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BATTERY AND ELECTRICAL DEVICE

Abstract

A battery includes an electrode plate and a tab. The electrode plate includes a current collector and an active material layer disposed on the current collector. The tab is connected to the current collector. The tab protrudes beyond the electrode plate along a width direction of the electrode plate. Along the width direction of the electrode plate, the tab includes a first region and a second region. The first region is located between the second region and the active material layer, a thickness of the first region is $t_{sub.1}$, and a thickness of the second region is $t_{sub.2}$, and $0.5\% \leq (t_{sub.1} - t_{sub.2}) / t_{sub.1} \leq 5\%$.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation application of International Application No. PCT/CN2023/120464, filed on Sep. 21, 2023, which claims the benefit of priority of Chinese patent application 202211379482.7, filed on Nov. 4, 2022, the contents of which are incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the technical field of energy storage, and in particular, to a battery and an electrical device.

BACKGROUND

[0003] Currently, a production process of electrode plates of a battery usually includes a coating process and a cold pressing process. Through cold pressing, the electrode plates are compacted. The cold pressing is very important for improving the energy density and electrical performance of the battery. In a cold pressing process, the elongation degree differs between an active material layer region and a blank foil region in which tabs are formed. Therefore, in order to reduce the risk of deformation or warping of the tabs, the blank foil region usually needs to be stretched and elongated after the electrode plate is cold pressed. However, the stretching and elongation operations are very likely to lead to breakage of the electrode plate, thereby impairing the yield rate of the cold pressing process. To reduce the risk of breakage of the electrode plate, a conventional measure in the prior art is to use a thicker current collector or to reduce the compaction density of the electrode plate. This measure not only brings a poor effect on alleviation of the electrode plate breakage, but also results in a loss of energy density.

SUMMARY

[0004] In view of the above situation, there is a need to provide a battery to reduce the risk of breakage of an electrode plate and increase energy density of the battery.

[0005] Some embodiments of this application provide a battery. The battery includes an electrode plate and a tab. The electrode plate includes a current collector and an active material layer disposed on the current collector. The tab is connected to the current collector. The tab protrudes beyond the electrode plate along a width direction of the electrode plate. Along the width direction of the electrode plate, the tab includes a first region and a second region. The first region is located between the second region and the active material layer, a thickness of the first region is $t_{\text{sub.1}}$, and a thickness of the second region is $t_{\text{sub.2}}$, satisfying: $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$

[0006] In the battery, the tab is divided into a first region and a second region along the width direction of the electrode plate. The first region is located between the second region and the active material layer. The second region is pre-elongated by calendaring before being cold pressed. The thickness $t_{\text{sub.1}}$ of the first region and the thickness $t_{\text{sub.2}}$ of the second region satisfy:

$0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$. The difference between the thickness of the first region and the thickness of the second region needs to be prevented from being unduly large. If the difference is unduly large, the electrode plate is prone to break due to stress concentration at the junction. If the difference is unduly small, for example, less than 0.5%, a desired elongation effect of the second region fails to be achieved, and the tab is prone to warps and folds. Therefore, the thickness $t_{\text{sub.1}}$ of the first region and the thickness $t_{\text{sub.2}}$ of the second region are set to satisfy: $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$, thereby reducing the phenomena of breakage of the electrode

plate after cold pressing, and improving the processing yield rate. In this way, a thinner current collector and/or a higher compaction density can be employed, and the energy density of the battery can be improved.

[0007] In some embodiments of this application, the thicknesses satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 3\%$, thereby further reducing the phenomena of breakage of the electrode plate after cold pressing.

[0008] In some embodiments of this application, the thicknesses satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 1.5\%$, thereby further reducing the phenomena of breakage of the electrode plate after cold pressing.

[0009] In some embodiments of this application, because the electrode plate is subjected to a cold pressing process during preparation, the current collector region covered by the active material layer is of relatively high ductility after being cold pressed. The second region is of relatively high ductility after being pre-calendered. Because the first region abuts the active material layer, the process limitations make it impracticable to calender the first region, and the ductility of the first region is relatively low. In a process of winding the electrode plate, the first region is located between the active material layer and the second region, and the electrode plate is prone to be raised in the second region, and is thereby warped or bent. Therefore, generally, it is preferable to minimize the area of the first region and maximize the area of the second region. Therefore, along a thickness direction of the tab, an area of a projection of the tab is $S_{\text{sub.1}}$ and an area of a projection of the second region is $S_{\text{sub.2}}$, satisfying: $60\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$. This setting reduces the warps or folds of the tab, improves the yield rate of the wound batteries as well as flatness and energy density of batteries.

[0010] In some embodiments of this application, the area of the projection satisfies $80\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$, thereby further reducing the defects such as warps and folds of the cold pressed tab and improving the yield rate of the wound electrode plates as well as the flatness and energy density of batteries.

[0011] In some embodiments of this application, the tab further includes a third region. The third region is located between the first region and the active material layer and connects the first region and the active material layer. A first insulation layer is disposed on the third region. The first insulation layer can serve an insulation function when the electrode plate is wound or stacked to form an electrode assembly, and reduce the risk of short circuits between the tab and another tab/electrode plate of an opposite polarity due to burrs piercing the separator.

[0012] In some embodiments of this application, a first boundary line exists at a junction between the first region and the second region. A minimum distance between the first boundary line and the first insulation layer is $d_{\text{sub.1}}$, satisfying: $0.1 \text{ mm} \leq d_{\text{sub.1}} \leq 1 \text{ mm}$. In this way, the first region possesses a specified width along the width direction of the electrode plate. The first region may be used as a transition region between the pre-calendered second region and the active material layer, so as to improve structural strength of a junction region between the first tab and the active material layer, reduce the risk of bending or fracture of the first tab along the junction between the first tab and the active material layer, and improve the shock resistance performance of the battery.

[0013] In some embodiments of this application, the first insulation layer satisfies at least one of the following conditions: a. a thickness of the first insulation layer is less than a thickness of the active material layer; b. along the width direction of the electrode plate, a length of the tab is $W_{\text{sub.1}}$, and a length of the first insulation layer is $W_{\text{sub.2}}$, satisfying: $W_{\text{sub.2}} / W_{\text{sub.1}} \leq 0.5$, and $W_{\text{sub.2}} \geq 1 \text{ mm}$; and, c. the first insulation layer includes an inorganic compound, and the inorganic compound is made of a material that includes at least one of aluminum oxide, magnesium oxide, or titanium oxide.

[0014] In some embodiments of this application, there are a plurality of tabs.

[0015] In some embodiments of this application, the tab is a positive tab.

[0016] An embodiment of this application further provides an electrical device, including the

battery according to any one of the embodiments described above.

[0017] In the electrical device, the tab of the battery is set to contain a first region and a second region, and the second region is calendered and pre-elongated, thereby reducing the phenomenon of breakage of the cold pressed electrode plate. This design enables a thinner current collector and/or a higher compaction density, and increases the energy density of the battery.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. 1 is a three-dimensional schematic structural diagram of a battery according to an embodiment of this application;

[0019] FIG. 2 is a schematic diagram of status of a battery to be packaged according to an embodiment of this application;

[0020] FIG. 3 is a cross-sectional view of an electrode assembly in FIG. 2 sectioned along a III-III line;

[0021] FIG. 4 is a schematic structural diagram of a first tab connected to a first electrode plate according to an embodiment of this application;

[0022] FIG. 5 is a cross-sectional view of FIG. 4 sectioned along a V-V line;

[0023] FIG. 6 is a schematic structural diagram of a structure shown in FIG. 4 according to an extended embodiment;

[0024] FIG. 7 is a cross-sectional view of FIG. 6 sectioned along a VII-VII line;

[0025] FIG. 8 is a schematic structural diagram of a structure shown in FIG. 4 according to an extended embodiment;

[0026] FIG. 9 is a cross-sectional view of FIG. 8 sectioned along an IX-IX line;

[0027] FIG. 10 is a schematic structural diagram of a structure shown in FIG. 4 according to an extended embodiment;

[0028] FIG. 11 is a cross-sectional view of FIG. 10 sectioned along an XI-XI line;

[0029] FIG. 12 is a schematic structural diagram of a structure shown in FIG. 4 according to an extended embodiment;

[0030] FIG. 13 is a schematic structural diagram of a second tab connected to a second electrode plate according to an embodiment of this application;

[0031] FIG. 14 is a cross-sectional view of FIG. 13 sectioned along an XIV-XIV line; and

[0032] FIG. 15 is a schematic structural diagram of an electrical device according to an embodiment of this application.

LIST OF REFERENCE NUMERALS

[0033] battery **100** [0034] housing **10** [0035] first part **11** [0036] second part **12** [0037] body portion **13** [0038] seal edge portion **14** [0039] top seal edge **141** [0040] side seal edge **142** [0041] electrode assembly **20** [0042] first electrode plate **21** [0043] first current collector **211** [0044] first active material layer **212** [0045] fourth region **213** [0046] second electrode plate **22** [0047] second current collector **221** [0048] second active material layer **222** [0049] separator **23** [0050] first tab **30** [0051] first region **31** [0052] second region **32** [0053] third region **33** [0054] first boundary line **34** [0055] second tab **40** [0056] first insulation layer **50** [0057] second insulation layer **60** [0058] electrical device **200** [0059] first direction Z [0060] second direction X [0061] third direction Y [0062] This application is further described below with reference to the following specific embodiments and the foregoing drawings.

DETAILED DESCRIPTION

[0063] The following describes the technical solutions in the embodiments of this application with reference to the drawings hereto. Evidently, the described embodiments are merely a part of but not all of the embodiments of this application.

[0064] It is hereby noted that a component considered to be “connected to” another component may be directly connected to the other component or may be connected to the other component through an intermediate component. A component considered to be “disposed on” another component may be directly disposed on the other component or may be disposed on the other component through an intermediate component.

[0065] Unless otherwise defined, all technical and scientific terms used herein bear the same meanings as what is normally understood by a person skilled in the technical field of this application. The terms used in the specification of this application are merely intended to describe specific embodiments but not to limit this application.

[0066] Currently, a production process of electrode plates of a battery usually includes a coating process and a cold pressing process. Through cold pressing, the electrode plates are compacted. The cold pressing is very important for improving the energy density and electrical performance of the battery. In a cold pressing process, the elongation degree differs between an active material layer region and a blank foil region in which tabs are formed. Therefore, in order to reduce the risk of deformation or warping of the tabs, the blank foil region usually needs to be stretched and elongated after the electrode plate is cold pressed. However, the stretching and elongation operations are very likely to lead to breakage of the electrode plate, thereby impairing the yield rate of the cold pressing process. To reduce the risk of breakage of the electrode plate, a conventional measure in the prior art is to use a thicker current collector or to reduce the compaction density of the electrode plate. This measure not only brings a poor effect on alleviation of the electrode plate breakage, but also results in a loss of energy density.

[0067] Some embodiments of this application provide a battery. The battery includes an electrode plate and a tab. The electrode plate includes a current collector and an active material layer disposed on the current collector. The tab is connected to the current collector. The tab protrudes beyond the electrode plate along a width direction of the electrode plate. Along the width direction of the electrode plate, the tab includes a first region and a second region. The first region is located between the second region and the active material layer, a thickness of the first region is $t_{\text{sub.1}}$, and a thickness of the second region is $t_{\text{sub.2}}$, satisfying: $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$.

[0068] In the battery, the tab is divided into a first region and a second region along the width direction of the electrode plate. The first region is located between the second region and the active material layer. The second region is pre-elongated by calendaring. The thickness $t_{\text{sub.1}}$ of the first region and the thickness $t_{\text{sub.2}}$ of the second region satisfy: $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$. The difference between the thickness of the first region and the thickness of the second region needs to be prevented from being unduly large. If the difference is unduly large, the electrode plate is prone to break due to stress concentration at the junction. If the difference is unduly small, for example, less than 0.5%, a desired elongation effect of the second region fails to be achieved, and the tab is prone to warps and folds. Therefore, the thickness $t_{\text{sub.1}}$ of the first region and the thickness $t_{\text{sub.2}}$ of the second region satisfy: $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$, so as to reduce the phenomena of breakage of the electrode plate after cold pressing. The difference between the thickness of the first region and the thickness of the second region needs to be prevented from being unduly large. If the difference is unduly large, the electrode plate is prone to break due to stress concentration at the junction. If the difference is unduly small, a desired elongation effect of the second region fails to be achieved, and the tab is prone to warps and folds.

[0069] The following further describes the embodiments of this application with reference to drawings.

[0070] As shown in FIG. 1, FIG. 2, and FIG. 3, an embodiment of this application provides a battery **100**, including a housing **10**, an electrode assembly **20**, a first tab **30**, and a second tab **40**. The electrode assembly **20** is accommodated in the housing **10**. The first tab **30** and the second tab **40** are both connected to the electrode assembly **20**, and protrude out of the housing **10**.

[0071] In an embodiment, the housing **10** includes a first part **11** and a second part **12** connected to

each other. after being connected toward each other, the first part **11** and the second part **12** can form an internal space capable of accommodating the electrode assembly **20**.

[0072] In an embodiment, the housing **10** includes a body portion **13** and a seal edge portion **14**. The seal edge portion **14** is connected to the body portion **13** and extends from the body portion **13**. The electrode assembly **20** is disposed inside the body portion **13**. The first tab **30** and the second tab **40** protrude from the seal edge portion **14**. In an embodiment, the seal edge portion **14** includes a top seal edge **141** and a side seal edge **142** connected to each other. The first tab **30** and the second tab **40** protrude from the top seal edge **141**.

[0073] In an embodiment, the first tab **30** and the second tab **40** are located on the same side of the body portion **13**. In other embodiments, the first tab **30** and the second tab **40** may be located at two opposite ends of the body portion **13** respectively (not shown in the drawing).

[0074] The electrode assembly **20** includes a first electrode plate **21**, a second electrode plate **22**, and a separator **23**. The separator **23** is disposed between the first electrode plate **21** and the second electrode plate **22**. The first electrode plate **21**, the separator **23**, and the second electrode plate **22** are wound together to form an electrode assembly **20**. The first tab **30** is connected to the first electrode plate **21**, and the second tab **40** is connected to the second electrode plate **22**. In some other embodiments, the first electrode plate **21**, the separator **23**, and the second electrode plate **22** are stacked together to form an electrode assembly **20** (not shown in the drawing).

[0075] One of the first tab **30** or the second tab **40** is a positive tab, and the other of the first tab **30** or the second tab **40** is a negative tab. In an embodiment, the first tab **30** is a positive tab and the second tab **40** is a negative tab, and the first electrode plate **21** is a positive electrode plate and the second electrode plate **22** is a negative electrode plate. In an embodiment, the first tab **30** is made of a material including aluminum. In an embodiment, the second tab **40** is made of a material including any one of copper, nickel, or nickel alloy.

[0076] As shown in FIG. 4 and FIG. 5, the first electrode plate **21** includes a first current collector **211** and a first active material layer **212** disposed on a surface of the first current collector **211**. The first tab **30** is connected to the first current collector **211**. Along a first direction Z, the first tab **30** protrudes beyond the first electrode plate **21**, where the first direction Z is the width direction of the first electrode plate **21**.

[0077] In an embodiment of this application, the first tab **30** and the first current collector **211** are formed in one piece. The first tab **30** is formed by cutting the first current collector **211**. In an embodiment, the first current collector **211** is made of a material including aluminum.

[0078] It is hereby noted that a region coated with the first active material layer **212** on the first electrode plate **21** is also referred to as a coating region. A region that exposes the first current collector **211** on the first electrode plate **21** and a region that exposes the first current collector **211** on the first tab **30** are also referred to as blank foil regions.

[0079] To improve the compaction density of the first active material layer **212** so as to improve the energy density of the battery **100**, the first electrode plate **21** needs to be cold pressed before the first tab **30** is formed from the first current collector **211** on the first electrode plate **21**. During the cold pressing, some particles of the first active material layer **212** are pressed and embedded into the first current collector **211**. Consequently, the structural strength and ductility of the first current collector **211** are decreased. When the blank foil region is stretched after cold pressing, the first current collector **211** is very prone to break, thereby impairing the yield rate of the processed electrode plates. In the technical solutions of this application, before the first electrode plate **21** is cold pressed, at least a part of blank foil region is calendered so that the first electrode plate is pre-elongated and stretched. In addition, after the first current collector **211** is cut to form the first tab **30**, the pre-calendered and elongated blank foil region forms at least a part of the first tab **30**.

[0080] The first tab **30** includes a first region **31** and a second region **32**. The first region **31** is located between the second region **32** and the first active material layer **212**. The first region **31** connects the second region **32** and the first electrode plate **21**.

[0081] The first tab **30** includes a first boundary line **34**. The first boundary line **34** is located at the junction between the first region **31** and the second region **32**. Along the first direction Z, the first region **31** and the second region **32** are located on two sides of the first boundary line **34** respectively.

[0082] In this application, the first boundary line **34** is formed by pre-calendering and elongating the first electrode plate **21**. The pre-calendered and elongated blank foil region constitutes a second region **32**. In an embodiment, the first boundary line **34** is an indentation.

[0083] Along a second direction X perpendicular to the first direction Z, the thickness of the first region **31** is $t_{\text{sub.1}}$, and the thickness of the second region **32** is $t_{\text{sub.2}}$, satisfying:

$0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$, where the second direction X is a thickness direction of the first electrode plate **21**.

[0084] In the battery **100** of this application, before cold pressing the first electrode plate **21**, a part of the blank foil region is calender so that the first electrode plate is pre-elongated and stretched, and the thickness $t_{\text{sub.1}}$ of the first region **31** that is not pre-calendered and elongated and the thickness $t_{\text{sub.2}}$ of the second region **32** that is pre-calendered and elongated satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$. The difference between the thickness of the first region **31** and the thickness of the second region **32** needs to be prevented from being unduly large. If the difference is unduly large, the electrode plate is prone to break due to stress concentration at the junction. If the difference is unduly small, for example, less than 0.5%, a desired elongation effect of the second region **32** fails to be achieved, and the first tab **30** is prone to warps and folds. After the first electrode plate **21** of this application is cold pressed, the thickness $t_{\text{sub.1}}$ of the first region **31** and the thickness $t_{\text{sub.2}}$ of the second region **32** satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$. The first electrode plate **21** provided in this application can reduce the phenomena of electrode plate breakage in contrast to other first electrode plates **21** with the blank foil region stretched and elongated after cold pressing. Moreover, the first electrode plate **21** of this application can employ a thinner first current collector **211** and a first active material layer **212** with a higher compaction density without increasing the frequency of breakage of electrode plates, thereby improving the energy density of the battery **100**.

[0085] In an embodiment, the thicknesses satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 3\%$, thereby further reducing the phenomena of breakage of the first electrode plate **21**. In this way, a thinner current collector and/or a higher compaction density can be employed, and the energy density of the battery can be improved.

[0086] In an embodiment, the thicknesses satisfy $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 1.5\%$, thereby further reducing the phenomena of breakage of the first electrode plate **21**. In an embodiment, the value of $(t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}}$ is any one of 0.5%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%, 4%, 4.5%, or 5%.

[0087] In an embodiment, along a second direction X, an area of a projection of the first tab **30** is $S_{\text{sub.1}}$, and an area of a projection of the second region **32** is $S_{\text{sub.2}}$, satisfying:

$60\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$. The first region **31** is of low ductility, and the second region **32** is of relatively high ductility after being pre-calendered. If the area of the second region **32** is unduly small, the first electrode plate **21** is prone to warps and folds during winding. Therefore, along the thickness direction of the tab **30**, an area $S_{\text{sub.1}}$ of the projection of the first tab **30** and the area $S_{\text{sub.2}}$ of the projection of the second region **32** satisfy $60\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$. This setting reduces the warps or folds of the first tab **30**, improves the flatness and energy density of batteries.

[0088] In some embodiments, the area of the projection satisfies $80\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$, thereby further reducing the warps and folds of the first tab **30** and improving the flatness and energy density of batteries.

[0089] In an embodiment, the value of $S_{\text{sub.2}} / S_{\text{sub.1}}$ is any one of 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95%, or 100%.

[0090] As shown in FIG. 6 and FIG. 7, in some embodiments, the first tab **30** further includes a

third region **33**. The third region **33** is located between the first region **31** and the first active material layer **212**. The third region **33** connects the first region **31** and the first active material layer **212**.

[0091] In an embodiment, the first tab **30** further includes a second boundary line **35**. The second boundary line **35** is located at the junction between the first region **31** and the third region **33**. Along the first direction Z, the first region **31** and the third region **33** are located on two sides of the second boundary line **35** respectively.

[0092] The battery **100** further includes a first insulation layer **50**. The first insulation layer **50** is disposed on the surface of the third region **33**. The first insulation layer **50** is connected to the first active material layer **212**. When the first electrode plate **21**, the second electrode plate **22**, and the separator **23** are wound or stacked to form an electrode assembly **20**, the first insulation layer **50** can play a role of insulation protection, reduce the risk of a short circuit between the first tab **30** and the second tab **40**, and improve the safety performance of the battery **100**. In contrast to the battery **100** without the first insulation layer **50**, the burrs at the edge of the first tab **30** are very prone to pierce the separator **23** so as to be electrically connected to the second tab **40**, resulting in a short circuit of the battery **100**. In an embodiment of this application, the first insulation layer **50** is disposed, and the first insulation layer **50** can wrap the burrs at the edge of the first tab **30**, thereby reducing the risk of a short circuit of the battery **100**.

[0093] In an embodiment, the first active material layer **212** fully covers the first current collector **211** of the first electrode plate **21**. The first insulation layer **50** is connected to the first active material layer **212**, thereby reducing the exposed area of the blank foil region, further reducing the risk of the short circuit between the first tab **30** and the second tab **40**, and improving the safety performance of the battery **100**.

[0094] As shown in FIG. **8** and FIG. **9**, in an embodiment, a fourth region **213** is disposed on the first electrode plate **21**. The fourth region **213** exposes the first current collector **211**. The fourth region **213** is located between the first active material layer **212** and the first tab **30**, and connects the first active material layer **212** and the first tab **30**. In an embodiment, the fourth region **213** is located between the first active material layer **212** and the third region **33**, and connects the first active material layer **212** and the third region **33**.

[0095] The battery **100** further includes a second insulation layer **60**. The second insulation layer **60** is disposed on the surface of the fourth region **213**. The second insulation layer **60** is connected to the first insulation layer **50** and the first active material layer **212**. When the first electrode plate **21**, the second electrode plate **22**, and the separator **23** are wound or stacked to form an electrode assembly **20**, the second insulation layer **60** can play a role of insulation, reduce the risk of a short circuit between the first electrode plate **21** and the second electrode plate **22**, and improve the safety performance of the battery **100**. In contrast to the battery **100** without the second insulation layer **60**, the burrs at the edge of the first electrode plate **21** are very prone to pierce the separator **23** so as to be electrically connected to the second electrode plate **22**, resulting in a short circuit of the battery **100**. In an embodiment of this application, the second insulation layer **60** is disposed, and the second insulation layer **60** can wrap the burrs at the edge of the first electrode plate **21**, thereby reducing the risk of a short circuit of the battery **100**.

[0096] As shown in FIG. **10** and FIG. **11**, in an embodiment, the first insulation layer **50** and the second insulation layer **60** are made of the same material. The first insulation layer **50** and the second insulation layer **60** are molded in a single pass, thereby simplifying the preparation process of the battery **100**, shortening the preparation cycle of the battery **100**, and saving cost.

[0097] For ease of understanding and description, an example is further described below in which the first insulation layer **50** is disposed on the surfaces of both the third region **33** and the fourth region **213**.

[0098] In an embodiment, along the first direction Z, a first boundary line **34** exists at a junction between the first region **31** and the second region **32**. A minimum distance between the first

boundary line **34** and the first insulation layer **50** is $d_{\text{sub.1}}$, satisfying: $0.1 \text{ mm} \leq d_{\text{sub.1}} \leq 1 \text{ mm}$. In this way, the first region **31** possesses a specified width along the first direction Z. The first region **31** may be used as a transition region between the pre-calendered second region **32** and the first tab **30**, so as to improve structural strength of a junction region between the first tab **30** and the first electrode plate **21**, reduce the risk of bending or fracture of the first tab **30** along the junction between the first tab and the first electrode plate **21**, and improve the shock resistance performance of the battery **100**.

[0099] In an embodiment, the minimum distance satisfies $0.4 \text{ mm} \leq d_{\text{sub.1}} \leq 1 \text{ mm}$, thereby further ensuring sufficient structural strength of the junction region between the first tab **30** and the first electrode plate **21**, reducing the risk of bending or fracture of the first tab **30** along the junction between the first tab and the first electrode plate **21**, and improving the shock resistance performance of the battery **100**.

[0100] In an embodiment, the value of $d_{\text{sub.1}}$ is any one of 0.1 mm, 0.2 mm, 0.3 mm, 0.4 mm, 0.5 mm, 0.6 mm, 0.7 mm, 0.8 mm, 0.9 mm, or 1 mm.

[0101] In an embodiment, along the second direction X, the thickness of the first insulation layer **50** is $t_{\text{sub.3}}$, and the thickness of the first active material layer **212** is $t_{\text{sub.4}}$, satisfying: $t_{\text{sub.3}} < t_{\text{sub.4}}$. In an embodiment, $50 \mu\text{m} \leq t_{\text{sub.4}} \leq 150 \mu\text{m}$.

[0102] In some other embodiments, $t_{\text{sub.3}} = t_{\text{sub.4}}$ (not shown in the drawing). In some other embodiments, $t_{\text{sub.3}} > t_{\text{sub.4}}$ (not shown in the drawing).

[0103] In an embodiment, along the first direction Z, the length of the first insulation layer **50** is $W_{\text{sub.2}}$, satisfying: $W_{\text{sub.2}} \geq 1 \text{ mm}$. The length range of the first insulation layer **50** along the first direction Z ensures a good protective effect of the first insulation layer **50** and reduces the risk of a short circuit of the battery **100**. In an embodiment, $W_{\text{sub.2}} \geq 2 \text{ mm}$.

[0104] In an embodiment, the length of the first tab **30** along the first direction Z is $W_{\text{sub.1}}$, satisfying $W_{\text{sub.2}}/W_{\text{sub.1}} \leq 0.5$. The specified dimensional relationship between the first tab **30** and the first insulation layer **50** along the first direction Z improves the ability of the first tab **30** to conduct current and the ability to dissipate heat, and increases the charging and discharging speed of the battery **100** and the efficiency of heat dissipation.

[0105] In an embodiment, the first insulation layer **50** includes an inorganic compound. In an embodiment, the inorganic compound is made of a material including but not limited to at least one of aluminum oxide, magnesium oxide, or titanium oxide.

[0106] In an embodiment, the weight of the first active material layer **212** is $G_{\text{sub.1}}$, satisfying: $100 \text{ g/m}^2 \leq G_{\text{sub.1}} \leq 300 \text{ g/m}^2$, where the weight $G_{\text{sub.1}}$ of the first active material layer **212** is the weight of the first active material layer **212** applied per square meter of the surface on a single side of the first current collector **211**.

[0107] In an embodiment, the compaction density of the first active material layer **212** is $D_{\text{sub.1}}$, satisfying: $2.2 \text{ g/cm}^3 \leq D_{\text{sub.1}} \leq 4.2 \text{ g/cm}^3$, where the compaction density $D_{\text{sub.1}}$ of the first active material layer **212** is the weight of the first active material layer **212** per unit volume of the cold-pressed first electrode plate **21**.

[0108] As shown in FIG. 12, in an embodiment, there are a plurality of first tabs **30**. The plurality of first tabs **30** are spaced apart along a third direction Y perpendicular to the first direction Z and the second direction X. The plurality of first tabs **30** not only improve the charging and discharging speed of the battery **100**, but also improve the heat dissipation capability of the battery **100**. Optionally, there are two first tabs **30**.

[0109] As shown in FIG. 13 and FIG. 14, the second electrode plate **22** includes a second current collector **221** and a second active material layer **222** disposed on a surface of the second current collector **221**. The second tab **40** is connected to the second current collector **221**. Along the first direction Z, the second tab **40** protrudes beyond the second electrode plate **22**.

[0110] In an embodiment, the second tab **40** and the second current collector **221** are formed in one piece. The second tab **40** is formed by cutting the second current collector **221**. In an embodiment,

the second current collector **221** is made of a material including any one of copper, nickel, or nickel alloy.

[0111] Compared to the first tab **30** and the first current collector **211**, the second tab **40** and the second current collector **221** are made of materials of higher structural strength and higher resistance to deformation. In an embodiment, after the second electrode plate **22** is cold pressed, the blank foil region does not need to be stretched or elongated. In an embodiment, before the second electrode plate **22** is cold pressed, the blank foil region does not need to be pre-calendered.

[0112] In an embodiment, before the second electrode plate **22** is cold pressed, the blank foil region on the second electrode plate **22** is pre-calendered to reduce the phenomena of breakage of the second electrode plate **22** after cold pressing. In an embodiment, the pre-calendering operation for the blank foil region on the second electrode plate **22** is the same as the pre-calendering operation for the blank foil region on the first electrode plate **21** in any one of the embodiments described above, and details of the operation is omitted here.

[0113] In an embodiment, the first electrode plate **21** is prepared in the following process: [0114] 1) Mixing 96 wt % lithium cobalt oxide, 1.5 wt % conductive carbon, and a 2.5 wt % binder evenly in an appropriate amount of solvent (such as deionized water or N-methyl-pyrrolidone) to make a slurry in which the solid content is approximately 75%; [0115] 2) Applying the slurry in step 1) to a part of the surface of the first current collector **211**, and leaving a part of the surface of the first current collector **211** to be blank and bare; [0116] 3) Drying the slurry on the surface of the first current collector **211** in step 2) to obtain the first electrode plate **21**; and [0117] 4) Pre-calendering the blank foil region on the surface of the first electrode plate **21** obtained in step 3), and then rolling the coated region of the first electrode plate **21** to obtain a first electrode plate **21**.

[0118] In an embodiment, the first tab **30** is prepared in the following process: cutting the blank foil region of the first electrode plate **21** to obtain the first tab **30** that protrudes beyond the first electrode plate **21**.

[0119] It is hereby noted that the preparation process and techniques of the first electrode plate **21** are merely an example. The ingredients of each material and the percentages of various ingredients in the material in the first electrode plate **21** are not particularly limited in this application.

[0120] To verify how the pre-calendering for the first electrode plate **21** in this application before cold pressing reduces the breakage of the electrode plate and how a thinner current collector and/or a higher compaction density of the electrode plate affects the energy density of the battery **100**, a plurality of contrast tests are conducted. The detailed test information are as follows:

[0121] A plurality of groups of first electrode plates **21** are selected for being tested in comparative embodiments versus embodiments. In the test of each comparative embodiment, the number of samples of the first electrode plate **21** is 10. In the test of each embodiment, the number of samples of the first electrode plate **21** is 10.

[0122] An average probability of breakage of each first electrode plate **21** after the blank foil region is stretched and elongated and the electrode plate is cold pressed, and an average energy density of the batteries **100** containing each first electrode plate **21** in the plurality of comparative embodiments, are obtained.

[0123] Additional details of the test in the comparative embodiments and the test in the embodiments are as follows:

Comparative Embodiment 1

[0124] The first electrode plate **21** is not pre-calendered. The blank foil region is stretched and elongated after the first electrode plate **21** is cold pressed. The coating concentration of the first active material layer **212** is 150 g/m.^{sup.2}. The compaction density of the first active material layer **212** is 3.85 g/cm.^{sup.3}.

Comparative Embodiment 2

[0125] The first electrode plate **21** is pre-calendered, and then the first electrode plate **21** is cold pressed. After the cold pressing, the blank foil region is not stretched or elongated. The coating

concentration of the first active material layer **212** is 150 g/m.sup.2, and the compaction density of the first active material layer **212** is 3.85 g/cm.sup.3. The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=10\%$. The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 0.5 mm. The ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 90%.

Comparative Embodiment 3

[0126] The only difference from Comparative Embodiment 2 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=7\%$.

Embodiment 1

[0127] The first electrode plate **21** is pre-calendered, and then the first electrode plate **21** is cold pressed. After the cold pressing, the blank foil region is not stretched or elongated. The coating concentration of the first active material layer **212** is 150 g/m.sup.2, and the compaction density of the first active material layer **212** is 3.85 g/cm.sup.3. The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=5\%$. The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 0.5 mm. The ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 90%.

[0128] The method for testing the thicknesses of the first region **31** and the second region **32** is: Selecting 3 positions in the first region **31** randomly, and measuring the thickness at each position by using a vernier caliper, and then calculating an arithmetic average of the measured thicknesses, that is, the thickness of the first region **31**. The thickness of the second region **32** is tested in the same way.

Embodiment 2

[0129] The only difference from Embodiment 1 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=3.5\%$.

Embodiment 3

[0130] The only difference from Embodiment 1 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=3.0\%$.

Embodiment 4

[0131] The only difference from Embodiment 1 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=2.5\%$.

Embodiment 5

[0132] The only difference from Embodiment 1 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=1.5\%$.

Embodiment 6

[0133] The only difference from Embodiment 1 is: The relationship between the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** is:
 $(t_{sub.1}-t_{sub.2})/t_{sub.1}=0.5\%$.

Embodiment 7

[0134] The only difference from Embodiment 6 is: The compaction density of the first active material layer **212** is 3.90 g/cm.sup.3.

Embodiment 8

[0135] The only difference from Embodiment 6 is: The compaction density of the first active material layer **212** is 4.00 g/cm.sup.3.

Embodiment 9

[0136] The only difference from Embodiment 6 is: The compaction density of the first active material layer **212** is 4.10 g/cm.sup.3.

Embodiment 10

[0137] The only difference from Embodiment 6 is: The compaction density of the first active material layer **212** is 4.20 g/cm.sup.3.

Embodiment 11

[0138] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 0.1 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 95%.

Embodiment 12

[0139] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 0.3 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 93%.

Embodiment 13

[0140] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 0.7 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 85%.

Embodiment 14

[0141] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 1.0 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 80%.

Embodiment 15

[0142] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 1.2 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 75%.

Embodiment 16

[0143] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 1.5 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 60%.

Embodiment 17

[0144] The only difference from Embodiment 6 is: The minimum distance d.sub.1 between the first boundary line **34** and the first insulation layer **50** is 1.6 mm, and the ratio of the area S.sub.2 of the second region **32** (pre-calendered region) to the area S.sub.1 of the first tab **30** is 55%.

[0145] For the plurality of comparative embodiments and embodiments, the number of breaks per unit length of each first electrode plate **21** is obtained, and the data of all the first electrode plates **21** is recorded, so as to obtain the energy density of the battery **100** containing each first electrode plate **21** and the number of folds of the first tab **30** in some embodiments.

[0146] The statistic data is made into the following table:

TABLE-US-00001 TABLE 1 Compaction Number of breaks Energy density of (t.sub.1 – of cold pressed density of active material t.sub.2)/t.sub.1 d.sub.1 S.sub.2/S.sub.1 electrode plate battery layer (g/cm.sup.3) (%) (mm) (%) (breaks/10000 m) (Wh/L) Comparative 3.85 / / / 33.0 716 Embodiment 1 Comparative 3.85 10 0.5 90 22.3 716 Embodiment 2 Comparative 3.85 7 0.5 90 18.5 716 Embodiment 3 Embodiment 1 3.85 5.0 0.5 90 5.0 716 Embodiment 2 3.85 3.5 0.5 90 4.0 716 Embodiment 3 3.85 3.0 0.5 90 3.5 716 Embodiment 4 3.85 2.5 0.5 90 3.1 716 Embodiment 5 3.85 1.5 0.5 90 2.8 716 Embodiment 6 3.85 0.5 0.5 90 2.0 716

TABLE-US-00002 TABLE 2 Compaction Number of breaks Energy density of (t.sub.1 – of cold pressed density of active material t.sub.2)/t.sub.1 d.sub.1 S.sub.2/S.sub.1 electrode plate battery layer (g/cm.sup.3) (%) (mm) (%) (breaks/10000 m) (Wh/L) Comparative 3.85 / / / 33.0 716 Embodiment 1 Embodiment 6 3.85 0.5 0.5 90 2.0 716 Embodiment 7 3.90 0.5 0.5 90 2.1 720

Embodiment 8 4.00 0.5 0.5 90 2.2 725 Embodiment 9 4.10 0.5 0.5 90 3.7 731 Embodiment 10 4.20 0.5 0.5 90 4.8 736

TABLE-US-00003 TABLE 3 Compaction Number of breaks of density of (t.sub.1 – cold pressed Frequency active material t.sub.2)/t.sub.1 d.sub.1 S.sub.2/S.sub.1 electrode plate of folding layer (g/cm.sup.3) (%) (mm) (%) (breaks/10000 m) of tab (%) Embodiment 6 3.85 0.5 0.5 90 2.0 0.000 Embodiment 11 3.85 0.5 0.1 95 1.7 0.000 Embodiment 12 3.85 0.5 0.3 93 1.5 0.000 Embodiment 13 3.85 0.5 0.7 85 2.0 0.000 Embodiment 14 3.85 0.5 1.0 80 1.8 0.000 Embodiment 15 3.85 0.5 1.2 75 2.1 0.001 Embodiment 16 3.85 0.5 1.5 60 2.1 0.002 Embodiment 17 3.85 0.5 1.6 55 2.1 0.022

[0147] As can be seen from Table 1, compared to the first electrode plate **21** that is not pre-calendered before cold pressing, the blank foil region of the first electrode plate **21** of this application is pre-calendered before cold pressing, thereby reducing the frequency of breakage of the first electrode plate **21**.

[0148] As can be seen from Table 2, the first electrode plate **21** disclosed in an embodiment of this application possesses a greater compaction strength, improves the compaction density of the first active material layer **212**, and improves the energy density of the battery **100**.

[0149] As can be seen from Table 3, the first electrode plate **21** disclosed in an embodiment of this application reduces the frequency of folding of the first tab **30**, and improves the yield rate of the battery **100**.

[0150] In summary, in the battery **100** of this application, the tab is set to include a first region **31** and a second region **32** along the width direction of the electrode plate. The first region **31** is connected to the second region **32** and the electrode plate. The second region **32** is calendered before cold pressing, so as to pre-elongate the second region. In addition, the thickness t.sub.1 of the first region **31** and the thickness t.sub.2 of the second region **32** satisfy:

$0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$, thereby reducing the phenomenon of breakage of the cold pressed electrode plate. This design enables a thinner current collector and/or a higher compaction density, and increases the energy density of the battery **100**.

[0151] As shown in FIG. **15**, an embodiment of this application further provides an electrical device **200**. The electrical device includes the battery **100** according to any one of the embodiments described above. The battery **100** can provide electrical energy for the electrical device **200**.

[0152] In an embodiment, the electrical device **200** includes electronic devices such as an unmanned aerial vehicle, a mobile phone, a watch, a tablet computer, or a laptop computer.

[0153] In the electrical device **200**, the blank foil region is pre-calendered before the first electrode plate **21** of the battery **100** is cold pressed, thereby alleviating the problem of breakage of the first electrode plate **21**. This design enables a thinner current collector and/or a higher compaction density, thereby improving the energy density of the battery **100** and alleviating the impact caused by a low energy density of the battery **100** onto the electrical device **200**.

[0154] In addition, a person skilled in the art may make other variations to this application without departing from the essence of this application. The variations made based on the essence of this application still fall within the protection scope of this application.

Claims

1. A battery, comprising: an electrode plate, the electrode plate comprises a current collector and an active material layer disposed on the current collector; a tab, connected to the current collector, and the tab protrudes beyond the electrode plate along a width direction of the electrode plate; wherein along the width direction of the electrode plate, the tab comprises a first region and a second region, the first region is located between the second region and the active material layer, a thickness of the first region is t.sub.1, and a thickness of the second region is t.sub.2, $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$.

2. The battery according to claim 1, wherein $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 3\%$.

3. The battery according to claim 1, wherein $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 1.5\%$.
 4. The battery according to claim 1, wherein, along a thickness direction of the tab, an area of a projection of the tab is $S_{\text{sub.1}}$ and an area of a projection of the second region is $S_{\text{sub.2}}$, $60\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$.
 5. The battery according to claim 4, wherein $80\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$.
 6. The battery according to claim 1, wherein along the width direction of the electrode plate, the tab further comprises a third region, the third region is located between the first region and the active material layer and connects the first region and the active material layer, a first insulation layer is disposed on the third region.
 7. The battery according to claim 6, wherein a first boundary line exists at a junction between the first region and the second region, and a minimum distance between the first boundary line and the first insulation layer is $d_{\text{sub.1}}$, and $0.1 \text{ mm} \leq d_{\text{sub.1}} \leq 1 \text{ mm}$.
 8. The battery according to claim 6, wherein a thickness of the first insulation layer is less than a thickness of the active material layer.
 9. The battery according to claim 6, wherein along the width direction of the electrode plate, a length of the tab is $W_{\text{sub.1}}$, and a length of the first insulation layer is $W_{\text{sub.2}}$, and $W_{\text{sub.2}} / W_{\text{sub.1}} \leq 0.5$, $W_{\text{sub.2}} \geq 1 \text{ mm}$.
 10. The battery according to claim 6, wherein the first insulation layer comprises an inorganic compound, and the inorganic compound is made of a material comprising at least one of aluminum oxide, magnesium oxide, or titanium oxide.
 11. The battery according to claim 1, wherein the battery comprises a plurality of tabs.
 12. The battery according to claim 1, wherein the tab is a positive tab.
 13. An electrical device, comprising a battery; the battery, comprising: an electrode plate, the electrode plate comprises a current collector and an active material layer disposed on the current collector; a tab, connected to the current collector, and the tab protrudes beyond the electrode plate along a width direction of the electrode plate; wherein along the width direction of the electrode plate, the tab comprises a first region and a second region, the first region is located between the second region and the active material layer, a thickness of the first region is $t_{\text{sub.1}}$, and a thickness of the second region is $t_{\text{sub.2}}$, $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 5\%$.
 14. The electrical device according to claim 13, wherein $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 3\%$.
 15. The electrical device according to claim 13, wherein $0.5\% \leq (t_{\text{sub.1}} - t_{\text{sub.2}}) / t_{\text{sub.1}} \leq 1.5\%$.
 16. The electrical device according to claim 13, wherein, along a thickness direction of the tab, an area of a projection of the tab is $S_{\text{sub.1}}$ and an area of a projection of the second region is $S_{\text{sub.2}}$, $60\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$.
 17. The electrical device according to claim 16, wherein $80\% \leq S_{\text{sub.2}} / S_{\text{sub.1}} \leq 95\%$.
 18. The electrical device according to claim 13, wherein along the width direction of the electrode plate, the tab further comprises a third region, the third region is located between the first region and the active material layer and connects the first region and the active material layer, a first insulation layer is disposed on the third region.
 19. The electrical device according to claim 18, wherein a first boundary line exists at a junction between the first region and the second region, and a minimum distance between the first boundary line and the first insulation layer is $d_{\text{sub.1}}$, and $0.1 \text{ mm} \leq d_{\text{sub.1}} \leq 1 \text{ mm}$.
 20. The electrical device according to claim 18, wherein the first insulation layer satisfies at least one selected characteristic from the group consisting of: a thickness of the first insulation layer is less than a thickness of the active material layer; along the width direction of the electrode plate, a length of the tab is $W_{\text{sub.1}}$, and a length of the first insulation layer is $W_{\text{sub.2}}$, $W_{\text{sub.2}} / W_{\text{sub.1}} \leq 0.5$, and $W_{\text{sub.2}} \geq 1 \text{ mm}$; and the first insulation layer comprises an inorganic compound, and the inorganic compound is made of a material that comprises at least one of aluminum oxide, magnesium oxide, or titanium oxide.
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