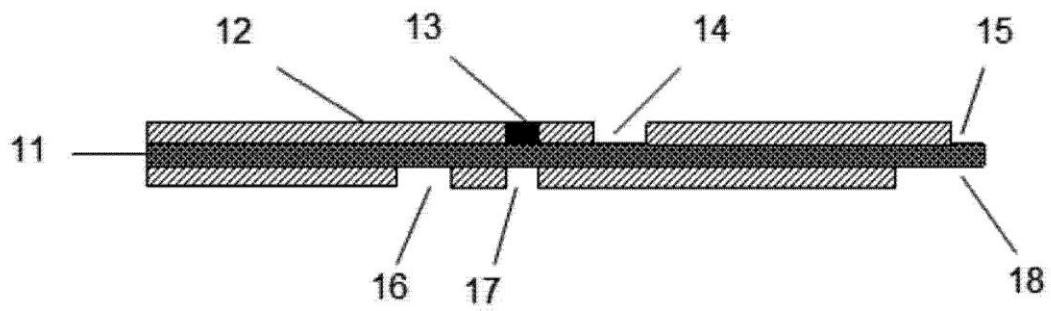


FIG. 1

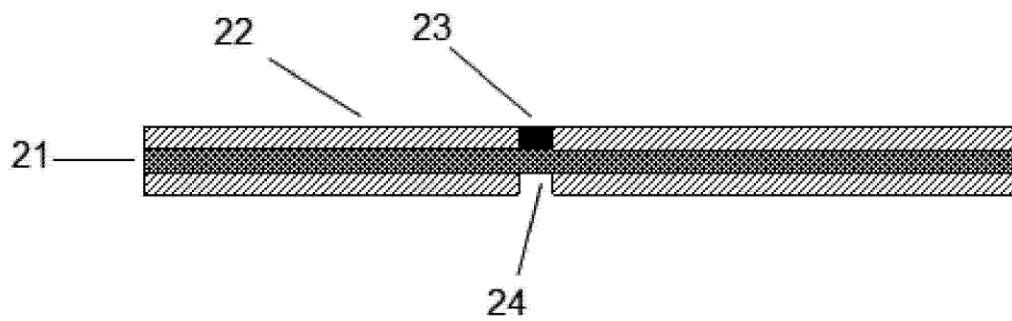


FIG. 2

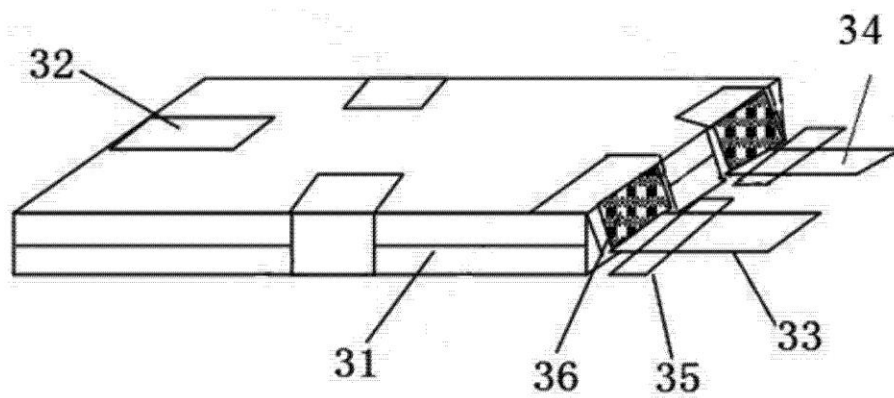


FIG. 3

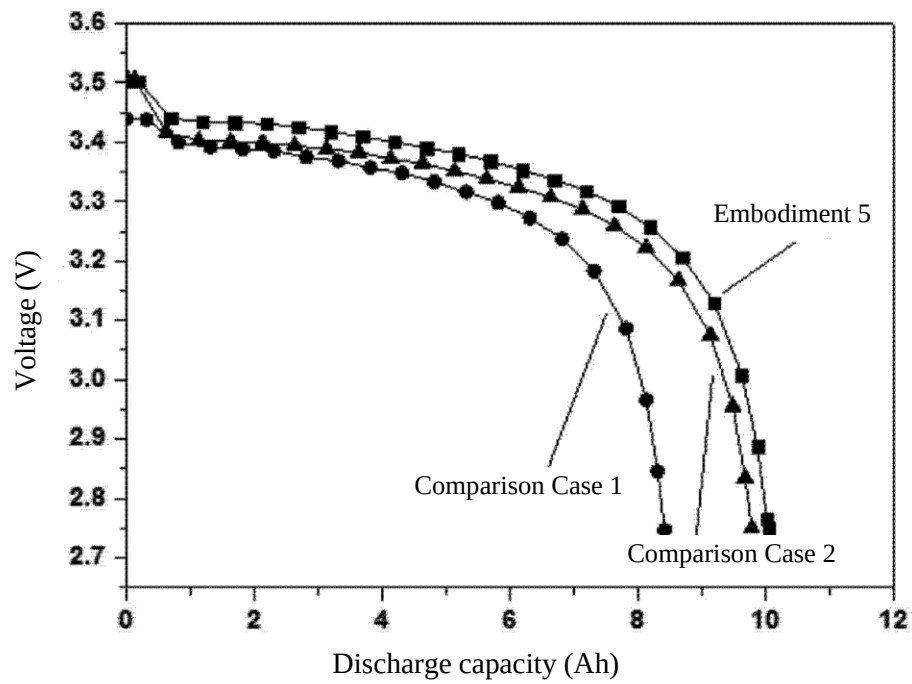


FIG. 4



Acta Chinese Language Services, LLC

www.actalanguage.com | (202)618-2307 | info@actalanguage.com | Gaithersburg, MD

CERTIFICATE OF ACCURACY

I, Evelyn Garland, am competent to translate from Chinese into English and certify that the attached English language document(s) is a true and accurate translation of the original Chinese language document(s) CN104157914A to the best of my abilities.

I further declare that the statement in the preceding paragraph is true, and I understand that false statements and the like are punishable by fine and imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: January 17, 2023

Evelyn Yang Garland

*ATA Certified Translator, English<->Chinese
Maryland Court Certified Interpreter, English<->Mandarin
Chinese*

President
Acta Chinese Language Services, LLC

PO Box 3884
Gaithersburg, MD 20885
egarland@actalanguage.com, (202) 618-2307
www.actalanguage.com



Verify at www.atanet.org/verify



Verify at www.atanet.org/verify



(12) 发明专利申请

(10) 申请公布号 CN 104157914 A

(43) 申请公布日 2014. 11. 19

(21) 申请号 201410443798. 7

(22) 申请日 2014. 09. 02

(71) 申请人 山东齐星新能源科技有限责任公司

地址 256200 山东省滨州市邹平县城东经济
开发区会仙二路 697 号

(72) 发明人 王艳飞 黄磊 刘亚明 张妍
郭大利

(74) 专利代理机构 济南金迪知识产权代理有限
公司 37219

代理人 杨磊

(51) Int. Cl.

H01M 10/0587(2010. 01)

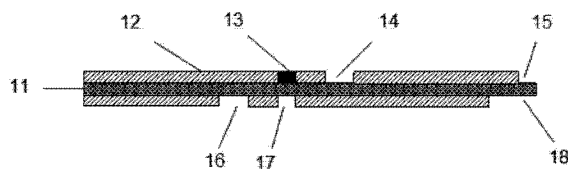
权利要求书2页 说明书8页 附图2页

(54) 发明名称

一种高功率软包装锂离子电池及其制作工艺

(57) 摘要

本发明涉及高功率软包装锂离子电池及其制作工艺。该单体电芯包括负极片、正极片、第一隔膜和第二隔膜并按照第一隔膜、负极片、第二隔膜、正极片的顺序叠放,正极片在最内层,卷绕制得。本发明的锂离子电池在正积极耳两侧一定距离处设置一段无涂覆活性物质的正极第一岛区和正极第二岛区,卷绕时正极第二岛区和正极第一岛区分别对应并包裹负极极耳和负极极耳的背面,避免正极活性物质正对负极极耳而产生析锂;制备方法中,通过在化成前对电池进行热冷压,将电池内多余的电解液挤入气囊,提高电池硬度,使各层隔膜、正极片和负极片接触更紧密,电池界面阻抗降低,以降低电池内阻,提高锂离子电池的功率能量密度。



1. 一种卷绕单体电芯,其特征在于,该单体电芯包括负极片、正极片、第一隔膜和第二隔膜并按照第一隔膜、负极片、第二隔膜、正极片的顺序叠放,正极片在最内层,卷绕制得;

单体电芯展开时,所述的正极片包括正积极片带,所述的正积极片带的两侧设置有正极活性物质,所述的正积极片带的一侧设置有正积极耳、正极第一岛区和正极第一空白区,所述的正积极片带的另一侧设置有正极第二岛区、正极第二空白区和正极第三空白区;所述的正积极耳和正极第二空白区位于正积极片带的中间位置并且相对设置,所述的正极第一岛区和正极第二岛区分别位于正积极耳的两边;所述的正极第一空白区和正极第三空白区位于正积极片带的两侧且设置在正积极片带的端部;

所述的负极片包括负极极片带,所述的负极极片带的两侧设置有负极活性物质,所述的负极极片带的两侧且位于中间位置处相对设置有负极极耳和负极空白区。

2. 根据权利要求1所述的卷绕单体电芯,其特征在于,所述的正极第一岛区距离正积极耳 0-270mm,所述的正极第二岛区距离正极第二空白区 0-270mm。

3. 根据权利要求1所述的卷绕单体电芯,其特征在于,所述的正积极耳和负极极耳的宽度均为 5-70mm,厚度均为 0.1-0.2mm;

所述的正极第一岛区和正极第二岛区宽度均为 13-80mm;

所述的正极第一空白区宽度为 0-220mm,所述的正极第三空白区宽度为 15-620mm;

所述的正极第二空白区和负极空白区的宽度均为 6-75mm。

4. 根据权利要求1所述的卷绕单体电芯,其特征在于,所述的正积极片带为铝箔材质,所述的负极极片带为铜箔材质;

所述的正积极耳为铝材质,所述的负极极耳为镍、铜或铜镀镍材质。

5. 根据权利要求1所述的卷绕单体电芯,其特征在于,所述的正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区设置有聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 0.02-0.04mm,绝缘胶带宽度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的宽度宽 0.5-1mm,绝缘胶带长度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的长度长 2-8mm;所述的正极第二空白区设置有聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 0.02-0.04mm,绝缘胶带长度比正极第二空白区长 2-8mm,绝缘胶带宽度比正极第二空白区宽度宽 2.5-6.5mm;

所述的负极空白区设置有聚酰亚胺亚克力绝缘胶带,绝缘胶带厚度为 0.055-0.065mm,绝缘胶带的长度比负极空白区的长度长 2-8mm,绝缘胶带的宽度比负极空白区的宽度宽 1.5-5.5mm。

6. 根据权利要求1所述的卷绕单体电芯,其特征在于,所述的正积极耳和负极极耳外露 10-20mm,外露部分分别设置有极耳胶,极耳胶距离正积极片带或负极极片带的边缘 1.5-2.5mm;极耳胶材质为黄胶、白胶或黑胶。

7. 一种高功率软包装锂离子电池,电池内部包括至少一个权利要求1-6任一项所述的卷绕单体电芯。

8. 一种高功率软包装锂离子电池的制备方法,步骤如下:

(1) 将锰酸锂、炭黑导电剂、粘结剂聚偏氟乙烯按照 (90-100):(2-4):(1-3) 的质量配比搅拌均匀,制成料浆,得正极活性物质;

将人造石墨、炭黑导电剂、粘结剂羧甲基纤维素钠、增稠剂苯乙烯-丁二烯橡胶按照

(94-97):(0.5-2):(1-2):(1-3) 的质量配比搅拌均匀,制成料浆,得负极活性物质;

(2) 将正极活性物质和负极活性物质分别涂覆在正极极片带的表面和负极极片带的表面,其中,正极极耳处、正极第一岛区、正极第一空白区、正极第二岛区、正极第二空白区和正极第三空白区不涂覆正极活性物质;负极极耳处和负极空白区不涂覆负极活性物质;

所述的正极活性物质的涂覆密度为 $160-210\text{g}/\text{m}^2$,

所述的负极活性物质的涂覆密度为 $60-100\text{g}/\text{m}^2$;

然后,经烘干、辊压和分切,将正极极耳处和负极极耳处焊接带极耳胶的极耳,或者焊接不带极耳胶的极耳用于制作复合锂离子电芯,得正极片和负极片;

(3) 按第一隔膜、负极片、第二隔膜、正极片的顺序叠放,正极片在最内层,将步骤(2)制得负极片和正极片同第一隔膜和第二隔膜进行卷绕,正极极片带和负极极片带都以焊接有极耳的一面朝上放置卷绕成卷芯;

所述的第一隔膜和第二隔膜为聚丙烯隔膜、聚乙烯隔膜、陶瓷涂覆聚丙烯隔膜、陶瓷涂覆聚乙烯隔膜、聚偏氟乙烯涂覆聚丙烯隔膜、聚偏氟乙烯涂覆聚乙烯隔膜或聚丙烯-聚乙烯-聚丙烯三层材质组成的隔膜,卷绕完毕得卷绕单体电芯;

或者,将至少两个上述卷绕单体电芯焊接并联,使用绝缘胶带固定,得到复合锂离子电芯;

(4) 将步骤(3)得到的卷绕单体电芯或复合锂离子电芯经封装、真空烘烤、注液、热冷压、化成,即得;

所述的热压和冷压的参数如下:

热压:面压力 $1-6\text{kgf}/\text{cm}^2$,每次压芯数量 2-16 只,热压温度 $60-80^\circ\text{C}$,热压时间 20-180S;

冷压:面压力 $1-6\text{kgf}/\text{cm}^2$,每次压芯数量 2-16 只,冷压温度 $25-30^\circ\text{C}$,冷压时间 20-180S。

9. 根据权利要求 8 所述的高功率软包装锂离子电池的制备方法,其特征在于,步骤(2)中正极极片带的表面和负极极片带的表面涂覆活性物质后,正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区粘贴聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 $0.02-0.04\text{mm}$,绝缘胶带宽度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的宽度宽 $0.5-1\text{mm}$,绝缘胶带长度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的长度长 $2-8\text{mm}$;正极第二空白区粘贴聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 $0.02-0.04\text{mm}$,绝缘胶带长度比正极第二空白区长 $2-8\text{mm}$,绝缘胶带宽度比正极第二空白区宽度宽 $2.5-6.5\text{mm}$;

负极空白区粘贴聚酰亚胺亚克力绝缘胶带,绝缘胶带厚度为 $0.055-0.065\text{mm}$,绝缘胶带的长度比负极空白区的长度长 $2-8\text{mm}$,绝缘胶带的宽度比负极空白区的宽度宽 $1.5-5.5\text{mm}$ 。

10. 根据权利要求 8 所述的高功率软包装锂离子电池的制备方法,其特征在于,步骤(4)中所述的电解液溶剂为碳酸乙烯酯、碳酸二乙酯和碳酸甲基乙基酯的混合体系,电解质为六氟磷酸锂,并添加 1,2-碳酸亚乙烯酯作为添加剂,注液量按照 $4.0\text{g}/\text{Ah}\pm 0.1\text{g}$ 注。

一种高功率软包装锂离子电池及其制作工艺

技术领域

[0001] 本发明属于锂离子电池领域,涉及一种锂离子电池及其制作工艺,尤其涉及一种高功率软包装锂离子电池及其制作工艺。

背景技术

[0002] 为满足市场对于大容量型动力软包装锂离子电池的要求,在严格控制极片面密度的情况下需要通过增加极片长度来实现。但对采用卷绕工艺的动力锂离子电池来讲,极片过长会给生产过程带来不必要的麻烦,导致产品不良率上升,且采用长极片的电池内阻大,不利于动力电池的大电流充放电,严重阻碍其功率能量密度的提高。

[0003] 在中国专利文献 CN203119046U 中提到一种将正积极耳置于正极片中间的极片结构,来降低锂离子电池内阻,解决锂离子电池循环性能差,一致性差的问题。但是该方法负极没有采用极耳置于极片中间的结构对电池内阻降低效果不明显。在中国专利文献 CN202905842U 中提到一种正负极耳均焊接在极片中间的极片结构,来进一步降低电池内阻,提高电池充放电效率和使用寿命。在这两项专利中,正极片极耳右端一定距离以及正极耳焊接位置反面左端一定距离,都没有设置一个无涂覆活性材料的空白箔材区,行业内统称“岛区”来避免负极耳卷绕时正对正极料区,这样的极片结构会导致电池在充电后产生析锂现象而引发的一系列热失控现象,降低电池安全性。因此,有必要在此位置设置一段岛区,来提高电池的安全性。

[0004] 软包装锂离子电池的正负极极片、隔膜均为多孔状膜片结构,具有一定的吸液能力,注液后静置一段时间会因吸液而产生膨胀发生层与层之间的分离,导致隔膜与极片接触不够紧密,使得界面阻抗增加,化成时界面反应不均匀,不利于负极表面形成致密的固体电解质界面膜(SEI膜),加之化成过程会发生产气反应,则更加剧这一不利反应的发生,当化成电压超过3.95V时,负极表面SEI膜疏松的地方会产生析锂现象,一方面会给动力电池带来安全隐患,增加电池内阻;另一方面由于软包装锂离子电池外壳为材质较软的铝塑膜,电芯在3.9-4.1V的形变较铝/钢壳锂离子电池表现得更明显,需要在化成结束后在该电压范围内对电芯进行热夹具整形,释放电池内部应力,消除电芯变形现象。而通过将化成电压降低到3.95V来避免化成时析锂现象,不利于电池热夹具整形效果。因此,为降低大容量型软包装动力锂离子电池内阻,提高其功率能量密度,改善电芯变形现象,有必要在软包装锂离子电池化成前,通过一定方式将电池内部层与层之间较为蓬松的接触变得更为紧密。

发明内容

[0005] 本发明针对上述现有技术中存在的缺陷和不足,提供一种高功率能量密度软包装锂离子电池及其制造工艺。

[0006] 术语说明:

[0007] 岛区:本发明所述岛区为本领域公知术语,是指在电芯卷绕完毕后,正积极片带上正对负极极耳焊接位正反面,没有涂覆正极活性物质的空白箔材区。

[0008] 涂布线：本发明所述涂布线为本领域公知术语，是指岛区或空白区边沿处，即活性物质和极片带的临界处。

[0009] 本发明的技术方案如下：

[0010] 一种卷绕单体电芯，该单体电芯包括负极片、正极片、第一隔膜和第二隔膜并按照第一隔膜、负极片、第二隔膜、正极片的顺序叠放，正极片在最内层，卷绕制得；

[0011] 单体电芯展开时，所述的正极片包括正积极片带，所述的正积极片带的两侧设置有正极活性物质，所述的正积极片带的一侧设置有正积极耳、正极第一岛区和正极第一空白区，所述的正积极片带的另一侧设置有正极第二岛区、正极第二空白区和正极第三空白区；所述的正积极耳和正极第二空白区位于正积极片带的中间位置并且相对设置，所述的正极第一岛区和正极第二岛区分别位于正积极耳的两边；所述的正极第一空白区和正极第三空白区位于正积极片带的两侧且设置在正积极片带的端部；

[0012] 所述的负极片包括负极极片带，所述的负极极片带的两侧设置有负极活性物质，所述的负极极片带的两侧且位于中间位置处相对设置有负极极耳和负极空白区。

[0013] 根据本发明，优选的，所述的正极第一岛区距离正积极耳 0-270mm，所述的正极第二岛区距离正极第二空白区 0-270mm。

[0014] 根据本发明，优选的，所述的正积极耳和负极极耳的宽度均为 5-70mm，厚度均为 0.1-0.2mm。

[0015] 根据本发明，优选的，所述的正极第一岛区和正极第二岛区宽度均为 13-80mm。

[0016] 根据本发明，优选的，所述的正极第一空白区宽度为 0-220mm，所述的正极第三空白区宽度为 15-620mm。

[0017] 根据本发明，优选的，所述的正极第二空白区和负极空白区的宽度均为 6-75mm。

[0018] 根据本发明，优选的，所述的正积极片带为铝箔材质，所述的负极极片带为铜箔材质。

[0019] 根据本发明，优选的，所述的正积极耳为铝材质，所述的负极极耳为镍、铜或铜镀镍材质。

[0020] 根据本发明，优选的，所述的正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区设置有聚对苯二甲酸乙二酯绝缘胶带，绝缘胶带厚度为 0.02-0.04mm，绝缘胶带宽度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的宽度宽 0.5-1mm，绝缘胶带长度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的长度长 2-8mm；所述的正极第二空白区设置有聚对苯二甲酸乙二酯绝缘胶带，绝缘胶带厚度为 0.02-0.04mm，绝缘胶带长度比正极第二空白区长 2-8mm，绝缘胶带宽度比正极第二空白区宽度宽 2.5-6.5mm。

[0021] 根据本发明，优选的，仅在正极第一岛区涂布线位置、正极第一空白区涂布线位置、正极第二岛区涂布线位置和正极第三空白区涂布线位置设置聚对苯二甲酸乙二酯绝缘胶带，绝缘胶带贴住涂布线两侧 2-8mm。

[0022] 根据本发明，优选的，所述的负极空白区设置有聚酰亚胺亚克力绝缘胶带，绝缘胶带厚度为 0.055-0.065mm，绝缘胶带的宽度比负极空白区的宽度宽 2-8mm，绝缘胶带的长度比负极空白区的长度长 1.5-5.5mm。

[0023] 根据本发明，优选的，所述的正积极耳和负极极耳外露 10-20mm，外露部分分别设

置有极耳胶,极耳胶距离正极极片带或负极极片带的边缘 1.5-2.5mm;极耳胶材质为黄胶、白胶或黑胶。

[0024] 根据本发明,所述的正极活性物质和负极活性物质均为本领域常规成分,优选的,所述的正极活性物质为锰酸锂、导电剂和粘结剂经过搅拌混合均匀后的浆料,所述的负极活性物质为人造石墨、导电剂和粘结剂经过搅拌混合均匀后的浆料。

[0025] 根据本发明,一种高功率软包装锂离子电池,电池内部包括至少一个上述卷绕单体电芯,更优选的,卷绕单体电芯的个数为 2 个,并联组成双卷芯电池。卷绕单体电芯可经压芯制得方形锂离子电池。

[0026] 根据本发明,一种高功率软包装锂离子电池的制备方法,步骤如下:

[0027] (1) 将锰酸锂、炭黑导电剂 (SP)、粘结剂聚偏氟乙烯 (PVDF) 按照 (90-100):(2-4):(1-3) 的质量配比搅拌均匀,制成料浆,得正极活性物质;

[0028] 将人造石墨、炭黑导电剂 (SP)、粘结剂羧甲基纤维素钠 (CMC)、增稠剂苯乙烯-丁二烯橡胶 (SBR) 按照 (94-97):(0.5-2):(1-2):(1-3) 的质量配比搅拌均匀,制成料浆,得负极活性物质;

[0029] (2) 将正极活性物质和负极活性物质分别涂覆在正极极片带的表面和负极极片带的表面,其中,正极极耳处、正极第一岛区、正极第一空白区、正极第二岛区、正极第二空白区和正极第三空白区不涂覆正极活性物质;负极极耳处和负极空白区不涂覆负极活性物质;

[0030] 所述的正极活性物质的涂覆密度为 160-210g/m²,

[0031] 所述的负极活性物质的涂覆密度为 60-100g/m²;

[0032] 然后,经烘干、辊压和分切,将正极极耳处和负极极耳处焊接带极耳胶的极耳,或者焊接不带极耳胶的极耳用于制作复合锂离子电芯,得正极片和负极片;

[0033] (3) 按第一隔膜、负极片、第二隔膜、正极片的顺序叠放,正极片在最内层,将步骤(2) 制得负极片和正极片同第一隔膜和第二隔膜进行卷绕,正极极片带和负极极片带都以焊接有极耳的一面朝上放置卷绕成卷芯;

[0034] 所述的第一隔膜和第二隔膜为聚丙烯隔膜、聚乙烯隔膜、陶瓷涂覆聚丙烯隔膜、聚偏氟乙烯 (PVDF) 涂覆聚丙烯隔膜或聚丙烯-聚乙烯-聚丙烯三层材质组成的隔膜,卷绕完毕得卷绕单体电芯;

[0035] 或者,将至少两个上述卷绕单体电芯焊接并联,使用绝缘胶带固定,得到复合锂离子电芯;

[0036] (4) 将步骤(3) 得到的卷绕单体电芯或复合锂离子电芯经封装、真空烘烤、注液、热冷压、化成,即得;

[0037] 所述的热压和冷压的参数如下:

[0038] 热压:面压力 1-6kgf/cm²,每次压芯数量 2-16 只,热压温度 60-80℃,热压时间 20-180S;

[0039] 冷压:面压力 1-6kgf/cm²,每次压芯数量 2-16 只,冷压温度 25-30℃,冷压时间 20-180S。

[0040] 根据本发明,优选的,步骤(2) 中所述的正极活性物质的涂覆密度为 180-185g/m²,所述的负极活性物质的涂覆密度为 65-70g/m²。

[0041] 根据本发明,优选的,步骤(2)中正极极片带的表面和负极极片带的表面涂覆活性物质后,正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区粘贴聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 0.02-0.04mm,绝缘胶带宽度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的宽度宽 0.5-1mm,绝缘胶带长度比正极第一岛区、正极第一空白区、正极第二岛区和正极第三空白区的长度长 2-8mm;正极第二空白区粘贴聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 0.02-0.04mm,绝缘胶带长度比正极第二空白区长 2-8mm,绝缘胶带宽度比正极第二空白区宽度宽 2.5-6.5mm;

[0042] 负极空白区粘贴聚酰亚胺亚克力绝缘胶带,绝缘胶带厚度为 0.055-0.065mm,绝缘胶带的长度比负极空白区的长度长 2-8mm,绝缘胶带的宽度比负极空白区的宽度宽 1.5-5.5mm。

[0043] 根据本发明,优选的,步骤(3)中至少两个卷绕单体电芯并联并联焊接的方式是通过超声波焊接。卷绕时,正极片在最内层,以正极片收尾,卷绕结束后,露在卷芯的最外层为正极极片带上的第三空白区。

[0044] 根据本发明,电解液为本领域常用电解液,优选的,步骤(4)中所述的电解液溶剂为碳酸乙烯酯(EC)、碳酸二乙酯(DEC)和碳酸甲基乙基酯(EMC)的混合体系,电解质为六氟磷酸锂(LiPF_6),并添加 1,2-碳酸亚乙烯酯(VC)作为添加剂,注液量按照 $4.0\text{g}/\text{Ah} \pm 0.1\text{g}$ 注。

[0045] 更优选的,化成后还包括二次封装和分容步骤。

[0046] 本发明的高功率软包装锂离子电池内部包括至少一个卷绕单体电芯,各卷绕单体电芯都分别设置有正极极耳和负极极耳,且设置在正极极片带和负极极片带的中间位置,其中所述正极极片带设置有正极第一岛区和正极第二岛区,其能够在保证电池容量不变的情况下有效降低电池内阻,提高其安全性。

[0047] 本发明的有益效果如下:

[0048] 1、本发明的锂离子电池内部包括至少一个卷绕单体电芯,各卷绕单体电芯都分别设置有正负极耳,其中所述单体电芯极性相同的极耳通过超声波焊接的方式焊接为一体形成复合电芯,电池内阻低,功率能量密度高。

[0049] 2、本发明的锂离子电池在正极极耳两侧一定距离处设置一段无涂覆活性物质的正极第一岛区和正极第二岛区,卷绕时正极第二岛区和正极第一岛区分别对应并包裹负极极耳和负极极耳的背面,避免正极活性物质正对负极极耳而产生析锂。

[0050] 3、本发明的高功率软包装锂离子电池的制备方法中,通过在化成前对电池进行热冷压,将电池内多余的电解液挤入气囊,提高电池硬度,使各层隔膜、正极片和负极片接触更紧密,电池界面阻抗降低,以降低电池内阻,提高锂离子电池的功率能量密度。

[0051] 4、由于本发明所述的正极极耳和负极极耳分别位于正极极片带和负极极片带的中间位置,且正极极片带设置两个位置不同的岛区,因而在保证软包装锂离子电池容量不变的基础上,既能有效降低电池内阻,降低电池放电时的产热量,又能改善电池的倍率性能,还可以避免电池析锂离提高其安全性。

附图说明

[0052] 图 1 为本发明实施例 1 卷绕单体电芯正极片展开时的剖面示意图。

[0053] 图 2 为本发明实施例 1 卷绕单体电芯负极片展开时的剖面示意图。

[0054] 图 3 为本发明实施例 2 复合锂离子电芯的立体结构示意图。

[0055] 图 4 为本发明实施例 5 和对比例 1-2 制作得到的电池的 3C 放电曲线。

[0056] 其中, 11- 正极极片带, 12- 正极活性物质, 13- 正极极耳, 14- 正极第一岛区, 15- 正极第一空白区, 16- 正极第二岛区, 17- 正极第二空白区, 18- 正极第三空白区 ;

[0057] 21- 负极极片带, 22- 负极活性物质, 23- 负极极耳, 24- 负极空白区 ;

[0058] 31- 单体电芯, 32- 绝缘胶带, 33- 复合锂离子电芯正极耳, 34- 复合锂离子电芯负极耳, 35- 极耳胶, 36- 焊接处。

具体实施方式

[0059] 为了更好地理解本发明, 下面用具体实例来详细说明本发明的技术方案, 但是本发明并不局限于此。

[0060] 实施例中正极活性物质 12 为锰酸锂 ; 导电剂 SP ; 粘结剂 PVDF 按照 95:3:2 的配比混合均匀的浆料, 负极活性物质 22 为人造石墨 ; 导电剂 SP ; 粘结剂 CMC ; 增稠剂 SBR 按照 95.4:1:1.6:2 的配比混合均匀的浆料, 卷绕单体电芯容量为 5Ah。

[0061] 电解液的溶剂为碳酸乙烯酯 (EC)、碳酸二乙酯 (DEC) 和碳酸甲基乙基酯 (EMC) 的混合体系, 电解质为六氟磷酸锂 (LiPF_6), 并添加 1, 2- 碳酸亚乙烯酯 (VC) 作为添加剂。

[0062] 实施例 1、卷绕单体电芯

[0063] 一种卷绕单体电芯, 该单体电芯包括负极片、正极片、第一隔膜和第二隔膜并按照第一隔膜、负极片、第二隔膜、正极片的顺序叠放, 正极片在最内层, 卷绕制得 ;

[0064] 单体电芯展开时, 所述的正极片包括正极极片带 11, 所述的正极极片带 11 的两侧均匀有正极活性物质 12, 所述的正极极片带 11 的一侧设置有正极极耳 13、正极第一岛区 14 和正极第一空白区 15, 所述的正极极片带 11 的另一侧设置有正极第二岛区 16、正极第二空白区 17 和正极第三空白区 18 ; 所述的正极极耳 13 和正极第二空白区 17 位于正极极片带 11 的中间位置并且相对设置, 所述的正极第一岛区 14 和正极第二岛区 16 分别位于正极极耳 13 的两边 ; 所述的正极第一空白区 15 和正极第三空白区 18 位于正极极片带 11 的两侧且设置在正极极片带 11 的端部 ;

[0065] 所述的负极片包括负极极片带 21, 所述的负极极片带 21 的两侧均匀设置有负极活性物质 22, 所述的负极极片带 21 的两侧且位于中间位置处相对设置有负极极耳 23 和负极空白区 24。

[0066] 本实施例中, 所述的正极第一岛区 14 与正极极耳 13 的距离为 32mm, 所述的正极第二岛区 16 与正极第二空白区 17 的距离为 32mm ;

[0067] 所述的正极极耳 13 和负极极耳 23 的宽度均为 15mm, 厚度均为 0.2mm ;

[0068] 所述的正极第一岛区 14 和正极第二岛区 16 宽度均为 35mm ;

[0069] 所述的正极第一空白区 15 宽度为 58mm, 所述的正极第三空白区 18 宽度为 180mm ;

[0070] 所述的正极第二空白区 17 和负极空白区 24 的宽度均为 24mm ;

[0071] 所述的正极极片带 11 为铝箔材质, 所述的负极极片带 21 为铜箔材质 ;

[0072] 所述的正极极耳 13 为铝材质, 所述的负极极耳 23 为铜镀镍材质 ;

[0073] 所述的正极第一岛区 14 涂布线位置、正极第一空白区 15 涂布线位置、正极第二岛

区 16 涂布线位置和正极第三空白区 18 涂布线位置设置有聚对苯二甲酸乙二酯 (PET) 绝缘胶带, 绝缘胶带厚度为 0.02mm, 绝缘胶带贴住涂布线两侧 5mm, 绝缘胶带宽度比正极第一岛区 14、正极第一空白区 15、正极第二岛区 16 和正极第三空白区 18 的宽度宽 1mm; 正极第二空白区 17 设置有聚对苯二甲酸乙二酯绝缘胶带, 绝缘胶带厚度为 0.02-0.04mm, 绝缘胶带长度比正极第二空白区 17 长 6mm, 绝缘胶带宽度比正极第二空白区 17 宽度宽 2.5mm;

[0074] 所述的负极空白区 24 设置有聚酰亚胺亚克力绝缘胶带, 绝缘胶带厚度为 0.055mm, 绝缘胶带的长度比负极空白区 24 的长度长 6mm, 绝缘胶带的宽度比负极空白区 24 的宽度宽 1.5mm;

[0075] 所述的正极极耳 13 和负极极耳 23 外露出 20mm, 外露部分分别设置极耳胶。极耳胶距离正极极片带 11 或负极极片带 21 的边缘 2mm; 极耳胶材质为黄胶;

[0076] 正极极片带 11 上正极活性物质 12 涂覆面密度为 $185\text{mg}/\text{cm}^2$, 负极极片带 21 上负极活性物质 22 涂覆面密度为 $76\text{mg}/\text{cm}^2$ 。

[0077] 实施例 2、复合锂离子电芯

[0078] 本实施例制得的电芯由两个实施例 1 制得的卷绕单体电芯并联后得到, 并联时按照极耳“左正右负”的顺序放置, 并联后容量为 10Ah。

[0079] 实施例 3、卷绕单体电芯

[0080] 如实施例 1 所述的卷绕单体电芯, 不同的是:

[0081] 所述的正极第一岛区 14 与正极极耳 13 的距离为 270mm, 所述的正极第二岛区 16 与正极第二空白区 17 的距离为 270mm;

[0082] 所述的正极极耳 13 和负极极耳 23 的宽度均为 70mm, 厚度均为 0.2mm;

[0083] 所述的正极第一岛区 14 和正极第二岛区 16 宽度均为 80mm;

[0084] 所述的正极第一空白区 15 宽度为 220mm, 所述的正极第三空白区 18 宽度为 620mm;

[0085] 所述的正极第二空白区 17 和负极空白区 24 的宽度均为 75mm;

[0086] 所述的负极极耳 23 为铜材质;

[0087] 正极极片带 11 上正极活性物质 12 涂覆面密度为 $210\text{mg}/\text{cm}^2$, 负极极片带 21 上负极活性物质 22 涂覆面密度为 $100\text{mg}/\text{cm}^2$ 。

[0088] 实施例 4、卷绕单体电芯

[0089] 如实施例 1 所述的卷绕单体电芯, 不同的是:

[0090] 所述的正极第一岛区 14 与正极极耳 13 的距离为 10mm, 所述的正极第二岛区 16 与正极第二空白区 17 的距离为 10mm;

[0091] 所述的正极极耳 13 和负极极耳 23 的宽度均为 5mm, 厚度均为 0.1mm;

[0092] 所述的正极第一岛区 14 和正极第二岛区 16 宽度均为 13mm;

[0093] 所述的正极第一空白区 15 宽度为 10mm, 所述的正极第三空白区 18 宽度为 15mm;

[0094] 所述的正极第二空白区 17 和负极空白区 24 的宽度均为 6mm;

[0095] 所述的负极极耳 23 为镍材质;

[0096] 正极极片带 11 上正极活性物质 12 涂覆面密度为 $160\text{mg}/\text{cm}^2$, 负极极片带 21 上负极活性物质 22 涂覆面密度为 $60\text{mg}/\text{cm}^2$ 。

[0097] 实施例 5

[0098] 一种高功率软包装锂离子电池的制备方法,包括使用实施例 2 所述的复合锂离子电芯,步骤如下:

[0099] (1) 将锰酸锂、导电剂 SP、粘结剂 PVDF 按照 95:3:2 的配比搅拌均匀,制成料浆,得正极活性物质 12;

[0100] 将人造石墨、导电剂 SP、粘结剂 CMC、增稠剂 SBR 按照 95.4:1:1.6:2 的配比搅拌均匀,制成料浆,得负极活性物质 22;

[0101] (2) 将正极活性物质 12 和负极活性物质 22 分别涂覆在正极极片带 11 的表面和负极极片带 21 的表面,其中,正极极耳 13 处、正极第一岛区 14、正极第一空白区 15、正极第二岛区 16、正极第二空白区 17 和正极第三空白区 18 不涂覆正极活性物质 12;负极极耳 23 处和负极空白区 24 不涂覆负极活性物质 22;

[0102] 正极极片带 11 的表面和负极极片带 21 的表面涂覆活性物质后,正极第一岛区 14 涂布线位置、正极第一空白区 15 涂布线位置、正极第二岛区 16 涂布线位置和正极第三空白区 18 涂布线位置设置有聚对苯二甲酸乙二酯 (PET) 绝缘胶带,绝缘胶带厚度为 0.02mm,绝缘胶带贴住涂布线两侧 5mm,绝缘胶带宽度比正极第一岛区 14、正极第一空白区 15、正极第二岛区 16 和正极第三空白区 18 的宽度宽 1mm;正极第二空白区 17 设置有聚对苯二甲酸乙二酯绝缘胶带,绝缘胶带厚度为 0.02-0.04mm,绝缘胶带长度比正极第二空白区 17 长 6mm,绝缘胶带宽度比正极第二空白区 17 宽度宽 2.5mm;

[0103] 所述的负极空白区 24 设置有聚酰亚胺亚克力绝缘胶带,绝缘胶带厚度为 0.055mm,绝缘胶带的长度比负极空白区 24 的长度长 6mm,绝缘胶带的宽度比负极空白区 24 的宽度宽 1.5mm;

[0104] 所述的正极活性物质 12 的涂覆密度为 $185\text{g}/\text{m}^2$,

[0105] 所述的负极活性物质 22 的涂覆密度为 $76\text{g}/\text{m}^2$;

[0106] 然后,经烘干、辊压和分切,将正极极耳 13 处和负极极耳 23 处焊接不带极耳胶的极耳用于制作复合锂离子电池,得正极片和负极片;

[0107] (3) 按第一隔膜、负极片、第二隔膜、正极片的顺序叠放,正极片在最内层,将步骤 (2) 制得负极片和正极片同第一隔膜和第二隔膜进行卷绕,正极极片带 11 和负极极片带 21 都以焊接有极耳的一面朝上放置卷绕成卷芯,以正极片收尾,卷绕结束后,露在卷芯的最外层为正极极片带 11 的第三空白区 18;

[0108] 所述的隔膜材质为聚丙烯,卷绕完毕得卷绕单体电芯;

[0109] 将两个步骤 (3) 得到的卷绕单体电芯通过超声波焊接的方式并联,并使用绝缘胶带固定,得到复合锂离子电池;

[0110] 如图 3 所示:焊接时复合锂离子电池正极耳 33 和复合锂离子电池负极耳 34 头部朝下放置,极耳胶 35 上边缘距隔膜上边缘 $1\pm 0.5\text{mm}$;极耳并联焊接结束后,将复合锂离子电池正极耳 33 和复合锂离子电池负极耳 34 朝上翻折,用剪刀修剪焊接处 36,将多余的极耳减掉,使焊接处 36 正好与最外端的电芯 31 边缘平齐;焊接处 36 下端粘贴绝缘胶带 32,绝缘胶带 32 比焊接处 36 宽 1-2mm,并用绝缘胶带 32 将焊接处 36 固定在卷芯上端;

[0111] (4) 将步骤 (3) 得到的复合卷绕单体电芯经封装、 80°C 真空烘烤、注液、热冷压、化成,二次封装、分容,即得;

[0112] 所述的注液量为 $39.9\sim 40.1\text{g}$

[0113] 所述的热压和冷压的参数如表 1 所示：

[0114] 表 1

[0115]

压芯方式	压力 (kgf)	温度 (°C)	时间 (S)	压芯数量 (PCS)
热压	663	75	40	2
冷压	663	25	70	2

[0116] 对比例 1

[0117] 如实施例 5 所示的高功率软包装锂离子电池的制备方法,不同的是,步骤 (5) 中不进行热冷压操作。

[0118] 对比例 2

[0119] 如实施例 1 所述的卷绕单体电芯,不同的是所述的正极极耳 13 和负极极耳 23 分别设置在所述的正极极片带 11 和负极极片带 21 的端部。

[0120] 按实施例 5 的步骤将本对比例的卷绕单体电芯制得软包装锂离子电池。

[0121] 实验例

[0122] 将实施例 5、对比例 1 和对比例 2 制得的软包装锂离子电池进行电性能数据测试,结果如表 2,图 4 所示。

[0123] 表 2 三种实施例制作电池电性能数据平均值

[0124]

实施例	1C 放电容量 (mAh)	1C 放电中值电压 (V)	内阻 (mΩ)	功率能量密度 (Wh/Kg)
实施例 5	11798	3.722	6.2	175.64
对比例 1	11631	3.643	7.8	168.14
对比例 2	11700	3.602	13.5	165.91

[0125] 通过表 2 数据对比可知,本发明制作的软包装锂离子电池内阻更小,功率能量密度更高。

[0126] 通过图 4 不同电池 3C 放电曲线可知,本发明制作的高功率能量密度软包装锂离子电池大电流放电时的倍率性能更好。

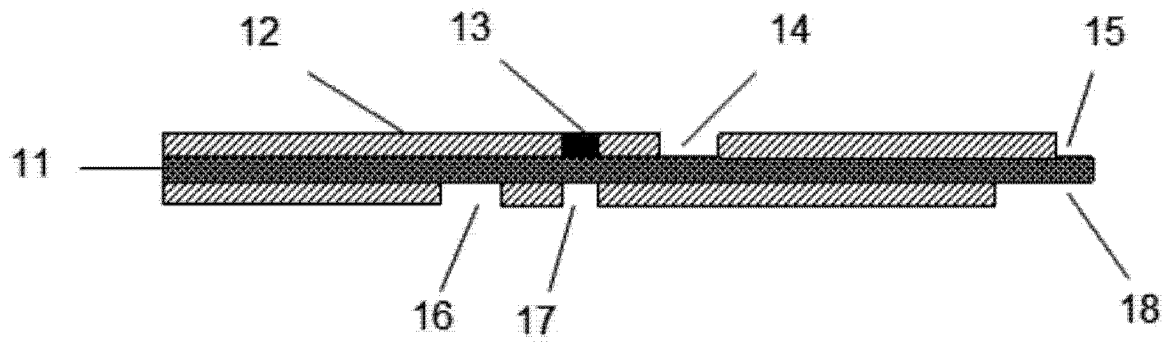


图 1

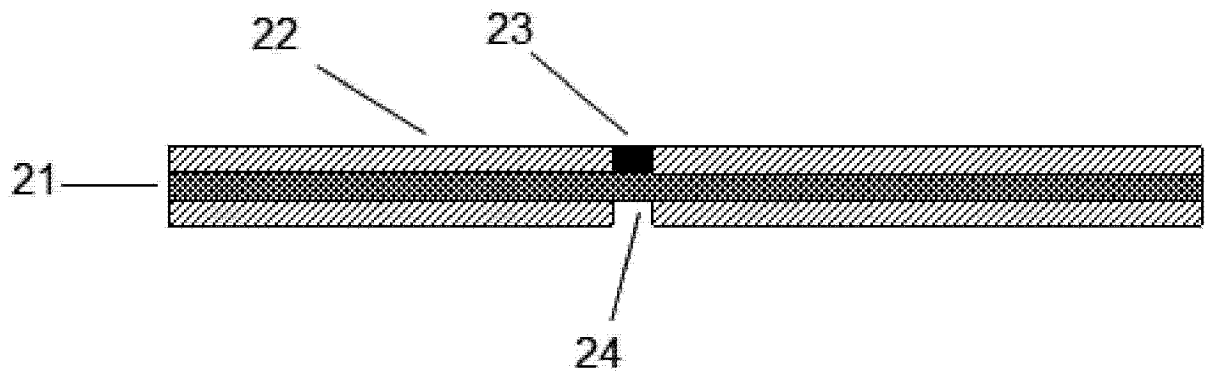


图 2

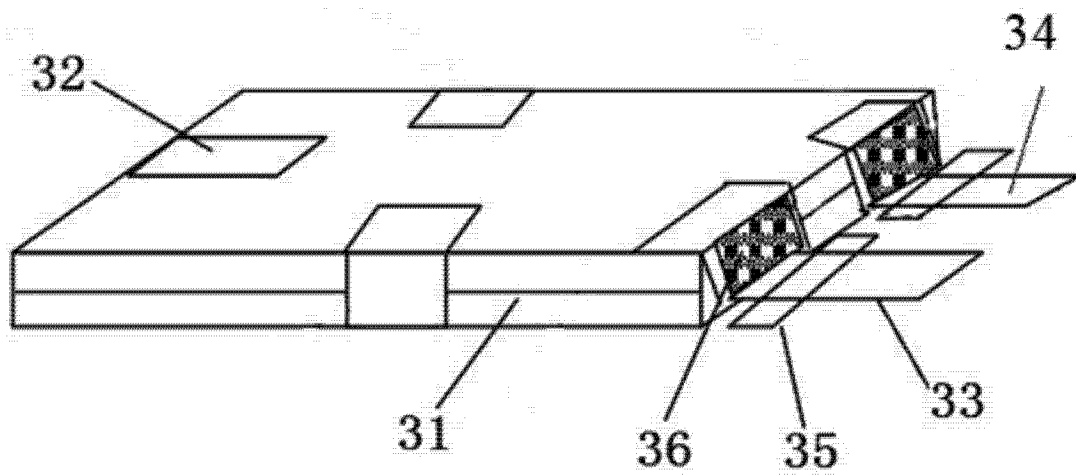


图 3

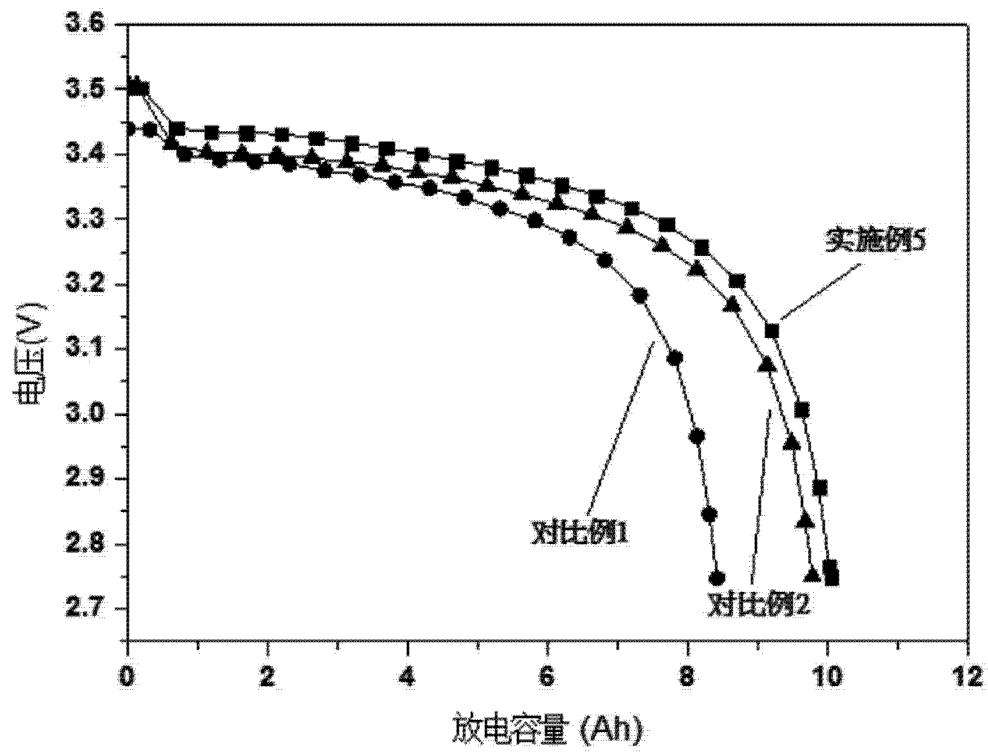


图 4