



(12) Utility Model Patent

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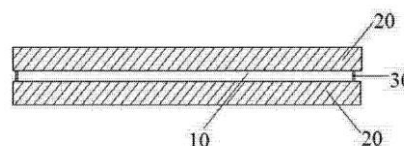
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(54) Name of Utility Model

LITHIUM-ION BATTERY POSITIVE ELECTRODE

(57) Abstract

The present utility model belongs to the field of lithium-ion battery technology and relates particularly to a lithium-ion battery positive electrode comprising a positive electrode current collector with an edge treated by gas plasma etching, and a positive electrode film disposed on a surface of the positive electrode current collector, the width of the positive electrode current collector being less than the width of the positive electrode film, an oxide layer being disposed at an edge of the positive electrode current collector. In comparison with the prior art, the lithium-ion battery positive electrode of the present utility model forms a special positive electrode structure with an “indented” the current collector by means of gas plasma etching treatment; without affecting the overall shape of the positive electrode or the integrity of the positive electrode film coating, this solution can remove cutting burrs on the positive electrode current collector, and, this solution, due to the indented structure of the positive electrode current collector and the insulation of the oxide layer on the outside, can prevent the risk of unremoved burrs or rough surfaces resulting from the etching extending out and piercing through a separator, thereby effectively ensuring the safety of the lithium-ion battery.



1. A lithium-ion battery positive electrode, comprising a positive electrode current collector with an edge treated by gas plasma etching, and a positive electrode film disposed on a surface of the positive electrode current collector, wherein the width of the positive electrode current collector is less than the width of the positive electrode film, and an oxide layer is disposed at an edge of the positive electrode current collector.
2. The lithium-ion battery positive electrode of claim 1, wherein the oxide layer has a thickness of 1-10 μm .
3. The lithium-ion battery positive electrode of claim 2, wherein the oxide layer has a thickness of 1-3 μm .
4. The lithium-ion battery positive electrode of claim 3, wherein the oxide layer has a thickness of 2 μm .
5. The lithium-ion battery positive electrode of claim 1, wherein in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 0-50 μm , the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 0-50 μm , and the left edge and the right edge of the positive electrode current collector are both located between the left edge and the right edge of the positive electrode film.
6. The lithium-ion battery positive electrode of claim 5, wherein in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 10-45 μm , and the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 10-45 μm .
7. The lithium-ion battery positive electrode of claim 6, wherein in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 30 μm , and the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 30 μm .

LITHIUM-ION BATTERY POSITIVE ELECTRODE

TECHNICAL FIELD

[0001] The present utility model belongs to the field of lithium-ion battery technology and particularly relates to a lithium-ion battery positive electrode.

BACKGROUND

[0002] As modern society develops, mobile devices, such as video cameras, laptop computers, portable DVD players, and digital cameras, have seen increasingly broad applications, and therefore the demand for high energy batteries is growing. Lithium-ion batteries offer many prominent advantages, including light weight, ample energy storage, high power, no pollution, long service life, low self-discharge coefficient, and broad temperature range; they have gained popularity and have become the best power sources for mobile devices, and they are also gradually replacing other conventional batteries in aviation, space, seafaring, automobiles, and medical devices, and other fields.

[0003] A lithium-ion battery typically comprises a number of sequentially stacked battery cells inside, and each battery cell comprises a positive electrode, a separator, and a negative electrode wound or stacked together; here, the separator is placed between adjacent positive and negative electrodes to block the flow of electrons, allow the passage of ions, and retain an electrolyte. The positive electrode comprises a positive electrode current collector made typically of aluminum foil, and a positive electrode film attached to the positive electrode current collector and containing a positive electrode active material; the negative electrode comprises a negative electrode current collector made typically of copper foil, and a negative electrode film attached to the negative electrode current collector and containing a negative electrode active material; the separator is a microporous film made from steps such as plasticization and extraction; a structure like this is conducive to the retention of lithium-salt-containing organic solvent electrolyte by the separator. To manufacture a lithium-ion battery, one simply needs to make one or more of the aforementioned battery cells into a battery core, wrap a packaging film around the battery core on the outside, inject the electrolyte into the packaging, and performing vacuuming and sealing. At present, the electrolyte used in lithium-ion batteries is a flammable organic electrolyte; therefore, secondary lithium-ion batteries have very high safety requirements.

[0004] The process for preparing lithium-ion battery electrodes typically comprises, steps such as slurry preparation, coating, drying, calendering, and cutting; although the manufacturing steps of different manufacturers or different batteries may vary, electrode cutting is an indispensable step. Most lithium-ion batteries use aluminum foil for their positive electrode current collectors, and aluminum, due to its own nature, is prone to have burrs at cut edges. As illustrated in FIG. 1, on a positive electrode 200, an aluminum foil 220 serving as a positive electrode current collector have edges that are level with or slightly protrude over edges of a positive electrode film 240 and have some burrs that resulted from cutting; therefore, when this positive electrode 200 is stacked with a separator and a negative electrode, the cutting burrs on the aluminum foil 220 can easily pierce through the separator and thereby come into contact with its adjacent negative electrode film and short-circuit. A short-circuited battery will rapidly increase in temperature, which leads to the flammable organic electrolyte catching fire or even causes the battery to explode.

[0005] To remove burrs on edges of the positive electrode, a Chinese patent application with the application number of CN200910036707.7 discloses a method for removing burrs by soaking a positive electrode winding material with an alkaline liquid. Although this wet treatment method can remove burrs at cut edges of a positive electrode current collector, it has challenges such as capillary action and

difficult implementation steps. Moreover, after soaking by the alkaline liquid, edges of the winding material may produce some burrs; in other words, new burrs are formed at the same time when old burrs are removed; so safety hazards remain.

[0006] Therefore, it is indeed necessary to provide a lithium-ion battery positive electrode whose positive electrode current collector has much fewer or even no burrs at its edges, so that the safety of a battery using the positive electrode is greatly improved.

SUMMARY

[0007] The purpose of the present utility model is as follows: in view of shortcomings in the prior art, the present utility model aims to provide a lithium-ion battery positive electrode whose positive electrode current collector has much fewer or even no burrs at its edges, so that the safety of a battery using the positive electrode is greatly improved.

[0008] To achieve the above purpose, the present utility model provides the following technical solution: a lithium-ion battery positive electrode, comprising a positive electrode current collector with an edge treated by gas plasma etching, and a positive electrode film disposed on a surface of the positive electrode current collector, the width of the positive electrode current collector being less than the width of the positive electrode film, an oxide layer being disposed at an edge of the positive electrode current collector.

[0009] In an improved lithium-ion battery positive electrode of the present utility model, the oxide layer has a thickness of 1-10 μm .

[0010] In an improved lithium-ion battery positive electrode of the present utility model, the oxide layer has a thickness of 1-3 μm .

[0011] In an improved lithium-ion battery positive electrode of the present utility model, the oxide layer has a thickness of 2 μm .

[0012] In an improved lithium-ion battery positive electrode of the present utility model, in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 0-50 μm , the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 0-50 μm , and the left edge and the right edge of the positive electrode current collector are both located between the left edge and the right edge of the positive electrode film.

[0013] In an improved lithium-ion battery positive electrode of the present utility model, in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 10-45 μm , and the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 10-45 μm .

[0014] In an improved lithium-ion battery positive electrode of the present utility model, in the widthwise direction, the distance between the left edge of the positive electrode current collector and the left edge of the positive electrode film is 30 μm , and the distance between the right edge of the positive electrode current collector and the right edge of the positive electrode film is 30 μm .

[0015] In comparison with the prior art, the lithium-ion battery positive electrode of the present utility model forms a special positive electrode structure with an "indented" current collector (i.e., the width of the positive electrode current collector is less than the width of the positive electrode film) by means of

gas plasma etching treatment; without affecting the overall shape of the positive electrode or the integrity of the positive electrode film coating, this solution can remove cutting burrs on the positive electrode current collector, and, this solution, due to the indented structure of the positive electrode current collector and the insulation of the oxide layer on the outside, can prevent the risk of unremoved burrs or rough surfaces resulting from the etching extending out and piercing through a separator, thereby effectively ensuring the safety of the lithium-ion battery.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A detailed description is provided below, in conjunction with drawings and embodiments, on the present utility model and its beneficial technical effects.

[0017] FIG. 1 is a structural diagram illustrating a positive electrode in the prior art.

[0018] FIG. 2 is a top-view diagram illustrating the present utility model.

[0019] FIG. 3 is a cross-section diagram illustrating the present utility model.

[0020] FIG. 4 is a structural diagram illustrating an apparatus for removing burrs on a positive electrode current collector according to one embodiment of the present utility model.

DETAILED DESCRIPTION

[0021] As illustrated in FIGs. 2 and 3, the present utility model provides a lithium-ion battery positive electrode, comprising a positive electrode current collector 10 with an edge treated by gas plasma etching, and a positive electrode film 20 disposed on a surface of the positive electrode current collector 10; the width of the positive electrode current collector 10 is less than the width of the positive electrode film 20, and an oxide layer 30 is disposed at an edge of the positive electrode current collector 10. Having the oxide layer 30 disposed can prevent the risk of unremoved burrs or rough surfaces resulting from the etching extending out and piercing through a separator.

[0022] Here, the oxide layer 30 has a thickness of 1-10 μm . If the oxide layer 30 is too thin, it will not be able to effectively prevent the risk of unremoved burrs or rough surfaces resulting from the etching extending out and piercing through the separator. However, if the oxide layer 30 is too thick, it will result in unnecessary waste of materials.

[0023] A preferred range of the thickness of the oxide layer 30 is 1-3 μm .

[0024] A more optimal thickness of the oxide layer 30 is 2 μm . The oxide layer 30 may be disposed at the edge of the positive electrode current collector 10 by means of by means such as sputtering, vacuum plating, or coating.

[0025] In the widthwise direction, the distance between the left edge of the positive electrode current collector 10 and the left edge of the positive electrode film 20 is 0-50 μm (i.e. the etch depth); the distance between the right edge of the positive electrode current collector 10 and the right edge of the positive electrode film 20 is 0-50 μm ; and the left edge and the right edge of the positive electrode current collector 10 are both located between the left edge and the right edge of the positive electrode film 20. The etch depth

is in the range of 0-50 μm . The limitation on the etch depth is to ensure that the burrs are removed without causing damage to the positive electrode. The larger the distance of indentation, the better the safety performance because burrs that may not have been removed and rough bumps that resulted from the gas etching are all covered by the film on the outside. However, if the distance is too large, the film will lack support on its edge by the current collector and fall off. Moreover, when the etch depth is too great, it will cause unnecessary damage to an area on the positive electrode current collector 10 that is not covered by a positive electrode active material, thereby affecting tab welding in a subsequent step. Therefore, a more optimal distance of indentation is 0-50 μm .

[0026] Preferably, in the widthwise direction, the distance between the left edge of the positive electrode current collector 10 and the left edge of the positive electrode film 20 is 10-45 μm ; and the distance between the right edge of the positive electrode current collector 10 and the right edge of the positive electrode film 20 is 10-45 μm .

[0027] More preferably, in the widthwise direction, the distance between the left edge of the positive electrode current collector 10 and the left edge of the positive electrode film 20 is 30 μm ; and the distance between the right edge of the positive electrode current collector 10 and the right edge of the positive electrode film 20 is 30 μm .

[0028] During specific operation, a plasma created from gas ionization bombards burrs on the positive electrode current collector 10 (the burrs being aluminum or aluminum oxide) at a high speed and reacts chemically with the burrs to remove the burrs at the cut edge of the positive electrode current collector 10 and, at the same time, to produce an indented structure for the positive electrode current collector 10, and an oxide layer is disposed on its outside by means such as coating for insulation. An apparatus for removing burrs on the positive electrode current collector 10 is illustrated in FIG. 4; the apparatus comprises a vacuum chamber 1, a rotatable tray rack 3 for placement of a positive electrode 2, a gas distribution system 4, a ionization chamber 5, a plasma generator 6, a negative bias power supply 7, and a vacuum control system 8 for exhaust gas treatment; the rotatable tray rack 3 is disposed inside the vacuum chamber 1; the ionization chamber 5 is located between the plasma generator 6 and the vacuum chamber 1 and is connected to the gas distribution system 4; the negative bias power supply 7 is connected to the ionization chamber 5 and the rotatable tray rack 3, respectively; and the vacuum control system 8 is connected to the vacuum chamber 1.

[0029] Here, the plasma generator 6 comprises a radio frequency power supply 61 and an electrode 62; the electrode 62 is connected to the ionization chamber 5, and the electrode 62 is electrically connected to the radio frequency power supply 61.

[0030] In actual application, first, an edge of a positive electrode that had been die-cut was placed under a scanning electron microscope for observation; it was observed that the cut edge of the positive electrode current collector 10 had burrs, and the lengths of the burrs were in the range of 0-30 μm .

[0031] Next, the positive electrode was wound and placed on the rotatable tray rack 3; the tray was placed into the sealed vacuum chamber 1; a gas mixture (Cl_2 , BCl_3 , Ar, and O_2) flew from the gas distribution system 4 into the ionization chamber 5 at a volume ratio of (1-5):(1-5):(0.5-2):(5-15); and the electrode 62 of the plasma generator 6 produced an adequately strong magnetic field at the action of the radio frequency power supply 61 and converted the gas mixture that had entered into the ionization chamber 5 into a plasma.

[0032] The negative bias power supply 7 formed an electric field between the ionization chamber 5 and the positive electrode; the plasma in the ionization chamber 5, at the action of the electric field, entered into the vacuum chamber 1, bombarded the positive electrode at a high speed, and reacted with the burrs (which were aluminum or aluminum oxide) at the cut edge of the exposed positive electrode current collector 10.

of the positive electrode with a reaction time of 20-60 minutes, so as to remove the burrs from the positive electrode. The equations for the chemical reactions between these gases and the burrs are, respectively: $\text{Al}_2\text{O}_3 + 3\text{BCl}_3 \rightarrow 2\text{AlCl}_3 + 3\text{BOCl}$ (1); $2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$ (2); $2\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$ (3).

[0033] Products of the reactions were drawn and discharged by the vacuum control system 8 and went through exhaust gas treatment. The aforementioned gases did not react with the positive electrode film 20 or the positive electrode active material therein; therefore, the process of burr removal hardly had any negative impact on the positive electrode film 20. Finally, an oxide layer 30 for insulation was formed on the outside of the positive electrode current collector 10 by means such as coating.

[0034] After the treatment, as illustrated in FIG. 3, the cut edge on the positive electrode current collector 10 and the burrs thereon were all removed by the etching. The edge of the positive electrode after the plasma gas treatment was once again placed under a scanning electron microscope for observation; it was observed that there were no burrs at the cut edge of the positive electrode current collector 10, that the edge of the positive electrode current collector 10 was smooth, that there were some micro serrations (resulting from the gas etching), and that the distance of indentation of the positive electrode current collector 10 was 0-50 μm .

[0035] The positive electrode film 20 did not react with the treatment gases; therefore, at this time, the width of the positive electrode current collector 10 was less than that of the separator, and the edge of the positive electrode current collector 10 had receded below the separator. And, the burrs on the positive electrode current collector 10 had been completely removed, and the oxide layer 30 for insulation was formed by passivation on the outside of the positive electrode current collector 10; therefore, it would be impossible to have short-circuit safety incidents anymore caused by the positive electrode current collector 10 piercing through the separator and coming into contact with the negative electrode film of the negative electrode. Moreover, even if the separator were damaged by other causes, the positive electrode current collector 10 receded below the positive electrode film 20 would hardly come into contact with the negative electrode film; therefore, the positive electrode of the present utility model can effectively ensure the safety of the lithium-ion battery.

[0036] Additionally, the aforementioned gases and other substances in the battery cell, such as the negative electrode current collector, the negative electrode film, the negative electrode active material, and the separator between the positive and negative electrodes, do not react with each other chemically or have very low levels of chemical reactivity.

[0037] As described above, the present utility model, by employing the plasma etching treatment method, removes the cut edge and burrs of the positive electrode current collector 10 without affecting the shape of the edge of the positive electrode or the integrity of the positive electrode film 20 coating. After the treatment, the positive electrode current collector 10 is less wide than the positive electrode film 20 and cannot be exposed at the edge of the positive electrode; therefore, it will not be able to pierce through the separator and short-circuit on contact with the negative electrode film; even when the separator is damaged by other causes, the positive electrode current collector will not come into contact with the negative electrode film, thereby effectively improving the safety performance of the lithium-ion battery.

[0038] It needs to be noted that although the description only offered the example of Cl_2 , BCl_3 , Ar, and O_2 for gases in the idea of the present utility model, persons of skill in the art may, based on the disclosure of the description, alternatively use other gases that affect neither the external shape of the edge of the positive electrode nor the integrity of the positive electrode film coating. Additionally, the description does not exclude the use of a similar dry treatment method to perform etching treatment on the negative electrode to remove burrs at an edge of the negative electrode after current collector cutting.

[0039] That persons of skill in the art to which the present utility model belongs may make suitable alterations and modifications to the aforementioned embodiments based on disclosures and instructions in the description above. Therefore, the present utility model is not limited to the embodiments disclosed and described above, and modifications and alterations of the present utility model shall also fall within the scope of protection of the claims of the present utility model. Moreover, although certain terminology is used in the description, such terminology simply facilitates the description and does not limit the present utility model in any way.

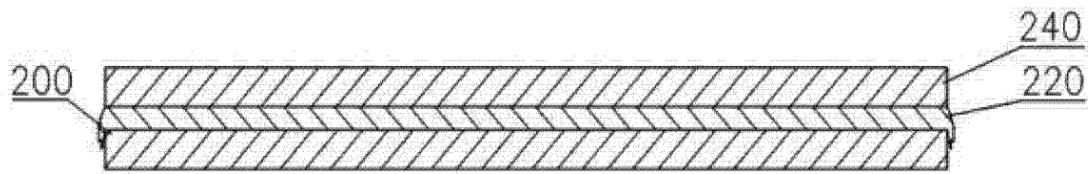


FIG. 1

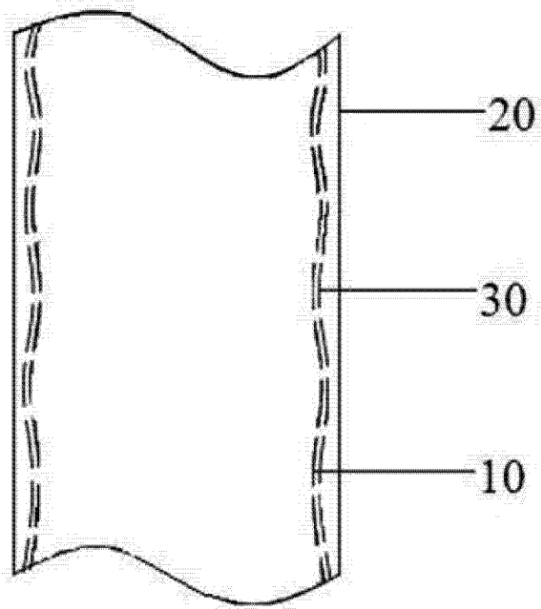


FIG. 2

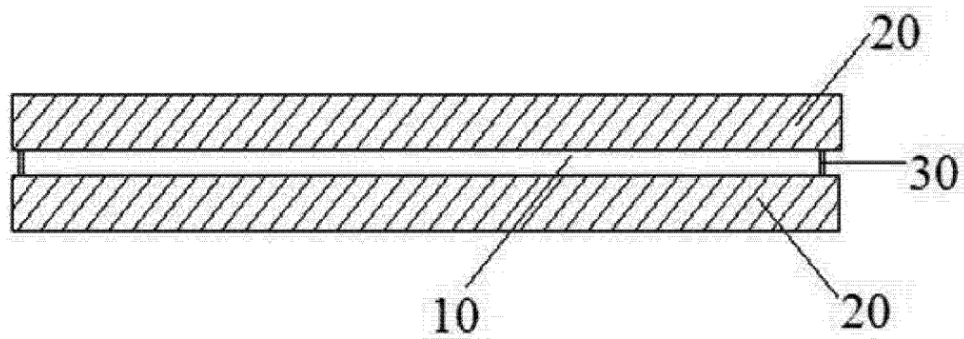


FIG. 3

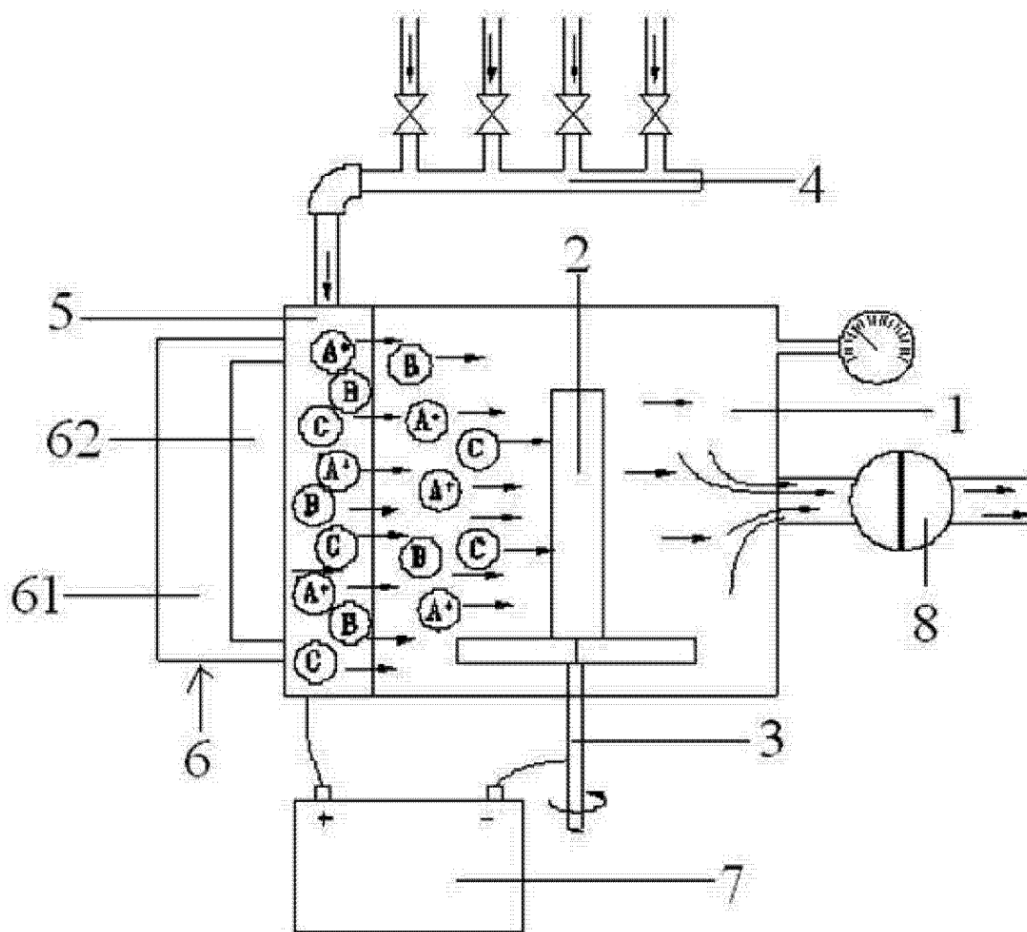


FIG. 4



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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) CN202839841U to the best of my abilities.

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Date: January 18, 2023

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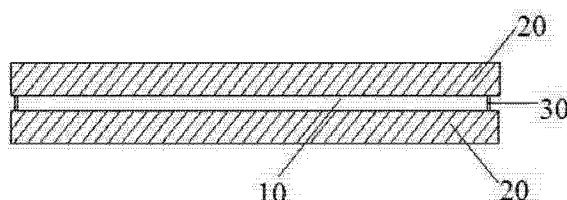
权利要求书 1 页 说明书 4 页 附图 2 页

(54) 实用新型名称

一种锂离子电池正极极片

(57) 摘要

本实用新型属于锂离子电池技术领域,尤其涉及一种锂离子电池正极极片,包括其边缘经气体等离子体刻蚀处理的正极集流体和设置于所述正极集流体表面的正极膜片,所述正极集流体的宽度小于所述正极膜片的宽度,所述正极集流体的边缘设置有氧化层。相对于现有技术,本实用新型的锂离子电池正极极片通过气体等离子体刻蚀处理的方法,形成集流体“缩进”的特殊的正极极片结构,在不影响正极极片整体形状且保持正极膜片涂层完整的情况下,一方面可以将正极集流体的切割毛刺去除,另一方面正极集流体的缩进结构和其外侧的氧化层的绝缘作用,可以避免未除尽的毛刺或由于刻蚀产生的粗糙表面伸出从而刺破隔离膜的风险,有效保证锂离子电池的安全。



1. 一种锂离子电池正极极片,包括其边缘经气体等离子体刻蚀处理的正极集流体和设置于所述正极集流体表面的正极膜片,其特征在于:所述正极集流体的宽度小于所述正极膜片的宽度,所述正极集流体的边缘设置有氧化层。

2. 根据权利要求1所述的锂离子电池正极极片,其特征在于:所述氧化层的厚度为 $1\sim 10\mu\text{m}$ 。

3. 根据权利要求2所述的锂离子电池正极极片,其特征在于:所述氧化层的厚度为 $1\sim 3\mu\text{m}$ 。

4. 根据权利要求3所述的锂离子电池正极极片,其特征在于:所述氧化层的厚度为 $2\mu\text{m}$ 。

5. 根据权利要求1所述的锂离子电池正极极片,其特征在于:在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $0\sim 50\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $0\sim 50\mu\text{m}$,并且所述正极集流体的左边缘和右边缘均位于所述正极膜片的左边缘和右边缘之间。

6. 根据权利要求5所述的锂离子电池正极极片,其特征在于:在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $10\sim 45\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $10\sim 45\mu\text{m}$ 。

7. 根据权利要求6所述的锂离子电池正极极片,其特征在于:在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $30\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $30\mu\text{m}$ 。

一种锂离子电池正极极片

技术领域

[0001] 本实用新型属于锂离子电池技术领域,尤其涉及一种锂离子电池正极极片。

背景技术

[0002] 随着现代社会的发展,各种移动设备,如摄像机、笔记本电脑、便携式 DVD 和数码相机等都有了越来越广泛的应用,因此,对高能电池的需求也越来越大。锂离子电池因具有重量轻、储能大、功率大、无污染、寿命长、自放电系数小、温度适应范围宽泛等许多突出的优点,逐渐受到人们的青睐,成为移动设备的最佳电源,甚至在航空、航天、航海、汽车、医疗设备等领域中也逐步取代了其他的传统电池。

[0003] 锂离子电池内一般包括若干个依次叠加的电池单体,每个电池单体包括相互卷绕或叠加的正极极片、隔离膜和负极片,其中,隔离膜间隔于相邻的正、负极片之间,起到电子阻隔、离子导通的作用,同时用于保持电解液。正极极片包括一般采用铝箔制作的正极集流体和附着在正极集流体上、含有正极活性物质的正极膜片;负极片包括一般采用铜箔制作的负极集流体和附着在负极集流体上、含有负极活性物质的负极膜片;隔离膜则为采用塑化、萃取等工艺制成的微孔薄膜,这样的结构有利于隔离膜对含有锂盐的有机溶剂电解液的保持。制造锂离子电池时,只要将一个或多个上述的电池单体制成电池芯,并在电池芯的外面包裹上包装薄膜,之后向其内注入电解液,经过抽空、密封即可。由于目前锂离子电池所使用的电解液为易燃的有机电解液,所以二次锂离子电池对安全性要求很高。

[0004] 锂离子电池的极片制备过程,通常包括制浆、涂膜、干燥、压型、切割等工序,虽然不同厂商或不同电池的制造工序可能会有所变化,但极片切割都是必不可少的工序。由于锂离子电池大都采用铝箔作为正极集流体,铝自身的特性决定其切割时容易在边缘处产生毛刺。如图 1 所示,正极极片 200 上作为正极集流体的铝箔 220 边缘与正极膜片 240 的边缘平齐或稍微突出于正极膜片 240 的边缘并且有一些切割产生的毛刺,因此将该正极极片 200 与隔离膜和负极片叠加后,铝箔 220 的切割毛刺就易于刺破隔离膜,以致与相邻的负极膜片接触而发生短路。短路的电池会迅速升温,从而导致易燃的有机电解液着火,甚至导致电池发生爆炸。

[0005] 为了去除正极极片边缘的毛刺,申请号为 CN200910036707.7 的中国专利申请公开了一种将正极极片卷料用碱液浸泡来去除毛刺的方法。该湿法处理虽然也可以将正极集流体切割边缘的毛刺去除,但是存在毛细现象以及工序实现困难等问题。而且,用碱液浸泡后的卷料边缘可能还会产生一定的毛刺,也就是说,在去毛刺的同时又会产生毛刺,还是有一定的安全隐患。

[0006] 有鉴于此,确有必要提供一种锂离子电池正极极片,该正极极片正极集流体的边缘毛刺大大减少甚至没有,从而大大提高使用该正极极片的电池的安全性。

实用新型内容

[0007] 本实用新型的目的在于:针对现有技术的不足,而提供一种锂离子电池正极极片,

该正极极片的正极集流体的边缘毛刺大大减少甚至没有,从而大大提高使用该正极极片的电池的安全性。

[0008] 为了达到上述目的,本实用新型采用如下技术方案:一种锂离子电池正极极片,包括其边缘经气体等离子体刻蚀处理的正极集流体和设置于所述正极集流体表面的正极膜片,所述正极集流体的宽度小于所述正极膜片的宽度,所述正极集流体的边缘设置有氧化层。

[0009] 作为本实用新型锂离子电池正极极片的一种改进,所述氧化层的厚度为 $1\sim 10\mu\text{m}$ 。

[0010] 作为本实用新型锂离子电池正极极片的一种改进,所述氧化层的厚度为 $1\sim 3\mu\text{m}$ 。

[0011] 作为本实用新型锂离子电池正极极片的一种改进,所述氧化层的厚度为 $2\mu\text{m}$ 。

[0012] 作为本实用新型锂离子电池正极极片的一种改进,在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $0\sim 50\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $0\sim 50\mu\text{m}$,并且所述正极集流体的左边缘和右边缘均位于所述正极膜片的左边缘和右边缘之间。

[0013] 作为本实用新型锂离子电池正极极片的一种改进,在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $10\sim 45\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $10\sim 45\mu\text{m}$ 。

[0014] 作为本实用新型锂离子电池正极极片的一种改进,在宽度方向上,所述正极集流体的左边缘与所述正极膜片的左边缘之间的距离为 $30\mu\text{m}$,所述正极集流体的右边缘与所述正极膜片的右边缘之间的距离为 $30\mu\text{m}$ 。

[0015] 相对于现有技术,本实用新型的锂离子电池正极极片通过气体等离子体刻蚀处理的方法,形成集流体“缩进”的特殊正极极片结构(即正极集流体的宽度小于正极膜片的宽度),在不影响正极极片整体形状且保持正极膜片涂层完整的情况下,一方面可以将正极集流体的切割毛刺去除,另一方面正极集流体的缩进结构及其外侧的氧化层的绝缘作用,可以避免未除尽的毛刺或由于刻蚀产生的粗糙表面伸出从而刺破隔离膜的风险,有效保证锂离子电池的安全。

附图说明

[0016] 下面结合附图和各个具体实施方式,对本实用新型及其有益技术效果进行详细说明。

[0017] 图 1 为现有技术中的正极极片的结构示意图。

[0018] 图 2 为本实用新型的俯视示意图。

[0019] 图 3 为本实用新型的剖视示意图。

[0020] 图 4 为本实用新型具体实施方式中去除正极集流体上的毛刺所采用的装置的结构示意图。

具体实施方式

[0021] 如图 2 和图 3 所示,本实用新型提供的一种锂离子电池正极极片,包括其边缘经气体等离子体刻蚀处理的正极集流体 10 和设置于正极集流体 10 表面的正极膜片 20,正极集流体 10 的宽度小于正极膜片 20 的宽度,正极集流体 10 的边缘设置有氧化层 30。氧化层

30 的设置可以避免未除尽的毛刺或由于刻蚀产生的粗糙表面伸出从而刺破隔离膜的风险。

[0022] 其中,氧化层 30 的厚度为 $1\sim 10\mu\text{m}$ 。若氧化层 30 的厚度太小,无法有效避免未除尽的毛刺或由于刻蚀产生的粗糙表面伸出从而刺破隔离膜的风险。而若氧化层 30 的厚度太大,又会造成不必要的材料的浪费。

[0023] 氧化层 30 的厚度为 $1\sim 3\mu\text{m}$,这是优选的范围。

[0024] 氧化层 30 的厚度为 $2\mu\text{m}$,这是较佳的而选择。氧化层 30 可以通过喷溅、真空镀层或涂覆等方式设置在正极集流体 10 的边缘。

[0025] 在宽度方向上,正极集流体 10 的左边缘与正极膜片 20 的左边缘之间的距离为 $0\sim 50\mu\text{m}$ (即蚀刻深度),正极集流体 10 的右边缘与正极膜片 20 的右边缘之间的距离为 $0\sim 50\mu\text{m}$,并且正极集流体 10 的左边缘和右边缘均位于正极膜片 20 的左边缘和右边缘之间。刻蚀深度在 $0\sim 50\mu\text{m}$ 范围内。刻蚀深度的限定是为了既保证达到去除毛刺的目的,又不破坏正积极片。缩进距离越大,可能未被除尽的毛刺以及由气体刻蚀产生的粗糙凸起都会被外层的膜片包裹住,安全性能越好。但距离太大会导致膜片的边缘没有集流体支撑,出现脱落。而且刻蚀深度太大,会对正极集流体 10 上无正极活性物质的区域产生不应该的破坏,影响后续工序的极耳焊接。因此缩进的距离在 $0\sim 50\mu\text{m}$ 是较优的结果。

[0026] 优选的,在宽度方向上,正极集流体 10 的左边缘与正极膜片 20 的左边缘之间的距离为 $10\sim 45\mu\text{m}$,正极集流体 10 的右边缘与正极膜片 20 的右边缘之间的距离为 $10\sim 45\mu\text{m}$ 。

[0027] 更优选的,在宽度方向上,正极集流体 10 的左边缘与正极膜片 20 的左边缘之间的距离为 $30\mu\text{m}$,正极集流体 10 的右边缘与正极膜片 20 的右边缘之间的距离为 $30\mu\text{m}$ 。

[0028] 具体操作时,通过气体电离产生等离子体高速轰击并与正极集流体 10 上的毛刺(毛刺为铝或铝的氧化物)发生化学反应以除去正极集流体 10 切割边缘的毛刺,同时产生正极集流体 10 缩进的结构且其外侧通过涂覆等方式设置有一层氧化层起绝缘作用。去除正极集流体 10 上的毛刺所采用的装置如图 4 所示,该装置包括真空腔体 1、用于放置正积极片 2 的可旋转的托盘架 3、气体分配系统 4、电离腔体 5、等离子体发生器 6、负偏压电源 7 和用于进行尾气处理的真空控制系统 8,可旋转的托盘架 3 设置于真空腔体 1 内,电离腔体 5 位于等离子体发生器 6 和真空腔体 1 之间并且与气体分配系统 4 连接,负偏压电源 7 分别与电离腔体 5 和可旋转的托盘架 3 电连接,真空控制系统 8 与真空腔体 1 连接。

[0029] 其中,等离子体发生器 6 包括射频电源 61 和电极 62,电极 62 与电离腔体 5 连接,电极 62 与射频电源 61 电连接。

[0030] 实际使用时,先将经过刀模组件切割的正积极片的边缘置于电子扫描显微镜下观察,发现正极集流体 10 切痕边缘出现毛刺,毛刺长度范围在 $0\sim 30\mu\text{m}$ 之间。

[0031] 再将正积极片卷绕放置在可以旋转的托盘架 3 上,此托盘置于密封的真空腔体 1 内,气体混合物(Cl_2 、 BCl_3 、Ar 和 O_2)由气体分配系统 4 按照体积比例 $(1\sim 5):(1\sim 5):(0.5\sim 2):(5\sim 15)$ 流入电离腔体 5 内,等离子体发生器 6 的电极 62 在射频电源 61 的作用下产生足够强的磁场,将进入电离腔体 5 的气体混合物变成等离子体。

[0032] 负偏压电源 7 在电离腔体 5 和正积极片间形成电场,电离腔体 5 内的等离子体在电场作用下进入真空腔体 1,高速轰击正积极片,并与正积极片中裸露的正极集流体 10 切痕边缘的毛刺(毛刺成分为铝或铝的氧化物)发生反应,反应时间为 $20\sim 60\text{min}$,从而将正积极片上的毛刺除去。这些气体与毛刺发生化学反应的方程式分别为: $\text{Al}_2\text{O}_3 + 3\text{BCl}_3 \rightarrow$

$2\text{AlCl}_3 + 3\text{BOCl} \quad (1); 2\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3 \quad (2); 2\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \quad (3)$ 。

[0033] 反应后的产物由真空控制系统 8 抽吸排出并经过尾气处理。由于上述气体物质并不与正极膜片 20 及其中的正极活性物质发生反应,因此去毛刺过程基本上不会对正极膜片 20 造成不良影响。最后在正极集流体 10 的外侧通过涂覆等方式形成一层起绝缘作用的氧化层 30。

[0034] 在处理,如图 3 所示,正极集流体 10 上的切割边缘及其上的毛刺都被刻蚀去掉。将经过等离子气体处理后的正极极片的边缘再次置于电子扫描显微镜下观察,发现正极集流体 10 的切痕边缘已无毛刺,正极集流体 10 的边缘光滑,部分微锯齿状突起(由气体刻蚀导致),正极集流体 10 的缩进距离为 $0 \sim 50 \mu\text{m}$ 。

[0035] 由于正极膜片 20 并不与处理气体反应,所以此时正极集流体 10 的宽度短于隔离膜,其边缘已缩入隔离膜内,而且由于正极集流体 10 上的毛刺也已经完全去除,并在正极集流体 10 的外侧钝化形成一层起绝缘作用的氧化层 30,因此不可能再发生正极集流体 10 刺破隔离膜后与负极极片的负极膜片接触短路的安全事故。而且,即使隔离膜由于其他原因发生了破损,缩入正极膜片 20 内的正极集流体 10 也很难接触到负极膜片,因此本实用新型的正极极片能够有效保证锂离子电池的安全。

[0036] 另外,上述气体物质与电池单体中的其他物质,如负极集流体、负极膜片、负极活性物质、正负极片间的隔离膜等,都不发生化学反应,或者是发生化学反应的活性很低。

[0037] 综上所述,本实用新型通过等离子刻蚀处理的方法,在不影响正极极片边缘形状且保持正极膜片 20 涂层完整的情况下,将正极集流体 10 的切割边缘和毛刺同时去除,处理后作为正极集流体 10 的宽度比正极膜片 20 还短,无法暴露在正极极片边缘,因此不会再刺破隔离膜而与负极膜片发生短路,甚至在隔离膜由于其他原因破损的情况下,也不会与负极膜片接触,从而有效提高锂离子电池的安全性能。

[0038] 需要说明的是,虽然本说明书仅仅以 Cl_2 、 BCl_3 、Ar、 O_2 为例对本实用新型构思中的气体物质进行说明,但是本领域的技术人员根据本说明书的揭示,也可以采用不影响正极极片边缘外形和不影响正极膜片涂层完整的其他气体物质。另外,不排除采用相类似的干法处理方法对负极极片进行刻蚀处理去掉负极极片边缘集流体切割后的毛刺。

[0039] 根据上述说明书的揭示和教导,本实用新型所属领域的技术人员还可以对上述实施方式适当的变更和修改。因此,本实用新型并不局限于上面揭示和描述的具体实施方式,对本实用新型的一些修改和变更也应当落入本实用新型的权利要求的保护范围内。此外,尽管本说明书中使用了一些特定的术语,但这些术语只是为了方便说明,并不对本实用新型构成任何限制。

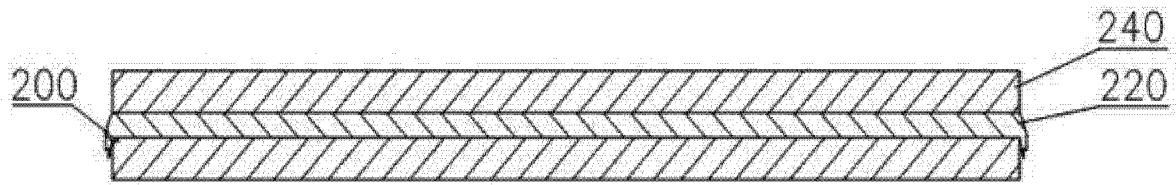


图 1

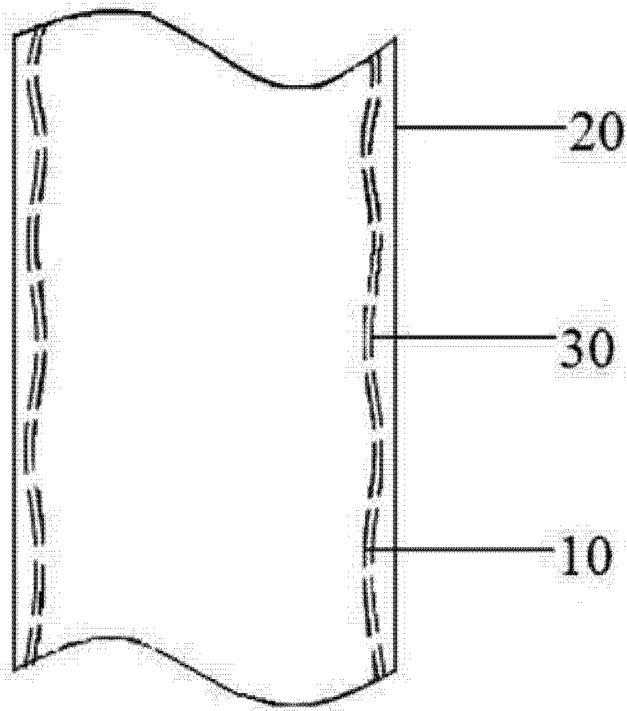


图 2

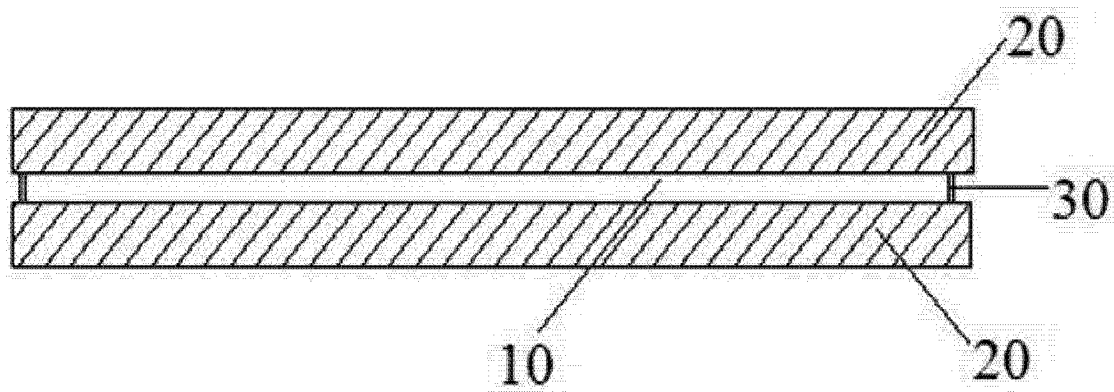


图 3

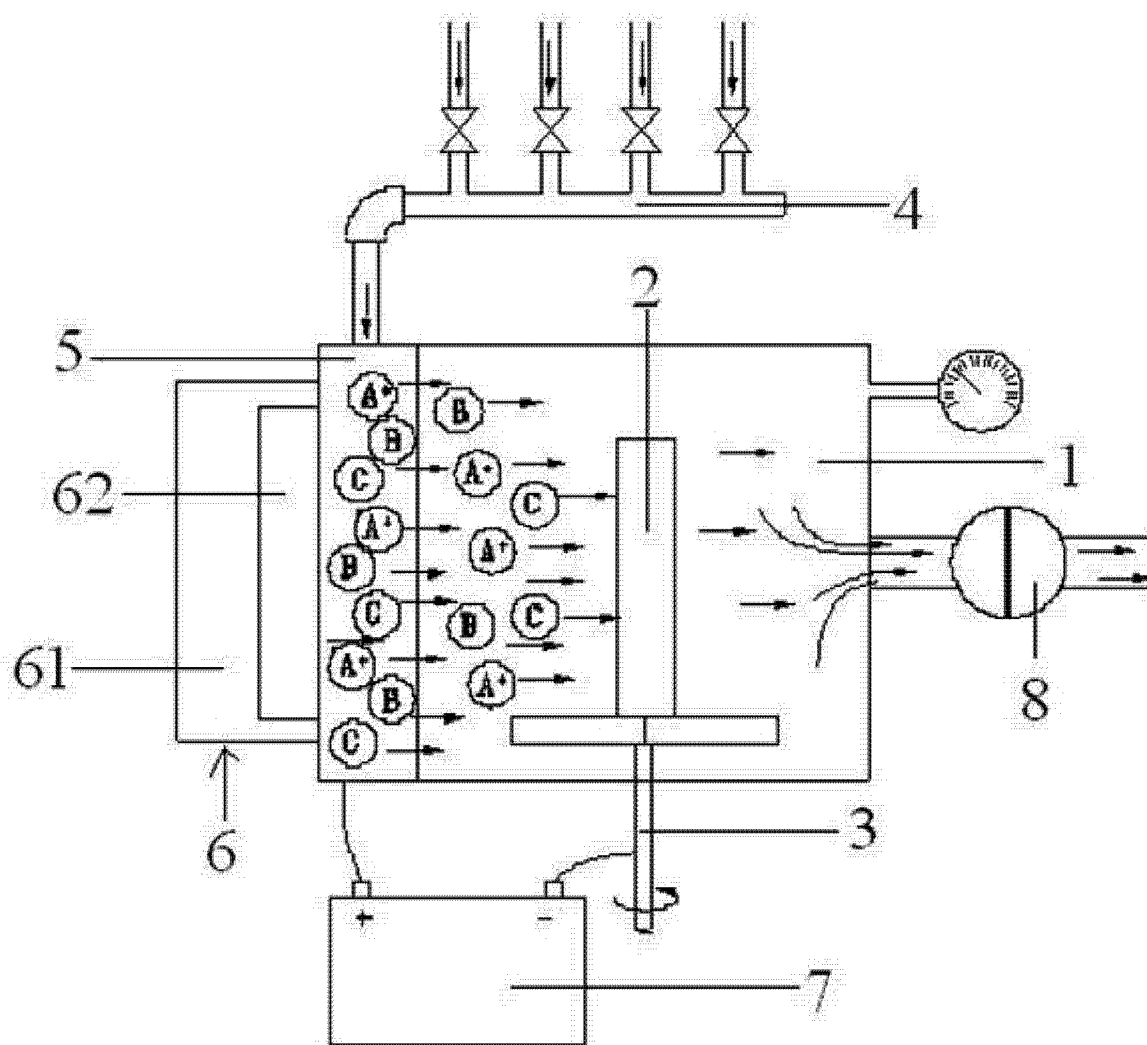


图 4