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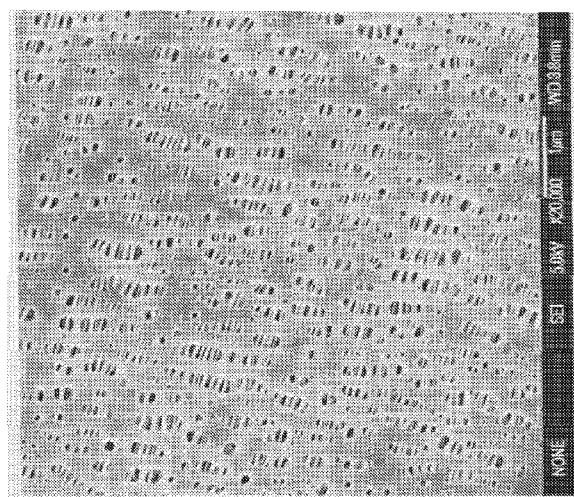


Fig. 3

(57) Abstract: A method for preparing a separator of a battery comprises the steps of: respectively stretching a first polypropylene film and a second polypropylene film in one direction at -3— 7°C, and keeping at 45-60 °C to provide a first polypropylene microporous film and a second polypropylene microporous film; perpendicularly compounding the films along the stretching direction to provide a polypropylene microporous composite film; and subjecting the polypropylene microporous composite film to hydrophilic treatment to provide the separator of the battery. The through micro-pores in the first and the second polypropylene film in the invention are attached and staggered to form tortuous pores, which greatly reduce the aperture of the through pores. Therefore, the passing of fine zinc particles and zincate can be blocked without influence on the passing of organic ions and the penetration of dendritic crystals is avoided.



METHOD FOR PREPARING MEMBRANE SEPARATOR OF BATTERY

Field of the Invention

[0001] The present invention relates to the technical field of membrane separator, and in particular, to a method for preparing a membrane separator of a battery.

Background of the Invention

[0002] In recent years, with the emerging of the problems such as the depletion of natural resources and the warming of the global weather, the green and low carbon life style is becoming popular. Replacing some of internal combustion engine vehicles consuming fossil fuel by electric vehicles and hybrid electric vehicles is one of the main solutions dealing with the energy crisis and environmental deterioration. The driving source is a key component affecting the promotion and use of an electric vehicle. The driving sources widely used at present include lead acid batteries, nickel-cadmium batteries (NiCd), lithium ion batteries, nickel-zinc batteries and the like. In various driving sources, nickel-zinc batteries are widely researched due to the advantages of high power, sufficient energy, free of environmental pollution, high reliability and safety, low cost, and long service life.

[0003] In nickel-zinc batteries, due to the problems of tendency to deformation, dendritic crystal, corrosion, and passivation present in zinc electrodes, a nickel-zinc battery suffers from the disadvantages of short cycling life, high self-discharging, and rapid capacity fading during cycling use. Continuous researches were made by relevant researchers on the membrane separator of the nickel-zinc battery in order to overcome the above defects existing in the nickel-zinc battery. For example, Andre H.Bull.Soc.Fr.Electrians published in 1941 reported a membrane separator, which is unstable and tends to degrade in 30% KOH solution; and US patent No. 4,279,978 reported a membrane separator consisted of polyamide, hydrophilic polymer, and some auxiliary materials.

[0004] However, the common disadvantage present in both of the above reported membrane separators lies in that the micro-pores in the membrane separator are straight pores, as shown in Fig. 1. Since ions, which have the characteristic of moving along a line, preferably choose micro-pores having smaller resistance, zinc ions are preferably reduced and repeatedly accumulated at the straight pores during charging, so that zinc material is gradually increased at

straight pores to form an elevated point higher than the electrode plane, that is, zinc dendrite. Dense and hard zinc dendrite will continue to grow, and penetrate the membrane separator from the micro-pores of the membrane separator, leading to short circuit between the electrodes of the nickel-zinc battery and in turn failure of the battery.

[0005] Therefore, the present inventor proposes a method for preparing a battery membrane separator that can be prevented from being penetrated by dendrites.

Summary of the invention

[0006] Correspondingly, the technical problem to be resolved by the present invention is to provide a method for preparing a membrane separator of a battery, and the prepared membrane separator can be avoided of being penetrated by dendrites.

[0007] The present invention provides a treating solution for a membrane separator of a battery, including the following components by weight percentage:

1.85 wt% ~2 wt% fluoro-carbon surfactant;

1.3wt % ~1.5wt % leveling agent;

1.4 wt % ~1.7wt % non-ion surfactant; and

95 wt % ~95.4wt % water.

[0008] Correspondingly, the present invention further provides a method for preparing a treating solution for a membrane separator of a battery, including the steps of:

adding 1.4 wt % ~1.7wt % non-ion surfactant to 95 wt % ~95.4wt % water, and mixing to provide a first solution; and

separately adding 1.85 wt% ~2 wt% fluoro-carbon surfactant and 1.3wt % ~1.5wt % leveling agent to the first solution, and mixing to provide the treating solution for the membrane separator of the battery.

[0009] The present invention further provides a method for preparing a membrane separator of a battery, including the steps of:

separately drawing a first polypropylene film and a second polypropylene film in one direction at -3~-7°C, and keeping at 45~60°C to provide a first polypropylene microporous film and a second polypropylene microporous film;

perpendicularly compounding the polypropylene microporous film and the second polypropylene microporous film along the drawing direction to provide a polypropylene microporous composite film; and

subjecting the polypropylene microporous composite film to hydrophilic treatment to provide the membrane separator of the battery.

[0010] Preferably, the step of subjecting the polypropylene microporous composite film to hydrophilic treatment includes: soaking the polypropylene microporous composite film in the treating solution of the membrane separator of the battery for 1-5 hours, and drying, in which the treating solution of the membrane separator of the battery includes the following components by weight percentage: 1.85 wt% ~2 wt% fluoro-carbon surfactant; 1.3wt % ~1.5wt % leveling agent; 1.4 wt % ~1.7wt % non-ion surfactant; and 95 wt % ~95.4wt % water.

[0011] Preferably, the polypropylene microporous composite film and the treating solution of the membrane separator of the battery have an area/mass ratio of $(30\text{ m}^2\sim 50\text{m}^2):(20\text{ Kg}\sim 30\text{Kg})$.

[0012] Preferably, the polypropylene microporous composite film has a thickness of 0.015~0.10mm.

[0013] Preferably, the polypropylene microporous composite film has an areal density of 12~43g/m², and an air permeability of 35~56%.

[0014] Preferably, the polypropylene microporous composite film has an anti-piercing strength of 8~50N.

[0015] Preferably, the polypropylene microporous composite film has a longitudinal tensile strength of 1500~1950kgf/cm², and a horizontal tensile strength of 300~657kgf/cm².

[0016] Preferably, the first polypropylene microporous film has a pore size of 7~15 μm ; and the second polypropylene microporous film has a pore size of 7~15 μm .

[0017] The present invention discloses a method for preparing a membrane separator of a battery, including: separately drawing a first polypropylene film and a second polypropylene film in one direction at -3~-7°C, and keeping at 45~60°C to provide a first polypropylene microporous film and a second polypropylene microporous film; perpendicularly compounding the polypropylene microporous film and the second polypropylene microporous film along the drawing direction to provide a polypropylene microporous composite film; and subjecting the

polypropylene microporous composite film to hydrophilic treatment to provide the membrane separator of the battery. In comparison with the prior art, the present invention perpendicularly compounds the first polypropylene microporous film and the second polypropylene microporous film along the drawing direction, so that the straight micro-pores in the first polypropylene microporous film and those in the second polypropylene microporous film joint in dislocation way to form curved pores, so as to significantly decrease the size of the pores, thereby effectively blocking the passing of fine zinc particles and zincate while allowing the passing of organic ions, and preventing the penetration of dendrites.

Brief description of the drawing

[0018] Technical solutions of the embodiments of the present invention or the prior art will be illustrated more clearly with the following brief description of the drawings. Apparently, the drawings referred in the following description constitute only some embodiments of the invention. Those skilled in the art may obtain some other drawings from these drawings without any inventive labor.

[0019] Fig.1 is the schematically structural view of the membrane separator of a battery in prior art;

[0020] Fig.2 is the schematically structural view of the membrane separator of a battery disclosed in the present invention; and

[0021] Fig. 3 is the scanning electron microscope image of the membrane separator of a battery prepared in example 1 of the present invention.

Detailed description of the invention

[0022] The technical solutions of the embodiments of the present invention will be described clearly and completely in conjunction with the drawings. Apparently, the described embodiments are only some rather than all embodiments of the present invention. Any other embodiments obtained from the embodiments of the present invention by those skilled in the art without any inventive labor fall within the scope of the invention.

[0023] The present invention discloses a method for preparing a membrane separator of a battery, including the steps of:

separately drawing a first polypropylene film and a second polypropylene film in one direction at $-3\sim-7^{\circ}\text{C}$, and keeping at $45\sim60^{\circ}\text{C}$ to provide a first polypropylene microporous film and a second polypropylene microporous film;

perpendicularly compounding the polypropylene microporous film and the second polypropylene microporous film along the drawing direction to provide a polypropylene microporous composite film; and

subjecting the polypropylene microporous composite film to hydrophilic treatment to provide the membrane separator of the battery.

[0024] The first polypropylene film is preferably prepared by dry uni-directional drawing, and has low degree of crystallinity and high degree of orientation. Preferably, the first polypropylene film has a pore size of $7\sim15\mu\text{m}$, more preferably $8\sim14\mu\text{m}$, and most preferably $10\sim13\mu\text{m}$. The temperature at which the first polypropylene film is uni-directionally drawn is preferably $-4\sim-6^{\circ}\text{C}$, and more preferably $-5\sim-6^{\circ}\text{C}$; and the temperature at which the first polypropylene film is kept is preferably $50\sim60^{\circ}\text{C}$, and more preferably $53\sim58^{\circ}\text{C}$.

[0025] In the present invention, the second polypropylene film is preferably the same as the first polypropylene film. The temperature at which the second polypropylene film is uni-directionally drawn is preferably $-4\sim-6^{\circ}\text{C}$, and more preferably $-5\sim-6^{\circ}\text{C}$; and the temperature at which the second polypropylene film is kept is preferably $50\sim60^{\circ}\text{C}$, and more preferably $53\sim58^{\circ}\text{C}$. The second polypropylene film has a pore size of preferably $7\sim15\mu\text{m}$, more preferably $8\sim14\mu\text{m}$, and most preferably $10\sim13\mu\text{m}$.

[0026] Taking the first polypropylene film as an example, it forms small wrinkling defects upon drawing at $-3\sim-7^{\circ}\text{C}$, which are then stretched upon being kept at $45\sim60^{\circ}\text{C}$ to form prolate micro-pores. Similarly, since the second polypropylene film is treated by the same method as that for the first polypropylene film, it similarly has the prolate micro-pores.

[0027] Since the first polypropylene film and the second polypropylene film are simply drawn in one direction and formed with prolate micro-pores, they have relatively poor horizontal tensile strength. Therefore, the method of the present invention perpendicularly compounds the first polypropylene microporous film and the second polypropylene microporous film along the drawn direction to obtain a polypropylene microporous composite film, in which the first

polypropylene microporous film and the second polypropylene microporous film are in staggered position, so that the longitudinal and horizontal tensile strengths of the obtained polypropylene microporous composite film are significantly improved compared with the first polypropylene film and the second polypropylene film before compounding.

[0028] Moreover, after perpendicularly compounding the first polypropylene microporous film and the second polypropylene microporous film along the drawn direction, the method of the present invention joints the straight micro-pores in the first polypropylene microporous film and the second polypropylene microporous film in dislocation way to form curved pores, which significantly reduces the size of the pores, so as to block the pass of fine zinc particles and zincate while allowing the pass of organic ions, thereby avoiding the penetration of dendrites. The polypropylene microporous composite film preferably has a pore size of 1~5 μm , and more preferably 1.5~4 μm .

[0029] In the present invention, the perpendicularly compounding of the first polypropylene microporous film and the second polypropylene microporous film along the drawn direction is preferably done by using a rolling device, and more preferably by using a rolling device having a diameter of 4.5~5.5m and a length of 6.5~7.5m under heating.

[0030] Fig.2 is the schematically structural view of the membrane separator of a battery provided by the present invention. It can be seen from Fig.2 that the first polypropylene microporous film 201 has a first micro-pore 202, and the second polypropylene microporous film 203 has a second micro-pore 204; the first polypropylene microporous film 201 and the second polypropylene microporous film 203 are compounded together so that the first micro-pore 202 and the second second micro-pore 204 are staggered to form a curved pore which has a greatly reduced size in comparison with those of the first micro-pore 202 and the second micro-pore 204.

[0031] The polypropylene microporous composite film prepared above has a thickness of preferably 0.015~0.10mm, and more preferably 0.02~0.08mm; an areal density of preferably 12~43g/m², and more preferably 20~40g/m²; an air permeability of preferably 35~56%, and more preferably 40~55%; an anti-piercing strength of preferably 8~50N, and more preferably 10~30N; a longitudinal tensile strength of preferably 1500~1950kgf/cm², and more preferably 1600~1800kgf/cm²; a horizontal tensile strength of preferably 300~657kgf/cm², and more

preferably 400~600kgf/cm²; and a longitudinal high-temperature resistance (90°/2h) of preferably 0.5~2.3%.

[0032] In the present invention, the step of subjecting the polypropylene microporous composite film to hydrophilic treatment includes:

soaking the polypropylene microporous composite film in the treating solution for the membrane separator of the battery for 1-5 hours, and drying. The treating solution for the membrane separator of the battery includes the following components by weight percentage: 1.85 wt% ~2 wt% fluoro-carbon surfactant; 1.3wt % ~1.5wt % leveling agent; 1.4 wt % ~1.7wt % non-ion surfactant; and 95 wt % ~95.4wt % water. The drying temperature is preferably 30~80°C, and more preferably 30~70°C. The drying process includes: after soaking the polypropylene microporous composite film in the treating solution for the membrane separator of the battery for 1-5 hours, baking the polypropylene microporous composite film in a horizontal drying device having four temperature zones of 70°C, 60°C, 45°C, and 30°C, respectively. In addition, the treatment after the hydrophilic treatment includes: coiling up the membrane separator of the battery, preferably by using a driven bearing.

[0033] The polypropylene microporous composite film and the treating solution for the membrane separator have an area/mass ratio of preferably (30 m²~50m²):(20 Kg ~30Kg), more preferably (35 m²~45m²):(22 Kg ~28Kg), more preferably 40m²: 25 Kg. Upon the hydrophilic treatment, the polypropylene microporous composite film is increased in weight by preferably 2.3~4.5g/ m², more preferably 2.5~4.2g/ m², and most preferably 2.8~4g/ m².

[0034] The fluoro-carbon surfactant is preferably INTECHEM-01 fluoro-carbon surfactant. It is an alkyl ether anion surfactant, having many of the excellent properties of anion and non-ion surfactants and capable of greatly reducing the surface tension of the electrolyte solution. Moreover, the surfactant is a low foaming surfactant, facilitating observing the wetting of the film. In the treating solution for the membrane separator of the battery, the content of the fluoro-carbon surfactant is preferably 1.88 wt% ~1.95 wt%, more preferably 1.9 wt% ~1.92 wt%, and most preferably 1.903 wt%.

[0035] The leveling agent used in the present invention is preferably wetting leveling agent, and more preferably KY-1028A wetting leveling agent. It is a polyether-modified organo-silicone, and has good anti-cratering performance and good effect in reducing the tension

of the solution, so that the treating solution for the membrane separator of the battery can be uniformly distributed on the surface of the polypropylene microporous composite film. In the treating solution for the membrane separator of the battery, the content of the leveling agent is preferably 1.3wt % ~1.45wt %, more preferably 1.32wt % ~1.4wt %, and most preferably 1.343wt %.

[0036] The non-ion surfactant is preferably FCNTACARE-1202 non-ion surfactant. It can provide abundant hydrophilic functional groups on the surface of the polypropylene microporous composite film and the surface of the micro-pores, playing an important role in the wetting and liquid absorption of the polypropylene micro-pores. In the treating solution for the membrane separator of the battery, the content of the non-ion surfactant is preferably 1.45 wt % ~1.6wt %, more preferably 1.5 wt % ~1.55wt %, and most preferably 1.523wt %.

[0037] The present invention further provides a method for preparing a treating solution for a membrane separator of a battery, including the steps of:

adding 1.4 wt % ~1.7wt % non-ion surfactant to 95 wt % ~95.4wt % water, and mixing to provide a first solution; and

separately Adding 1.85 wt% ~2 wt% fluoro-carbon surfactant and 1.3wt % ~1.5wt % leveling agent to the first solution, and mixing to provide the treating solution for the membrane separator of the battery.

[0038] Further, the present invention preferably includes preheating the water to a temperature of preferably 50~70°C, and more preferably 60°C.

[0039] In the step of providing the first mixed solution, the mixing is performed preferably by agitating, at a speed of preferably 2~10 rad/1s and more preferably 3~5 rad/1s, preferably for 10~30min, and more preferably for 15min. In the step of providing the treating solution for the membrane separator of the battery, the mixing is performed preferably by agitating, at a speed of preferably 1~2 rad/1s and more preferably 1.5~1.7 rad/1s, preferably for 50~100min, and more preferably for 60~80min.

[0040] The membrane separator of the battery prepared according to the present invention can be evaluated for its liquid-absorption ratio, material loading amount, surface resistance, and the like by the methods well-known by those skilled in the art. The results showed that the

membrane separator of the battery prepared according to the present invention meet the requirements for a nickel-zinc battery.

[0041] For the purpose of further explaining the technical solution of the present invention, the preferred embodiments of the present invention will be described in combination with the following examples. However, it should be noted that those descriptions are made simply for further explaining the features and advantages of the present invention, rather than making a limitation to the claims of the present invention.

[0042] The chemical agents used in the examples of the present invention are all commercially available.

[0043] Example 1

[0044] Preparing the treating solution for the membrane separator of the battery:

weighing 95.23g H₂O and preheating to 60°C;

adding 1.523g FCNTACARE-1202 non-ion surfactant to the preheated H₂O, and agitating at 3rad/1s for 15min to provide the first solution;

adding 1.904g INTECHEM-01 fluoro-carbon surfactant and 1.343 g KY-1028A wetting leveling agent to the first solution, agitating at 1.7rad/1s for 7.5min and then magnetically agitating at 1.5rad/1s for 70min to provide the treating solution for the membranes separator of the battery.

[0045] Preparing the polypropylene microporous composite film:

drawing the first polypropylene film in one direction at -4°C, and keeping it at 50°C for 1 hour to provide a first polypropylene microporous film having a thickness of 0.10mm, an areal density of 15g/m², an air permeability of 40%, a pore-area piercing strength of 1250g, a longitudinal tensile strength of 1650kgf/cm², a horizontal tensile strength of 480kgf/cm², and a longitudinal high-temperature resistance (90°/2h) of 0.5%; drawing a second polypropylene film that is same as the first polypropylene film in one direction at -4°C, keeping it at 50°C for 1 hour to provide a second polypropylene microporous film having a thickness of 0.10mm, an areal density of 15g/m², an air permeability of 40%, a pore-area piercing strength of 1250g, a longitudinal tensile strength of 1650kgf/cm², a horizontal tensile strength of 480kgf/cm², and a longitudinal high-temperature resistance (90°/2h) of 0.5%; and

perpendicularly compounding the first polypropylene microporous film and the second polypropylene microporous film at 75 °C by using a rolling device having a diameter of 500mm and a length of 700mm to provide the polypropylene microporous composite film.

[0046] Preparing the membrane separator of a battery:

placing the polypropylene microporous composite film prepared in the above treating solution for membrane separator of battery at room temperature, standing for 2 hours, and drying in a horizontal drying device having four temperature zones of 70 °C, 60 °C, 45 °C, and 30 °C to provide the membrane separator of the battery, in which the polypropylene microporous composite film and the treating solution for the membrane separator of the battery have an area/mass ratio of 40 m²:25 Kg.

[0047] Fig.3 shows the SEM image of the membrane separator of the battery prepared according to the first example.

[0048] The membrane separator of a battery prepared according the example is evaluated for its liquid absorption rate, providing a result of 180%. The polypropylene microporous composite film and the membrane separator are weighed, finding out a weight increase of 4g/m² for the polypropylene microporous composite film.

[0049] The surface resistance of the membrane separator of the battery prepared according to the example is determined by the following steps:

cutting the membrane separator of battery prepared according to the example into 5 pieces of equal size, soaking in a KOH solution having a mass concentration of 30% to provide a first testing sample, a second testing sample, a third testing sample, a forth testing sample, and a fifth testing sample.

[0050] TH2810B type LCR digital electric bridge as the surface resistance tester for the membrane separator, which operates as follows: supplying 120V alternate current, switching on the tester and standing at 20 °C±5 for 15 minutes; connecting the HP and HS interfaces of the output ports in parallel, to server as the positive electrode output terminal; connecting the LS and LP interfaces of the output ports in parallel, to server as the negative electrode output terminal; switching the measuring grade to mΩ grade; switching the switch to “zero clearing” grade; switching the parameter grade to “RQ” grade; switching the testing frequency to “1KHZ”;

switching the display window to “directly reading”; connecting the positive electrode terminal and the negative electrode terminal to the nickel plates on both sides of the alkali solution tank, respectively; respectively sandwiching the first testing sample, the second testing sample, the third testing sample, the fourth testing sample, and the fifth testing sample between two clamping plates with a hole, immersing and fixing the whole clamping plates in the alkali solution tank; and pouring 1.3g/ml KOH solution into the alkali solution tank. The test showed that the membrane separator of the battery prepared according to the present example has an internal resistance of 0.017~0.035mΩ/cm².

[0051] Example 2

[0052] The membrane separator of a nickel-zinc battery produced by Guangdong Power Link Ltd. Corp. was replaced with the membrane separator prepared according to the example 1, and then the nickel-zinc battery with the replaced membrane separator was charged for 100 hours. No dendrite penetration was observed for the membrane separator of the battery.

[0053] Example 3

[0054] Preparing the treating solution for the membrane separator of the battery:

weighing 95.23g H₂O and preheating to 60°C;

adding 1.523g FCNTACARE-1202 non-ion surfactant to the preheated H₂O, and agitating at 3rad/1s for 15min to provide the first solution;

adding 1.904g INTECHEM-01 fluoro-carbon surfactant and 1.343 g KY-1028A wetting leveling agent to the first solution, agitating at 1.7rad/1s for 7.5min and then magnetically agitating at 1.5rad/1s for 70min to provide the treating solution for the membranes separator of the battery.

[0055] Preparing the polypropylene microporous composite film:

drawing the first polypropylene film in one direction at -6°C, and keeping it at 55°C for 1 hour to provide a first polypropylene microporous film having a thickness of 0.12mm, an areal density of 28g/m², an air permeability of 45%, a pore-area piercing strength of 1480g, a longitudinal tensile strength of 1720kgf/cm², a horizontal tensile strength of 500kgf/cm², and a longitudinal high-temperature resistance (90°/2h) of 1.7%; drawing the second polypropylene film that is same as the first polypropylene film in one direction at -6°C, keeping it at 55°C for 1

hour to provide a second polypropylene microporous film having a thickness of 0.12mm, an areal density of 28g/m^2 , an air permeability of 45%, a pore-area piercing strength of 1480g, a longitudinal tensile strength of 1720kgf/cm^2 , a horizontal tensile strength of 500kgf/cm^2 , and a longitudinal high-temperature resistance ($90^\circ/2\text{h}$) of 1.7%; and

perpendicularly compounding the first polypropylene microporous film and the second polypropylene microporous film at 75°C by using a rolling device having a diameter of 500mm and a length of 700mm to provide the polypropylene microporous composite film.

[0056] Preparing the membrane separator of the battery:

placing the prepared polypropylene microporous composite film in the above treating solution for membrane separator of battery at room temperature, standing for 2 hours, and drying in a horizontal drying device having four temperature zones of 70°C , 60°C , 45°C , and 30°C to provide the membrane separator of the battery, in which the polypropylene microporous composite film and the treating solution for the membrane separator of the battery have an area/mass ratio of $40\text{ m}^2:25\text{ Kg}$.

[0057] The properties of the membrane separator of the battery prepared in example 3 is tested by the same method as in example 1, which gives a liquid absorption rate of 170%, a weight increase of 3.5g/m^2 , and a surface resistance of $0.022\sim 0.028\text{ m}\Omega/\text{cm}^2$.

[0058] Example 4

[0059] The membrane separator of a nickel-zinc battery produced by Guangdong Power Link Ltd. Corp. was replaced with the membrane separator prepared according to the example 3, and then the nickel-zinc battery with the replaced membrane separator was charged for 100 hours. No dendrite penetration was observed for the membrane separator of the battery.

[0060] The above description to the embodiments as disclosed is made so that those skilled in the art can carry out or utilize the present invention. It is obvious that various modifications to these examples can be made by those skilled in the art. The general principle defined herein can be carried out in other embodiments, without departing from the spirit or scope of the present invention. Therefore, the present invention will not be limited to those embodiments illustrated in the description, and on the contrary, will be defined by the broadest scope complying with the principle of the present invention and consistent with the novel features.

What is claimed is:

1. A treating solution for a membrane separator of a battery, comprising the following components by weight percentage:

1.85 wt% ~2 wt% fluoro-carbon surfactant;

1.3wt % ~1.5wt % leveling agent;

1.4 wt % ~1.7wt % non-ion surfactant; and

95 wt % ~95.4wt % water.

2. A method for preparing a treating solution for a membrane separator of a battery, characterized in comprising the steps of:

adding 1.4 wt % ~1.7wt % non-ion surfactant to 95 wt % ~95.4wt % water, and mixing to provide a first solution; and

separately adding 1.85 wt% ~2 wt% fluoro-carbon surfactant and 1.3wt % ~1.5wt % leveling agent to the first solution, and mixing to provide the treating solution for the membrane separator of the battery.

3. A method for preparing a membrane separator of a battery, comprising the steps of:

separately drawing a first polypropylene film and a second polypropylene film in one direction at -3~-7°C, and keeping at 45~60°C to provide a first polypropylene microporous film and a second polypropylene microporous film;

perpendicularly compounding the polypropylene microporous film and the second polypropylene microporous film along the drawing direction to provide a polypropylene microporous composite film; and

subjecting the polypropylene microporous composite film to hydrophilic treatment to provide the membrane separator of the battery.

4. The method according to claim 3, characterized in that the step of subjecting the polypropylene microporous composite film to hydrophilic treatment comprises:

soaking the polypropylene microporous composite film in the treating solution for the membrane separator of the battery for 1-5 hours, and drying, wherein the treating solution for the

membrane separator of the battery comprises the following components by weight percentage: 1.85 wt% ~2 wt% fluoro-carbon surfactant; 1.3wt % ~1.5wt % leveling agent; 1.4 wt % ~1.7wt % non-ion surfactant; and 95 wt % ~95.4wt % water.

5. The method according to claim 3, characterized in that the polypropylene microporous composite film and the treating solution for the membrane separator of the battery have an area/mass ratio of $(30 \text{ m}^2 \sim 50 \text{ m}^2) : (20 \text{ Kg} \sim 30 \text{ Kg})$.

6. The method according to claim 3, characterized in that the polypropylene microporous composite film has a thickness of 0.015~0.10mm.

7. The method according to claim 3, characterized in that the polypropylene microporous composite film has an areal density of $12 \sim 43 \text{ g/m}^2$, and an air permeability of 35~56%.

8. The method according to claim 3, characterized in that the polypropylene microporous composite film has an anti-piercing strength of 8~50N.

9. The method according to claim 3, characterized in that the polypropylene microporous composite film has a longitudinal tensile strength of $1500 \sim 1950 \text{ kgf/cm}^2$, and a horizontal tensile strength of $300 \sim 657 \text{ kgf/cm}^2$.

10. The method according to claim 3, characterized in that the first polypropylene microporous film has a pore size of 7~15 μm ; and the second polypropylene microporous film has a pore size of 7~15 μm .

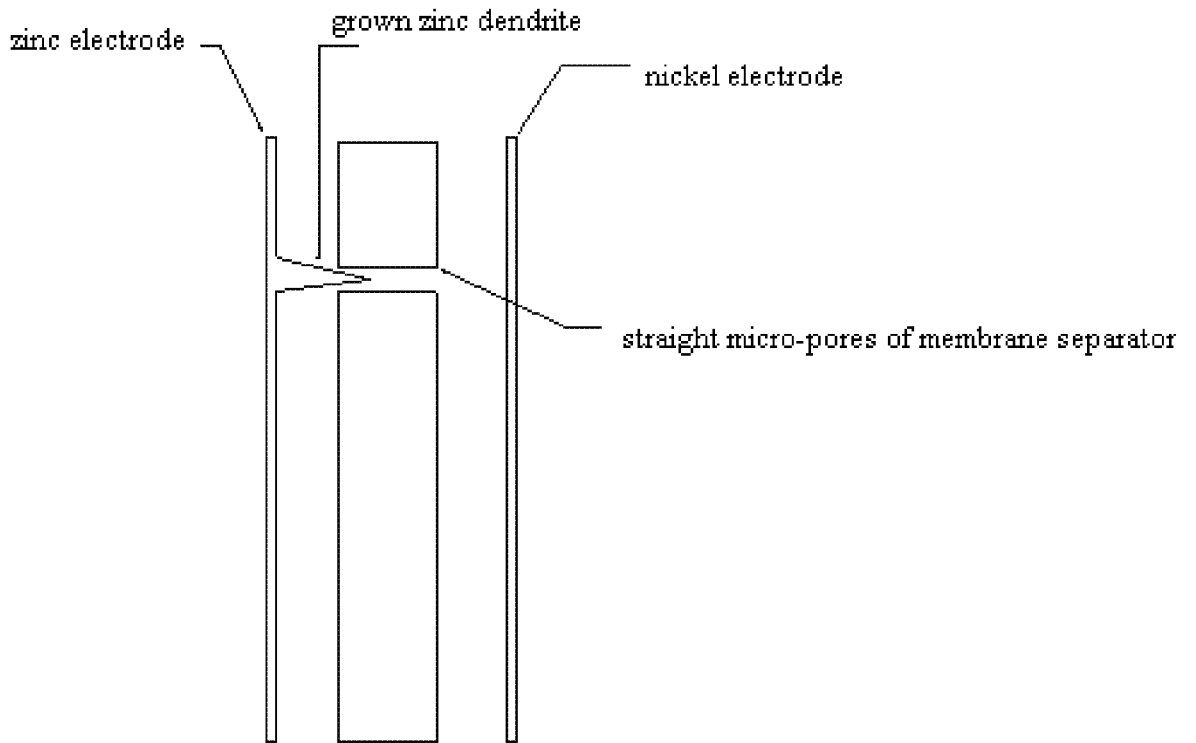


Fig. 1

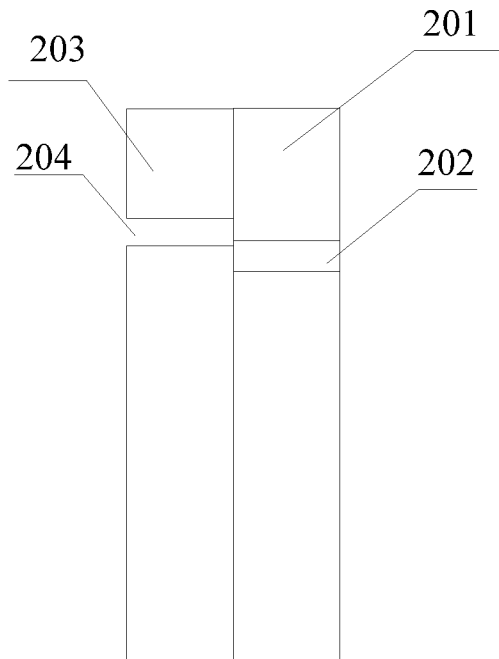


Fig. 2

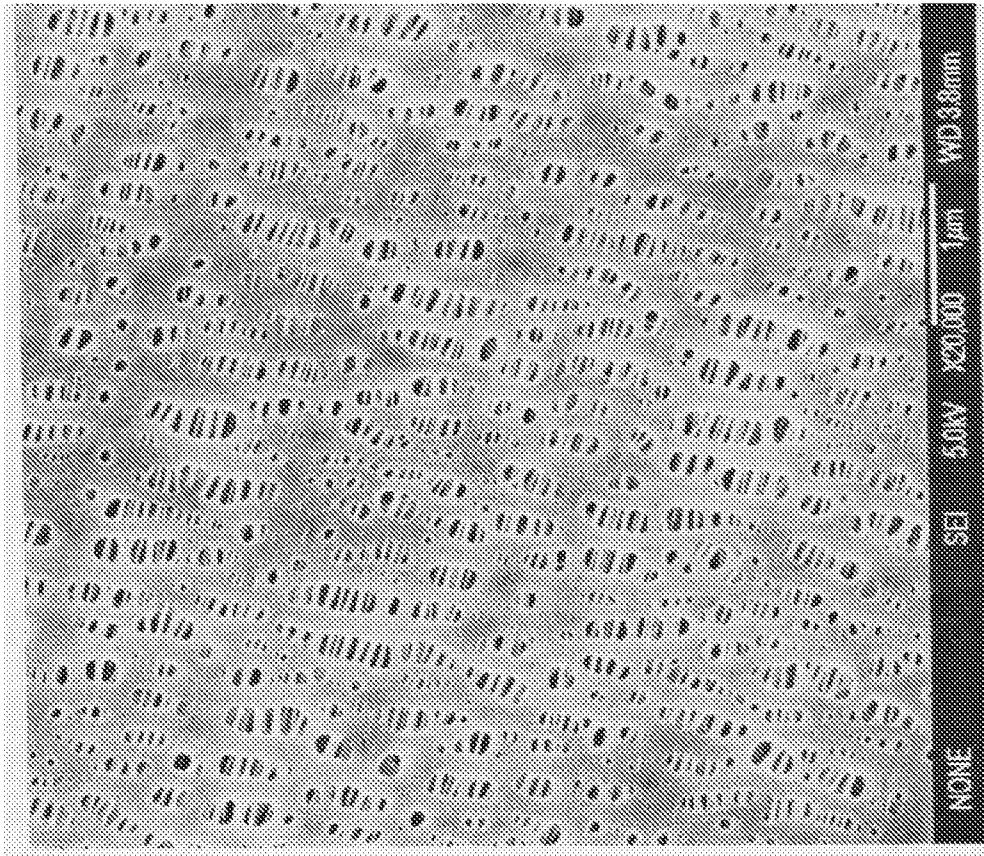


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/076968

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC: hydrophile, hydrophilic, polypropylene, polyolefine, surfactant, fluorocarbon, nonionic, non ionic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN102263220A(GUANGZHOU POWERLINK ENERGY CO., LTD)30 Nov. 2011 (30.11.2011) the whole document	1-10
Y	CN1400235A(SHANGHAI JIESHIJIE NEW MATERIA)05 Mar. 2003(05.03.2003) the whole document	3, 5-10
Y	CN1134043A(HOECHST CELANESE CORP)23 Oct. 1996(23.10.1996) claims 1-12 and page 10 paragraph 3	3, 5-10
Y	JP63072063A(TOSHIBA BATTERY)01 Apr. 1988(01.04.1988)examples 1-2	3, 5-10
A	US3843761A(CELANESE CORP)22 Oct. 1974(22.10.1974) the whole document	1-10

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 01 Sep. 2012(01.09.2012)	Date of mailing of the international search report 27 Sep. 2012 (27.09.2012)
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/076968

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

This Authority considers that there are two inventions covered by the claims indicated as follows:

I: Claims 1 and 2 direct to a treating solution for a separator of a battery and a method therefor.

II: Claim 3 directs to a method for preparing a separator of a battery.

The same or corresponding technical feature among the inventions above is "a separator of a battery", which is common knowledge in the art. It follows that the same or corresponding technical feature of claims above does not make a contribution over the prior art and can not be considered as a special technical feature within the meaning of Rule 13.2 PCT. The application, hence does not meet the requirements of unity of invention as defined in Rule 13.1 PCT.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/076968

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN102263220A	30.11.2011	NONE	
CN1400235A	05.03.2003	CN1210337C	13.07.2005
CN1134043A	23.10.1996	EP0723304A2	24.07.1996
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		JP57047017B	06.10.1982
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		NL190056B	17.05.1993

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/076968

Continuation of CLASSIFICATION OF SUBJECT MATTER:

H01M 2/16 (2006.01) i

B32B 27/08 (2006.01) i

B32B 27/32 (2006.01) i

B32B 3/24 (2006.01) i