The weight ratio of carbon to silicon in the particulate material of the invention is preferably at least 0.15, more preferably at least 0.20, more preferably at least 0.25, more preferably at least 0.3. The weight ratio of carbon to silicon in the particulate material may be no greater than 0.8, more preferably no greater than 0.7, more preferably no greater than 0.6, more preferably no greater than 0.55, more preferably no greater than 0.5, more preferably no greater than 0.45.

For example, the weight ratio of carbon to silicon in the particulate material of the invention may be from 0.2 to 0.6, more preferably from 0.25 to 0.5, more preferably from 0.3 to 0.45.

The weight ratio of carbon to the total amount of oxygen and nitrogen in the particulate material of the invention (i.e. weight [C]: weight [O + N]) may be at least 0.7, more preferably at least 0.8, more preferably at least 0.85, or at least 0.9, or at least 0.95.

The particulate material of the present invention preferably comprises at least 8 wt% oxygen, or at least 10 wt% oxygen, or at least 12 wt% oxygen, or at least 15 wt% oxygen.

The particulate material of the present invention may comprise less than 18 wt% oxygen.

The particulate material of the present invention preferably comprises from 8 wt% to less than 20 wt% oxygen, more preferably from 10 wt% to less than 20 wt% oxygen, more preferably from 12 wt% to less than 20 wt% oxygen, more preferably from 15 wt% to less than 20 wt% oxygen.

In a preferred embodiment, the particulate material of the present invention comprises from 2 to 6 wt% nitrogen, more preferably from 2.5 to 5 wt% nitrogen, more preferably from 3 to 4.5 wt% nitrogen, and most preferably from 3.5 to 4.5 wt% nitrogen.

The particulate material of the present invention preferably comprises at least 10 wt% carbon, at least 15 wt% carbon, or at least 18 wt% carbon. The particulate material of the present invention preferably comprises no greater than 35 wt.% carbon, no greater than 30 wt.% carbon, no greater than 28 wt.% carbon, or no greater than 25 wt.% carbon. For example, the particulate material of the present invention may comprise from 15 to 30 wt% carbon, or more preferably from 18 to 25 wt% carbon.

In a preferred embodiment, the particulate material of the present invention comprises 45 to 65 wt.% silicon, 10 to less than 20 wt.% oxygen, 2 to 6 wt.% nitrogen, and 15 to 30 wt.% carbon; wherein the weight ratio of the total amount of oxygen and nitrogen in the particulate material to the silicon in the particulate material is in the range of 0.25 to 0.45; and wherein the weight ratio of carbon to silicon in the particulate material is in the range of 0.2 to 0.6.

In a more preferred embodiment, the particulate material of the present invention comprises 48 to 62 wt% silicon, 12 to less than 20 wt% oxygen, 2.5 to 5 wt% nitrogen, and 18 to 25 wt% carbon; wherein the weight ratio of the total amount of oxygen and nitrogen in the particulate material to the silicon in the particulate material is in the range of 0.28 to 0.4; and wherein the weight ratio of carbon to silicon in the particulate material is in the range of 0.25 to 0.5.

In a particularly preferred embodiment, the particulate material of the present invention comprises 50 to 60 wt% silicon, 15 to less than 20 wt% oxygen, 3 to 4.5 wt% nitrogen and 18 to 25 wt% carbon; wherein the weight ratio of the total amount of oxygen and nitrogen in the particulate material to the silicon in the particulate material is in the range of 0.3 to 0.38, and wherein the weight ratio of carbon to silicon in the particulate material is in the range of 0.3 to 0.45.

The electrically conductive carbon matrix in the composite particles may be obtained by pyrolysis of a pyrolysed carbon precursor, as described with reference to the first aspect of the invention. The conductive carbon matrix obtained by pyrolysis (referred to herein as "pyrolytic carbon") can have an amorphous structure with graphite-like features, such as a large G-band (~1600 cm) in the raman spectrum[1]) As demonstrated.

The composite particles may have a D in the range of 1 to 25 μm$_{50}$And (4) the particle size. Optionally, D$_{50}$The particle size may be at least 2 μm, more preferably at least 3 μm, more preferably at least 4 μm, more preferably at least 5 μm. Optionally, D$_{50}$The particle size may be not more than 20 μm, more preferably not more than 18 μm, more preferably not more than 15 μm, more preferably not more than 12 μm, more preferably not more than 10 μm. For example, the composite particles may have a D in the range of 1 to 20 μm, more preferably 2 to 18 μm, more preferably 3 to 15 μm, more preferably 4 to 12 μm, more preferably 5 to 10 μm$_{50}$And (4) the particle size. Has already sent outflow, particles within this size range and having porosity and pore size distribution as set forth herein are ideally suited for use in the anode of a metal ion battery due to their dispersibility in the slurry, their structural robustness, their capacity retention during repeated charge-discharge cycles, and their suitability for forming a dense electrode layer of uniform thickness in the conventional range of 20 to 50 μm.

D of composite particles$_{10}$The particle size is preferably at least 0.5 μm, more preferably at least 1 μm, and still more preferably at least 2 μm. By mixing D$_{10}$Particle size is maintained above 1 μm, the likelihood of undesirable submicron-sized particles agglomerating is reduced, resulting in improved particulate material dispersibility and improved capacity retention.

D of composite particles$_{90}$The particle diameter is preferably not more than 40 μm, more preferably not more than 30 μm, more preferably not more than 25 μm, more preferably not more than 20 μm. The presence of large particles leads to uneven formation and accumulation of particles in the electrode active layer, thereby disrupting the formation of a dense electrode layer, particularly one having a thickness in the range of 20 to 50 μm.

D of composite particles$_{99}$The particle diameter is preferably not more than 50 μm, more preferably not more than 40 μm, more preferably not more than 35 μm, and most preferably not more than 30 μm.

The composite particles preferably have a narrow size distribution span. For example, the span of the particle size distribution (defined as (D)$_{90}$-D$_{10}$)/(D$_{50}$) Preferably 5 or less, more preferably 4 or less, more preferably 3 or less, more preferably 2 or less, and most preferably 1.5 or less. By maintaining a narrow size distribution span, efficient packing of the particles into a dense electrode layer is more easily achieved.

The silicon nanoparticles preferably have a D in the range of 30 to 500nm$_{50}$And (4) the particle size. If D of the silicon nanoparticles$_{50}$With a particle size less than 30nm, the surface area of the particles may become too large and the amount of oxygen/nitrogen required to bind the silicon nanoparticles to the surrounding conductive carbon matrix may become too large, thereby reducing the lithiation capacity of the silicon. If D of the silicon nanoparticles$_{50}$With a particle size of more than 500nm, the silicon nanoparticles are less effectively deposited within the composite particles and then an excess of carbon is required to compensate for the void space between the silicon nanoparticles. Optionally, D of silicon nanoparticles$_{50}$The particle size may be at least 50nm, or at least 60nm, or at least 70nm, or at least 75nm, for example at least 80 nm. Optionally, D of silicon nanoparticles$_{50}$The particle size may be no greater than 300nm, more preferably no greater than 250nm, more preferably no greater than 200nm, more preferably no greater than 150nm, more preferably no greater than 120 nm.

The silicon nanoparticles preferably have a D in the range of 50 to 250nm, more preferably in the range of 60 to 200nm, more preferably in the range of 70 to 150nm, more preferably in the range of 80 to 120nm$_{50}$And (4) the particle size. For example, D of silicon nanoparticles$_{50}$The particle size may be about 100 nm.

D of silicon nanoparticles$_{10}$The particle size may be at least 10nm, more preferably at least 20nm, more preferably at least 40nm, more preferably at least 60 nm. D of silicon nanoparticles$_{90}$The particle size may be no greater than 500nm, more preferably no greater than 400nm, more preferably no greater than 300nm, more preferably

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no greater than 200 nm. The silicon nanoparticles may have a particle size distribution span (as defined above) of 5 or less, more preferably 4 or less, more preferably 3 or less, more preferably 2 or less, more preferably 1.5 or less. Selecting these optimized D_{10}, D_{50}And a particle size distribution span value to minimize problems associated with too small or too large silicon nanoparticles as set forth above.

The composite particles constituting the particulate material of the present invention preferably have a low porosity. For example, the composite particles may have an intra-granular porosity of no greater than 30%, no greater than 20%, no greater than 10%, no greater than 5%, or no greater than 2%, as determined by mercury intrusion methods. Since the particulate material of the present invention relies on the use of nano-sized silicon particles to control the mechanical stress of lithiation and delithiation, the presence of large pore volumes within the composite particles only detracts from the volumetric energy density obtainable with the particulate material of the present invention. The particulate material of the present invention may be nanoporous and may comprise pores of diameter less than 2nm distributed over its entire volume.

As used herein, the term "intraparticle porosity" refers to the ratio of the volume of pores within a particle to the total volume of the particle, and the term "interparticle porosity" refers to the volume of pores between discrete particles. The total porosity of the particulate material may be defined as the sum of the intra-and inter-granular porosity.

Mercury porosimetry is a technique for characterizing the porosity and pore size distribution of a material by applying different levels of pressure to a sample of the material immersed in mercury. The pressure required to force mercury into the pores of the sample is inversely proportional to the size of the pores. More specifically, mercury porosimetry is based on the capillary law which controls the permeation of liquid into small pores. In the case of non-wetting liquids such as mercury, the law is expressed by the Washburn equation:

wherein D is pore size, P is applied pressure, γ is surface tension, andis the contact angle between the liquid and the sample. The volume of mercury that penetrated into the pores of the sample was measured directly as a function of the applied pressure. As the pressure increases during the analysis, the pore size is calculated for each pressure point and the corresponding volume of mercury needed to fill the pores is measured. These measurements, performed over a range of pressures, provide the pore volume relative to the pore size distribution of the sample material. The Washburn equation assumes that all holes are cylindrical. Although true cylindrical pores are rarely encountered in practical materials, this assumption provides a sufficiently useful representation of the pore structure for most materials. For the avoidance of

doubt, reference herein to pore size should be understood to refer to the equivalent cylindrical dimension as determined by mercury intrusion. The values obtained by mercury intrusion as reported herein are according to ASTM D9P574-11, taking surface tension γ of 480mN/m and contact angle for mercury at room temperatureObtained at 140 °. Taking mercury at room temperature and having density of $13.5462g/cm^3$,

For a sample in the form of a porous particle powder, the total pore volume of the sample is the sum of the intra-and inter-granular pores. This results in an at least bimodal pore size distribution curve in mercury intrusion analysis that includes a set of one or more peaks at smaller pore sizes associated with the intra-particulate pore size distribution and a set of one or more peaks at larger pore sizes associated with the inter-particulate pore size distribution. The lowest point between the two sets of peaks represents the diameter that can separate the intra-and inter-granular pore volumes from the pore size distribution curve. The pore volume at a larger diameter than this is considered to be the pore volume associated with the interparticle pores. The total pore volume minus the interparticle pore volume gives the intraparticle pore volume from which the intraparticle porosity can be calculated.

Various high precision mercury intrusion instruments are commercially available, such as the AutoPore IV series automated mercury intrusion porosimeter available from Micromeritics Instrument Corporation, USA. For a complete review of the mercury intrusion method, reference may be made to P.A. Webb and C.Orr in "Analytical Methods in Fine particle technology, 1997, Micromeritics Instrument Corporation, ISBN 0-9656783-0.

It should be understood that mercury intrusion and other pressure intrusion techniques are only effective in determining the pore volume of pores accessible to mercury (or other fluid) from outside the porous particles to be measured. The intraparticle porosity values as illustrated or reported herein should be understood to refer to the volume of open pores (i.e. pores accessible to fluids from the exterior of the particles of the invention). In this context, when values of intraparticle porosity are stated or reported, completely closed pores which cannot be determined by mercury porosimetry should not be taken into account.

The particulate material of the present invention preferably has a particle size of less than $100m^2$In g, more preferably less than $80m^2$In g, more preferably less than $60m^2A/g$, more preferably less than $40m^2$In g, more preferably less than $30m^2A/g$, more preferably less than $25m^2$In g, more preferably less than $20m^2A/g$, more preferably less than $15m^2$BET surface area in g. As used herein, the term "BET surface area" shall be used to refer to the surface area of a solid body formed from the surface of the solid body using Brunauer-Emmett-Teller theory according to ASTM B922/10Measurement of the physisorption of gas molecules the calculated surface area per unit mass. Since the particulate material of the present invention preferably comprises particles having low intraparticle porosity, the BET surface area will be substantially a function of the particle size and particle size distribution of the composite particles. Generally, a low BET surface area is preferred to minimize the formation of a Solid Electrolyte Interface (SEI) layer at the surface of the composite particles during the first charge-discharge cycle of an anode comprising the particulate material of the present invention. However, too low a BET surface area results in unacceptably low charging rates and capacities due to the poor accessibility of the bulk phase (bulk) of the electroactive material to metal ions in the surrounding electrolyte. For example, the BET surface area is preferably at least $0.1m^2A/g$, more preferably at least $1m^2A/g$, more preferably at least $2m^2A/g$, more preferably at least $5m^2$(ii) in terms of/g. For example, the BET surface area may be $1m^2G$ to $25m^2$In the range of/g, more preferably from 2 to $15m^2$In the range of/g

The silicon nanoparticles may be characterized by a Si (111) lattice spacing of at least 10nm, at least 12nm, at least 14nm, or at least 16nm, as measured by X-ray diffraction (XRD) techniques.

Optionally, the silicon nanoparticles have a Si (111) lattice spacing of no greater than 100nm, no greater than 50nm, or no greater than 35 nm.

The particulate material of the present invention typically has a specific charge capacity (specific charge capacity) of from 1200 to 2340mAh/g on first lithiation. Preferably, the particulate material of the present invention has a specific charge capacity of at least 1400mAh/g upon first lithiation.

The particulate material of the present invention is preferably obtained by a method as defined with reference to the first aspect of the present invention.

It will be appreciated that the particulate material produced according to the method of the first aspect of the invention may be further defined by any of the features defined in relation to the particulate material according to the second and third aspects of the invention. Any such features and combinations of features should be understood to apply analogously to the particulate material prepared according to the first aspect of the present invention.

In particular, the silicon nanoparticles in the particulate material prepared according to the method of the first aspect of the present invention may comprise a nanoparticle core and a nanoparticle surface, wherein the nanoparticle surface comprises a compound of oxygen or a compound of nitrogen or a mixture thereof disposed between the nanoparticle core and the conductive carbon matrix; the particulate material comprises 40 to 65 wt% silicon; the particulate material comprises at least 6 wt% and less than 20 wt% oxygen; the weight ratio of the total amount of oxygen and nitrogen to silicon in the particulate material is in the range of 0.1 to 0.45; and the weight ratio of carbon to silicon in the particulate material is in the range of 0.1 to 1.

The silicon nanoparticles in the particulate material prepared according to the method of the first aspect of the present invention may comprise a nanoparticle core and a nanoparticle surface, wherein the plurality of bridging oxygen atoms and/or the plurality of bridging nitrogen atoms are disposed between the nanoparticle surface and at least a portion of the conductive carbon matrix such that the conductive carbon matrix is chemically bound to the nanoparticle surface; and the particulate material comprises 40 to 65 wt% silicon; the particulate material comprises at least 6 wt% and less than 20 wt% oxygen; the weight ratio of the total amount of oxygen and nitrogen in the particulate material to the silicon in the particulate material is in the range of 0.1 to 0.45; and the weight ratio of carbon to silicon in the particulate material is in the range of 0.1 to 1.

In a fourth aspect, the present invention provides a particulate material comprising a plurality of composite particles obtainable by the method of the first aspect of the invention.

In a fifth aspect of the invention, there is provided a composition comprising a particulate material according to the second, third or fourth aspects of the invention and at least one further component. In particular, the particulate material of the second, third or fourth aspect of the invention may be used as a component of an electrode composition.

Accordingly, there is provided an electrode composition comprising a particulate material according to the second, third or fourth aspect of the present invention and at least one further component selected from: (i) a binder; (ii) a conductive additive; and (iii) a further particulate electroactive material. The particulate material used to prepare the electrode composition of the fifth aspect of the invention may have any of the features described as being preferred or optional in relation to the second and third aspects of the invention and/or may be prepared by a process comprising any of the features described as being preferred or optional in relation to the first aspect of the invention.

The particulate material of the present invention preferably constitutes from 0.5 to 80 wt%, more preferably from 1 to 70 wt%, more preferably from 1 to 60 wt%, more preferably from 2 to 50 wt%, more preferably from 2 to 40 wt%, more preferably from 2 to 30 wt%, more preferably from 5 to 15 wt% of the total dry weight of the electrode composition.

Preferably, the electrode composition is a mixed electrode composition comprising a particulate material according to the second, third or fourth aspect of the invention and at least one further particulate electroactive material. Examples of additional particulate electroactive materials include graphite, hard carbon black, silicon, germanium, gallium, aluminium, and lead. The at least one further particulate electroactive material is preferably selected from graphite and hard carbon, and most preferably the at least one further particulate electroactive material is graphite.

The at least one further particulate electroactive material preferably has a D in the range 10 to 50 μm, preferably 10 to 40 μm, more preferably 10 to 30 μm and most preferably 10 to 25 μm, for example 15 to 25 μm_{50}And (4) the particle size.

D of at least one additional particulate electroactive material$_{50}$The particle size is preferably at least 5 μm, more preferably at least 6 μm, more preferably at least 7 μm, more preferably at least 8 μm, more preferably at least 9 μm, and still more preferably at least 10 μm.

D of at least one additional particulate electroactive material$_{50}$The particle diameter is preferably not more than 100 μm, more preferably not more than 80 μm, more preferably not more than 60 μm, more preferably not more than 50 μm, and most preferably not more than 40 μm.

In a preferred embodiment, the at least one further particulate electroactive material is selected from carbonaceous particles, graphite particles and/or hard carbon particles, wherein the graphite and hard carbon particles have a D in the range of 10 to 50 μm_{50}And (4) the particle size. Still more preferably, the at least one further particulate electroactive material is selected from graphite particles, wherein the graphite particles have a D in the range of 10 to 50 μm_{50}And (4) the particle size.

The particulate material of the present invention preferably comprises from 1 to 50 wt% of the total dry weight of electroactive material in the electrode composition (i.e. the total dry weight of the particulate material of the present invention and the at least one additional particulate electroactive material). More preferably, the particulate material of the present invention comprises from 2 to 40 wt%, more preferably from 4 to 25 wt%, more preferably from 5 to 20 wt% of the total dry weight of electroactive material in the electrode composition.

The electrode composition may optionally comprise a binder. The binder serves to adhere the electrode composition to the current collector and to maintain the integrity of the electrode composition. Examples of binders that may be used according to the present invention include polyvinylidene fluoride (PVDF), polyacrylic acid (PAA) and its alkali metal salts, modified polyacrylic acid (mPAA) and its alkali metal salts, carboxymethylcellulose (CMC), modified carboxymethylcellulose (mCMC), sodium carboxymethylcellulose (Na-CMC), polyvinyl alcohol (PVA), alginates and their alkali metal salts, styrene-butadiene rubber (SBR), and polyimides. The electrode

composition may comprise a mixture of binders. Preferably, the binder comprises a polymer selected from the group consisting of polyacrylic acid (PAA) and alkali metal salts thereof, and modified polyacrylic acid (mPAA) and alkali metal salts thereof, SBR and CMC.

The binder may suitably be present in an amount of from 0.5 to 20 wt%, preferably from 1 to 15 wt%, and most preferably from 2 to 10 wt%, based on the total dry weight of the electrode composition.

The adhesive may optionally be present in combination with one or more additives that modify the properties of the adhesive, such as a crosslinking promoter, a coupling agent, and/or an adhesion promoter.

The electrode composition may optionally include one or more conductive additives. Preferred conductive additives are non-electroactive materials that are included to enhance electrical conductivity between electroactive components of the electrode composition and the current collector. The conductive additive may be suitably selected from carbon black, carbon fiber, carbon nanotube, graphene, acetylene black, Ketjen black, metal fiber, metal powder, and conductive metal oxide. Preferred conductive additives include carbon black and carbon nanotubes.

The one or more conductive additives may suitably be present in a total amount of from 0.5 wt% to 20 wt%, preferably from 1 wt% to 15 wt%, and most preferably from 2 wt% to 10 wt%, based on the total dry weight of the electrode composition.

In a sixth aspect, the present invention provides an electrode comprising a particulate material as defined with reference to the second, third or fourth aspects of the invention, the particulate material being in electrical contact with a current collector. The particulate material used to prepare the electrode of the sixth aspect of the invention may have any of the features described as being preferred or optional in relation to the second and third aspects of the invention and/or may be prepared by a process comprising any of the features described as being preferred or optional in relation to the first aspect of the invention.

As used herein, the term current collector refers to any electrically conductive substrate capable of transporting electrical current to and from the electroactive particles in the electrode composition. Examples of materials that may be used as the current collector include copper, aluminum, stainless steel, nickel, titanium, and sintered carbon. Copper is the preferred material. The current collector is typically in the form of a foil or mesh having a thickness between 3 and 500 μm. The particulate material of the present invention may be applied to one or both surfaces of the current collector to a thickness preferably in the range 10 μm to 1mm, for example 20 to 500 μm, or 50 to 200 μm.

up to 2000 μm.

Preferably, the electrode comprises an electrode composition as defined with reference to the fifth aspect of the invention, said electrode composition being in electrical contact with a current collector. The electrode composition may have any of the features described as preferred or optional with respect to the fifth aspect of the invention. In particular, it is preferred that the electrode composition used to form the electrode of the sixth aspect of the invention comprises one or more additional particulate electroactive materials as described above.

The electrode of the sixth aspect of the present invention may be suitably manufactured by: the particulate material of the present invention (optionally in the form of the electrode composition of the present invention) is combined with a solvent and optionally one or more viscosity modifying additives to form a slurry. The slurry is then cast onto the surface of the current collector and the solvent is removed, thereby forming an electrode layer on the surface of the current collector. Additional steps such as heat treatment to cure any adhesive and/or calendering the electrode layer may be suitably performed. The electrode layer suitably has a thickness in the range 20 μm to 2mm, preferably 20 μm to 1mm, preferably 20 μm to 500 μm, preferably 20 μm to 200 μm, preferably 20 μm to 100 μm, preferably 20 μm to 50 μm.

Alternatively, the slurry may be formed into a free-standing film or mat comprising the particulate material of the present invention, for example by casting the slurry onto a suitable casting template, removing the solvent and then removing the casting template. The resulting film or mat is in the form of a cohesive, free-standing mass, which can then be bonded to a current collector by known methods.

The electrode of the sixth aspect of the invention may be used as an anode for a metal-ion battery. Accordingly, in a seventh aspect, the present invention provides a rechargeable metal-ion battery comprising: an anode comprising an electrode as described above, a cathode comprising a cathode active material capable of releasing and reabsorbing metal ions; and an electrolyte between the anode and the cathode.

The metal ions are preferably selected from lithium, sodium, potassium, calcium or magnesium. More preferably, the rechargeable metal-ion battery of the present invention is a lithium-ion battery, and the cathode active material is capable of releasing lithium ions.

The cathode active material is preferably a metal oxide-based composite material. Examples of suitable cathode active materials include $LiCoO_2$、$LiCo_{0.99}Al_{0.01}O_2$、$LiNiO_2$、$LiMnO_2$、$LiCo_{0.5}Ni_{0.5}O_2$、$LiCo_{0.7}Ni_{0.3}O_2$、$LiCo_{0.8}Ni_{0.2}O_2$、$LiCo_{0.82}Ni_{0.18}O_2$、$LiCo_{0.8}Ni_{0.15}Al_{0.05}O_2$、$LiNi_{0.4}Co_{0.3}Mn_{0.3}O_2$And $LiNi_{0.33}Co_{0.33}Mn_{0.34}O_2$. The

cathode current collector generally has a thickness of 3 to 500 μm. Examples of materials that can be used as cathode current collectors includeincluding aluminium, stainless steel, nickel, titanium, and sintered carbon.

The electrolyte is suitably a nonaqueous electrolyte containing a metal salt such as a lithium salt, and may include, but is not limited to, a nonaqueous electrolytic solution, a solid electrolyte, and an inorganic solid electrolyte. Examples of the nonaqueous electrolytic solution that can be used include aprotic organic solvents such as propylene carbonate, ethylene carbonate, butylene carbonate, dimethyl carbonate, diethyl carbonate, γ-butyrolactone, 1, 2-dimethoxyethane, 2-methyltetrahydrofuran, dimethylsulfoxide, 1, 3-dioxolane, formamide, dimethylformamide, acetonitrile, nitromethane, methyl formate, methyl acetate, phosphoric acid triester, trimethoxymethane, sulfolane, methylsulfolane and 1, 3-dimethyl-2-imidazolidinone.

Examples of the organic solid electrolyte include polyethylene derivatives, polyethylene oxide derivatives, polypropylene oxide derivatives, phosphate ester polymers, polyester sulfides (polyester sulfides), polyvinyl alcohols, polyvinylidene fluorides, and polymers containing ionic dissociation groups.

Examples of the inorganic solid electrolyte include nitrides, halides and sulfides of lithium salts, such as Li_5NI_2、Li_3N、LiI、$LiSiO_4$、Li_2SiS_3、Li_4SiO_4LiOH and Li_3PO_4.

The lithium salt may be suitably dissolved in the selected solvent or solvent mixture. Examples of suitable lithium salts include LiCl, LiBr, LiI, $LiClO_4$、$LiBF_4$、$LiB_{C4}O_8$、$LiPF_6$、$LiCF_3SO_3$、$LiAsF_6$、$LiSbF_6$、$LiAlCl_4$、CH_3SO_3Li and CF_3SO_3Li.

In the case where the electrolyte is a non-aqueous organic solution, the metal-ion battery is preferably provided with a separator interposed between the anode and the cathode. The separator is generally formed of an insulating material having high ion permeability and high mechanical strength. The separator typically has a pore size of 0.01 to 100 μm and a thickness of 5 to 300 μm. Examples of suitable electrode separators include microporous polyethylene films.

The separator may be replaced by a polymer electrolyte material, and in this case, the polymer electrolyte material is present in both the composite anode layer and the composite cathode layer. The polymer electrolyte material may be a solid polymer electrolyte or a gel-type polymer electrolyte.

In an eighth aspect, the present invention provides the use of a particulate material as defined with reference to the second, third or fourth aspects of the invention as an anode active material. Preferably, the particulate material is in the form of an electrode composition as defined with reference to the fifth aspect of the invention, and most preferably the electrode composition comprises one or more further particulate electroactive materials as defined above.

According to ASTM D5373, usingThe TruSpec trace element analyzer performs elemental analysis on the particulate materials of the present invention reported herein to determine the weight% of carbon, nitrogen and oxygen in the particulate material. Analysis of silicon was performed according to ASTM D5600 using ICP-AES.

The invention will now be described by way of example and accompanying figure 1, which is the capacity retention (y-axis) versus carbon for samples 1 to 9 and comparative sample 1 as follows: graph of silicon ratio.

Examples

Example 1 preparation of particulate silicon-carbon Material

The particulate silicon-carbon materials of samples 1 to 12 and the control sample (CS1) were prepared using silicon feedstock and carbon source in the amounts specified in table 1.

The indicated carbon source was dissolved in the indicated solvent (about 46mL) in a glass beaker. A particulate silicon feedstock is added and the mixture is stirred to form a slurry. The resulting slurry was transferred to a Retsch ball mill cup containing 1mm zirconia grinding beads. The beaker was rinsed with additional solvent (2 × 15mL) and the washings were added to the Retsch ball mill cup. The lid was placed on the bowl of the ball mill and weighed. Weighing the second bowl mill cup and adjusting its weight until it is the same as the first bowl mill cup; during planetary ball milling, the second cup serves as a counter-balance for the first cup. Two cups were mounted on a Retsch PM200 planetary ball mill and the mixture was milled at 500rpm for 30 minute intervals, left to stand for 15 minutes, the direction of the mill reversed and the steps repeated until each sample had reached the total active milling time set forth in table 1.

TABLE 1

[1]2, 3-dihydronaphthalene;[2]2, 3-diaminonaphthalene;[3]1, 2-diaminobenzene;[4]isopropyl alcohol;[5]not determined

The grinding cup is cooled. The milled material was filtered through a 53 µm screen and washed with additional solvent (about 150mL) until the filtrate was light. The solvent was removed from the filtrate under reduced pressure using a Buchi rotary evaporator. The resulting residue was further dried in an oven at 75 °C overnight.

The dried material was washed with 5x 20mL portions of acetone to remove any unbound carbon source. The acetone washed material was then pyrolyzed in an alumina crucible in a furnace using the pyrolysis protocol specified in table 2. The material was sealed in an alumina crucible under argon flow (1L/min) and programmed into the furnace to heat at a rate of 5 °C/min to the initial temperature specified in table 2 (T1). The crucible was maintained at this initial temperature for the first holding time specified in table 2 (T1), then the temperature was increased at a rate of 5 °C/min to the final temperature specified in table 2 (T2), and the crucible was maintained at this temperature for the second holding time specified in table 2 (T2), and then cooled to room temperature.

The pyrolyzed material was removed from the crucible and micronized using a hand held micronizer for a period of time of up to 10 seconds for a total micronization time of up to 30 seconds to 1 minute. The micronized material was then dry milled using a fletsch PM200 planetary ball mill under the conditions specified in table 2. The material was placed in the bowl of a ball mill in the amounts specified in table 2 along with the required amount of milling beads, milled at 500rpm for 2 minutes, left to stand for 1 minute, the orientation of the mill changed, and repeated until the total active milling time specified in table 2 had been reached.

TABLE 2

The particulate material was then subjected to particle size analysis using a Malvern Mastersizer3000 instrument and elemental analysis using both ICP/MS and LECO techniques. The BET surface area values of the resulting particulate materials were also determined using a Micromeritics Tristar II3020 instrument and the results for samples 1 to 12 and comparative sample 1 are listed in table 3.

TABLE 3

Example 2 preparation of an electrode

Anodes having the compositions specified in table 4 were prepared from the materials of examples 1 to 12 and control sample 1(CS1) using the following method. Test coin cells were fabricated with anodes comprising silicon-carbon particulate material prepared as described above. Carbon Super P (conductive carbon) and natural graphite (D_{50}2.85 µm) dispersion in CMC binder in Thinky™Mixing in a mixer. Adding silicon carbon particulate material to the mixture and mixing in Thinky™Mix in the mixer for 30 minutes. The SBR binder was then added to give a 1: 1 CMC to SBR ratio, resulting in a 1: 1 CMC to SBR having the particulate silicon-carbon to graphite to CMC/SBR ratio as set forth in Table 4. conductive carbon in a weight ratio. The slurry was further mixed by magnetic stirring for 1 hour, and then coated on a copper substrate (current collector) 10 µm thick and dried at 50 °C for 10 minutes and then further dried at 120-180 °C for 12 hours, thereby forming an electrode comprising an active layer on the copper substrate. The active layer was calendered at 2T prior to cell manufacture.

TABLE 4

Example 3 Battery fabrication and cycling

Half cell fabrication

A coin half cell was fabricated using a disk-shaped electrode of 0.8cm radius cut from the electrode of example 2 with a porous polyethylene separator, lithium foil as the counter electrode, and an electrolyte comprising 1M LiPF in a 7: 3 solution of EC/FEC (ethylene carbonate/fluoroethylene carbonate) containing 3 wt% vinylene carbonate$_6$.

These half cells were used to measure the initial volumetric energy density (VED1), First Cycle Loss (FCL) and first delithiation capacity (DC1) of the active layer. The correlation values are listed in table 5. The half-cells were tested by applying a constant current of C/25 (where "C" represents the specific capacity of the electrode in mAh and "25" means 25 hours) to lithiate the electrode containing the porous particles with a cut-off voltage of 10 mV. When the cut-off value is reached, a constant voltage of 10mV is applied and the cut-off current is C/100. The cell was then left to stand in the lithiated state for 1 hour. The electrode was then delithiated at a constant current of C/25, with a cut-off voltage of 1V, and the cell was then left to stand for 1 hour. Then, a constant current of C/25 is applied to carry out secondary lithiation on the lithium battery, the cut-off voltage is 10mV, then a constant voltage of 10mV is applied, and the cut-off current is C/100.

Full cell fabrication

A full coin cell was fabricated using a disk-shaped negative electrode with a radius of 0.8cm cut from the electrode, a porous polyethylene separator, and a cobalt lithium oxide positive electrode. The positive and negative electrodes were designed to form a balanced pair such that the designed capacity ratio of the electrodes was about 1: 1. Then 1M LiPF in a 7: 3 solution of EMC/FEC (ethylene methyl carbonate/fluoroethylene carbonate) containing 3 wt % vinylene carbonate$_6$The electrolyte of (a) is added to the cell and then sealed.

The cycle of the full cell was as follows: a constant current was applied at a rate of C/25 to lithiate the anode with a cutoff voltage of 4.2V. When the cutoff value is reached, a constant voltage of 4.2V is applied until a cutoff current of C/100 is reached. The cell was then left to stand in the lithiated state for 1 hour. Then, the anode was delithiated at a constant current of C/25, and the cut-off voltage was 3.0V. The cell was then allowed to stand for 1 hour. After this initial cycle, a constant current of C/2 was applied to lithiate the anode with a cut-off voltage of 4.2V, and then a constant voltage of 4, 2V was applied with a cut-off current of C/40. The anode was then delithiated at a constant current of C/2 with a cut-off of 3.0V. The cell was then allowed to stand for 5 minutes. And then repeated for the desired number of cycles. The charge and discharge capacity (DC100) and capacity retention rate (CR100) at 100 cycles of each sample were determined; these values are also listed in table 5.

TABLE 5

FIG. 1 is a graph of capacity retention (y-axis) versus carbon to silicon ratio. It was observed that when the carbon good capacity retention was observed at silicon ratios greater than 0.10. At a carbon to silicon ratio of 0.1 or less, the capacity retention rate is relatively poor. Desirably, the ratio of carbon to silicon in the particulate material is about 0.4 to 0.65.

Example 4 preparation of particulate silicon-carbon Material

The isopropanol (IPA) was transferred to a Netzsch high energy stirred bead mill containing 200 micron zirconia grinding beads. The bead mill was then set to recycle IPA and silicon was slowly added to the solvent to produce an approximately 27% w/w silicon slurry. The slurry is then milled to D_{90}< 800nm while keeping the slurry temperature below 50 °C. Particle size measurements were performed on a malvern mastersizer 3000. The resulting milled slurry was then discharged into a suitable container and the solids content (typically-30% w/w) was measured on a Loss On Drying (LOD) moisture analyzer. This slurry is referred to as a "pre-milled" silicon slurry.

The "pre-milled" silica slurry was then adjusted to 20% w/w solids content using IPAAnd loaded into a Netzsch bead mill containing 50 micron zirconia grinding beads. The slurry is then milled to D_{90}< 188nm while keeping the slurry temperature below 50 °C. Particle size measurements were performed on a Malvern Mastersizer 3000. The resulting milled slurry was then discharged into a suitable container and the solids content (typically 27-30% w/w) was measured on a LOD moisture analyzer. This

slurry is referred to as a "nano-milled" silicon slurry.

A20% w/w polyvinylpyrrolidone (PVP) solution in IPA was prepared by dissolving PVP in IPA using an overhead stirrer. The solid content was then measured using a LOD moisture analyzer. This PVP solution was then combined with a "nano-milled" silicon slurry at a solids weight ratio of 1 part silicon to 1.1 parts PVP and mixed using an overhead stirrer until complete homogenization in a high pressure homogenizer. The homogeneous Si:PVP slurry was passed through a high pressure homogenizer at a pressure of about 1500 bar and collected in a suitable vessel. The solids content was then measured on a LOD moisture analyzer (Sartorius MA37 at 100 °C) and adjusted to 20% w/w total solids content with IPA prior to spray drying.

Spray drying was performed on a procept 4M8Trix dryer with nitrogen closed loop. A homogeneous Si/PVP/IPA slurry (411g) was fed to the spray dryer at a rate of 10 g/min. The dried product was collected from the cyclone (71.2g, 87% recovery) and was found to have D_{50} 10.6 μm (Malvern Mastersizer/Aero) and a volatiles content of 7% by weight.

Additional dried product (10.9g) was recovered from the wall of the drying chamber, but was not combined with the material from the cyclone.

The spray dried material (20g batch size) was then charged into a 400mL glass rotary furnace vessel and placed into a Carbolite HTR1100 rotary furnace. The material was then placed under dry compressed air at a flow rate of 0.2mL/min and rotated at about 0.75 rpm. The airflow and rotation is maintained throughout the process. The furnace is heated under controlled conditions at a ramp rate of no more than 5 °C/min to a maximum temperature of 270 °C and then held at that temperature for 4 hours to crosslink the PVP and silicon. After crosslinking, the material was left to cool for about 2 hours and then discharged from the container. At this stage, a 2g sample was taken and the material composition was analyzed using both ICP/MS and LECO techniques.

The crosslinked material was then placed in an alumina crucible and pyrolyzed in a static Carbolite tube furnace under flowing nitrogen (0.6L/min). The furnace was heated to 1170 °C at a rate of 5 °C/min, then held at that temperature for 3 hours, and then allowed to cool naturally (typically 10-15 hours).

The pyrolysis product was then sieved through a 38 micron screen prior to use. The materials are also well characterized in terms of elemental composition (as described above) and surface area (BET), particle size, and tap density. BET was measured using a Micromeritics Tristar II3020 instrument. The properties of the final product are provided below in table 6.

Example 5 preparation of particulate silicon-carbon Material without temperature control

Example 5 was carried out in the same manner as described in example 4, except that the crosslinking reaction was carried out in a static oven and the maximum temperature of the crosslinking reaction was not controlled. Due to the exothermic crosslinking reaction, the internal temperature rapidly increased from 100 °C to well over 300 °C. The properties of the final product are provided below in table 6.

Example 6 preparation of carbon-coated silicon-carbon composite via CVD

11.1g of the silicon-carbon composite prepared according to the method of example 5 was charged into a tared quartz reaction vessel (400mL/85mm diameter) and heated to 900 °C under argon (250mL/min) in a Carbolite HTR1100 rotary furnace at 5 °C/min. The oscillation was set to about 1/min. When the furnace reached the target temperature, ethylene gas (20mL/min) was introduced for 20 minutes. The ethylene flow was then stopped and argon was allowed to flow for an additional 5 minutes, after which the heating was stopped. While spinning, the product was allowed to cool passively under argon until the internal temperature had dropped to 80 °C. The reaction vessel was weighed and an approximate weight gain of 0.3g (2.6%) was recorded. The product (10.6g) was collected and found to have had a BET reduction from 5.0 to 3.4m^2/g in terms of/g. The properties of the final product are provided below in table 6.

TABLE 6

Patent Citations (9)

Publication number	Priority date	Publication date	Assignee	Title
Family To Family Citations				
FR2936102B1 *	2008-09-12	2010-10-29	Commissariat Energie Atomique	PROCESS FOR THE PREPARATION OF A COMPOSITE MATERIAL SILICON / CARBON, MATERIAL THUS PREPARED AND ELECTRODE IN PARTICULAR NEGATIVE ELECTRODE, COMPRISING THIS MATERIAL.
US8580432B2 *	2008-12-04	2013-11-12	Nanotek Instruments, Inc.	Nano graphene reinforced nanocomposite particles for lithium battery electrodes
CN104103807A *	2013-04-12	2014-10-15	华为技术有限公司	Silicon-carbon composite anode material, preparation method thereof and lithium ion battery
US20170047581A1 *	2014-02-11	2017-02-16	Battelle Memorial Institute	Additives to enhance electrode wetting and performance and methods of making electrodes comprising the same
EP2919298B1 *	2014-03-12	2017-08-23	Belenos Clean Power Holding AG	Si/C composite anodes for lithium-ion batteries with a sustained high capacity per unit area
WO2016106487A1 *	2014-12-29	2016-07-07	Robert Bosch Gmbh	Silicon-carbon composite, a method for preparing said composite, and an electrode material and a battery comprising said composite
KR101726037B1 *	2015-03-26	2017-04-11	(주)오렌지파워	Silicon based negative electrode material for rechargeable battery and method of fabricating the same
TWI594487B *	2015-04-28	2017-08-01	財團法人工業技術研究院	Composite powder for use in an anode of a lithium ion battery, method for manufacturing a composite powder and lithium ion battery
CN108574261B *	2016-05-06	2020-09-21	中国科学院宁波材料技术与工程研究所	A kind of lithium ion battery negative material, preparation method and lithium ion battery

			源材料技术与工程研究所	

* Cited by examiner, † Cited by third party

Cited By (7)

Publication number	Priority date	Publication date	Assignee	Title
CN111525194A *	2020-04-28	2020-08-11	宁德新能源科技有限公司	Electrochemical device and electronic device including the same
Family To Family Citations				
AU2020307830A1	2019-06-28	2022-02-10	Talga Technologies Limited	Silicon and graphite containing composite material and method for producing same
GB2587328B *	2019-09-16	2021-12-22	Nexeon Ltd	Composite materials and methods
GB2600386400 *	2019-09-16	2020-04-29	Nexeon Ltd	Electroactive materials for use in metal-ion batteries
KR20210156918A *	2020-06-18	2021-12-28	삼성에스디아이 주식회사	Negative active material for rechargeable lithium battery, method of preparing same, and rechargeable lithium battery including the same
WO2022002404A1	2020-07-02	2022-01-06	Wacker Chemie Ag	Method for producing carbon-coated silicon particles for lithium-ion batteries
CN111755684A *	2020-07-06	2020-10-09	马鞍山科达普锐能源科技有限公司	Silicon-carbon negative electrode material for lithium ion battery and preparation method thereof

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
CN107223288B	2021-02-02	Electrode of metal ion battery
KR20210107093A	2021-08-31	Electroactive materials for metal-ion batteries
CN110753674A	2020-02-04	Electroactive material for metal ion batteries
TWI594485B	2017-08-01	Anode material for lithium ion secondary battery, anode for lithium ion secondary battery and lithium ion secondary battery
KR20210088723A	2021-07-16	Electroactive Materials for Metal Ion Batteries
JP2014002890A	2014-01-09	Negative electrode material for nonaqueous electrolyte secondary battery, negative electrode active material for nonaqueous electrolyte secondary battery, negative electrode for nonaqueous electrolyte secondary battery, nonaqueous electrolyte secondary battery, and battery pack
AU2008279196B2	2011-08-11	Porous network negative electrodes for non-aqueous electrolyte secondary battery
JP6172564B2	2013-03-27	Nonaqueous electrolyte secondary battery
TWI624984B	2018-05-21	Anode material for lithium ion secondary cell, anode for lithium ion secondary cell and lithium ion secondary cell
JP2015210892A	2015-11-24	Negative electrode material for lithium ion secondary batteries, negative electrode for lithium ion secondary batteries, and lithium ion secondary battery
KR20210088720A	2021-07-16	Electroactive Materials for Metal Ion Batteries
WO2015140984A1	2015-09-24	Electrode for nonaqueous electrolyte battery, nonaqueous electrolyte secondary battery and battery pack
JP6615431B2	2019-12-04	Negative electrode material for lithium ion secondary battery, negative electrode for lithium ion secondary battery, and lithium ion secondary battery
WO2018173813A1	2018-10-04	Negative electrode active material for lithium ion secondary battery, negative electrode for lithium ion secondary battery, and lithium ion secondary battery
KR20150078868A	2015-07-08	Method of preparing anode active material for rechargeable lithium battery and rechargeable lithium battery
JP6409318B2	2018-10-24	Negative electrode material for lithium ion secondary battery, negative electrode for lithium ion secondary battery, and lithium ion secondary battery
US11056493B1	2021-03-30	Electroactive materials for metal-ion batteries
US20210276875A1	2021-09-09	Electroactive Materials for Metal-Ion Batteries
US20210408530A1	2021-12-30	Electroactive Materials for Metal-Ion Batteries

CN113795945A	2021-12-14	Electroactive material for metal ion batteries
GB2597760A	2022-02-09	Electroactive materials for metal-ion batteries

Priority And Related Applications

Priority Applications (3)

Application	Priority date	Filing date	Title
GB1709685.9A	2017-06-16	2017-06-16	Particulate electroactive materials for use in metal-ion batteries
GB1709685.9		2017-06-16	
PCT/GB2018/051689	2017-06-16	2018-06-18	Electroactive materials for metal-ion batteries

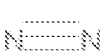
Legal Events

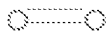
Date	Code	Title	Description
2020-02-04	PB01	Publication	
2020-02-04	PB01	Publication	
2020-07-10	SE01	Entry into force of request for substantive examination	
2020-07-10	SE01	Entry into force of request for substantive examination	

Concepts

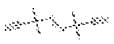
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Download Filter table

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metal		title,claims,description	20	0.000
metal		title,claims,description	20	0.000
ions		title,claims,description	16	0.000
particulate material		claims,abstract,description	209	0.000
carbon		claims,abstract,description	208	0.000
silicon		claims,abstract,description	203	0.000
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silicon		claims,abstract,description	203	0.000
nitrogen		claims,abstract,description	184	0.000
carbon		claims,abstract,description	179	0.000
oxygen		claims,abstract,description	134	0.000
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oxygen		claims,abstract,description	134	0.000



nano-size silicon particle	claims,abstract,description	112	0.000
nitrogen	claims,abstract,description	97	0.000
composite particle	claims,abstract,description	54	0.000
matrix material	claims,abstract,description	49	0.000
particle	claims,description	138	0.000
pyrolytic carbon	claims,description	64	0.000
mixture	claims,description	61	0.000
precursor	claims,description	57	0.000



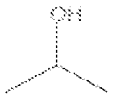
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coating agent	claims,description	11	0.000
coating method	claims,description	11	0.000
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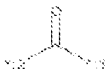
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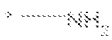
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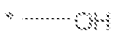
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germanium	claims,description	3	0.000



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ketones	claims,description	3	0.000
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Show all concepts from the description section

A kind of fast charge polymer lithium ion battery electric core structure

Abstract

The utility model discloses a kind of fast charge polymer lithium ion battery electric core structure, it is made of positive plate, positive pole ear, negative plate, negative lug, isolation film and electrolyte, positive plate includes aluminium foil and coated on the positive active material on aluminium foil, and lug is equipped with the anode pole piece head end surface region.Negative plate includes copper foil and coated on the negative electrode active material on copper foil, and lug is equipped with the front-end surface region of the negative plate The positive and negative lug of this core structure to the uncoated active material in region, the thickness of lug is equivalent to the thickness of two layers of active material so that core lug position thickness is consistent with other regions, improves space availability ratio, the battery capacity higher of same size.The good heat dispersion performance of copper foil, core is most interior and outermost layer is one layer of blank copper foil region, greatly improves the heat dissipation performance of battery, adds battery fast charging and discharging performance, avoiding heat accumulation of battery when high current works security incident occurs.

Classifications

» Y02P70/50 Manufacturing or production processes characterised by the final manufactured product

CN207303263U

China

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Other languages: Chinese

Inventor: 王敬, 李丽敏, 刘小红

Current Assignee : Shenzhen Greende Energy Group Co., Ltd.

Worldwide applications

2017 CN

Application CN201720234356.0U events

2017-03-12 Application filed by Shenzhen Greens Moral Ltd Energy Co

2017-03-12 Priority to CN201720234356.0U

2018-05-01 Application granted

2018-05-01 Publication of CN207303263U

Info: Cited by (1), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (4)

Hide Dependent

1. A kind of 1. fast charge polymer lithium ion battery electric core structure, by positive plate, positive pole ear, negative plate, negative lug, isolation Film and electrolyte composition, it is characterised in that the positive plate includes aluminium foil and coated on the positive active material on aluminium foil, The positive plate front-end surface region is equipped with lug, and the upper and lower surface of positive plate front end is both provided with uncoated positive active matter The blank aluminium foil area of matter floor; The negative plate includes copper foil and coated on the negative electrode active material on copper foil, is the anode The front-end surface region of piece is equipped with lug, and the upper and lower surface of negative plate front end and the upper and lower surface of tail end are both provided with uncoated negative The blank copper foil area of pole active material layer, the wherein upper and lower surface of leading portion are the first clear area, and the upper and lower surface of tail end is second Clear area, negative lug are arranged on the first clear area.

2. A kind of 2. fast charge polymer lithium ion battery electric core structure according to claim 1, it is characterised in that the battery core knot its positive pole ear of structure （1） Be the upper surface head blank copper foil area that is not coated with active material to negative regions （6） , lower surface head Blank copper foil area of portion （9） , and negative lug （3） Then it is wrapped in two layers of cathode pole piece that single side scribbles negative electrode active material, its Face region is the upper surface head blank copper foil area for being not coated with active material （6） , core innermost layer is uncoated negative electrode activity Material lower surface head blank copper foil area （9） , outermost layer is then uncoated negative electrode active material lower surface afterbody blank copper foil area （5） .

3. A kind of 3. fast charge polymer lithium ion battery electric core structure according to claim 1, it is characterised in that it is described just Pole piece front end upper and lower surface area blank aluminium foil section length is consistent, length 5-21mm.

4. 4. a kind of fast charge polymer lithium ion battery electric core structure according to claim 1, it is characterised in that described is negative The first clear area of pole piece upper surface length is more than the length of lower surface, and the second clear area lower surface length is longer than upper surface.

Description

A kind of fast charge polymer lithium ion battery electric core structure

Technical field

The utility model belongs to lithium ion battery technology manufacturing field, and in particular to a kind of thickness is uniform, thermal diffusivity is good, Safe fast charge polymer lithium ion battery electric core structure.

Background technology

Lithium ion battery has the advantages that energy density is big, output power is high, charge discharge life is long, pollution-free, extensively should For in the fields such as high energy portable electric appts, communications and transportation, unmanned plane, continuous with lithium ion battery applications field to be opened up Exhibition, quick rhythm of life make it that discharge and recharge time requirement of the people to battery is also higher and higher.Quickly, safety, high power capacity High performance lithium ion battery progressively develops into the standard configuration of some electronic equipments.Inside lithium ion cell positive and negative anodes active material and The chemical reaction of electrolyte can release heat, and the discharge and recharge of particularly high current can produce more heats, if the heat produced it cannot in time disperse, the heating for causing battery further be promoted to the aggravation of chemical reaction, the lasting accumulation of heat, battery is just in the presence of burning, explosion equivalent risk.

At present, as the continuous of lithium ion battery applications field is expanded, high security of the people to suitable fast charging and discharging Lithium ion battery demand it is more and more extensive Traditional lithium ion battery structure is not suitable for high current charge-discharge, and high current is filled internal temperature of battery is higher during electric discharge, and there are larger security risk.Therefore, find a kind of lithium of safe suitable fast charge from Sub- battery battery core structure is particularly significant.

The content of the invention

The utility model aim is: The fast charge polymer Li-ion that a kind of rapid heat dissipation, thickness are uniform, safe is provided Battery battery core structure.Compared with traditional battery core structure of lithium-ion battery, the positive and negative lug of this structure to the uncoated work in region Property material, the thickness of lug is equivalent to the thickness of two layers of active material so that core lug position thickness is protected with other regions Hold unanimously, improve space availability ratio, the battery capacity higher of same size.The good heat dispersion performance of copper foil, core it is most interior and Outermost layer is one layer of blank copper foil region, greatly improves the heat dissipation performance of battery, adds the property of battery fast charging and discharging Can, avoiding heat accumulation of battery when high current works security incident occurs.

The technical solution that the utility model is taken is as follows:

A kind of fast charge polymer lithium ion battery electric core structure, by positive plate, positive pole ear, negative plate, negative lug, every Formed from film and electrolyte, the positive plate includes aluminium foil and coated on the positive active material on aluminium foil, it is described just Pole piece front-end surface region is equipped with lug, and the upper and lower surface of positive plate front end is both provided with the sky of uncoated positive active material layer White aluminium foil area; The negative plate includes copper foil and coated on the negative electrode active material on copper foil, in the front end of the negative plate Surface region is equipped with lug, and the upper and lower surface of negative plate front end and the upper and lower surface of tail end are both provided with uncoated negative electrode active matter The blank copper foil area of matter floor, the wherein upper and lower surface of leading portion are the first clear area, and the upper and lower surface of tail end is the second clear area, are born Pole lug is arranged on the first clear area.

After the completion of winding, positive pole ear 1 be the upper surface head blank copper foil that is not coated with active material to negative regions Area 6, lower surface head blank copper foil area 9, and negative lug 3 is then wrapped in two layers of the anode pole that single side scribbles negative electrode active material in piece, its face region is the upper surface head blank copper foil area 6 for being not coated with active material, and core innermost layer is uncoated negative electrode Active material lower surface head blank copper foil area 8, outermost layer are then uncoated negative electrode active material lower surface afterbody blank copper foil Area 5.

The positive plate front end upper and lower surface area blank aluminium foil section length is consistent, length 5-20mm.

The first clear area of negative plate upper surface length is more than the length of lower surface, the second clear area lower surface length it is longer than upper surface.

Brief description of the drawings

Fig. 1 is the core structure schematic diagram of the utility model.

Fig. 2 is the structure diagram of the utility model positive plate.

Fig. 3 is the top view of the utility model Fig. 2.

Fig. 4 is the structure diagram of the utility model negative plate.

Fig. 5 is the top view of the utility model Fig. 4.

Embodiment

Below in conjunction with the accompanying drawings 1, Fig. 2, Fig. 3, Fig. 4 and Fig. 5 are described further the utility model:

Described in Fig. 1, the core of the utility model structure is formed by positive plate, negative plate, membrane winding, it is described just Pole piece is made of aluminium foil and the positive active material being coated onto, and the negative plate is by copper foil and is coated onto Negative electrode active material forms.Positive pole ear 1 be the upper surface head blank copper foil area that is not coated with active material to negative regions 6th, lower surface head blank copper foil area 9, and negative electrode lug 3 is then wrapped in 2 layers of cathode pole piece that single side scribbles negative electrode active material, its face region is also the upper surface head blank copper foil area 6 for being not coated with active material, and core innermost layer is lived for uncoated negative electrode Property material lower surface head blank copper foil area 9, outermost layer is then uncoated negative electrode active material lower surface afterbody blank copper foil area 8,

To realize the purpose of this utility model, negative plate as shown in Figure 4,5, its end is welded with negative lug, head and the tail two There is the blank copper foil area of uncoated active material at end, and head end is the first clear area, its upper surface head blank copper foil area 6 is longer than Lower surface head blank copper foil area 9, tail end are the second clear area, its lower surface afterbody blank copper foil area 5 is longer than upper surface afterbody Blank copper foil area 8.

As shown in Figure 2,3, cathode head end is equipped with the blank aluminium foil area of uncoated active material, wherein upper and lower surface clear area Length it is consistent, positive pole ear is welded in herein, the length of 5-20mm.

The positive and negative lug of this core structure to the uncoated active material in region, the thickness of lug is equivalent to two layers of activity The thickness of material so that core lug position thickness is consistent with other regions, improves space availability ratio, same size Battery capacity higher.The good heat dispersion performance of copper foil, core is most interior and outermost layer is a floor blank copper foil area, greatly improves The heat dissipation performance of battery, adds the performance of battery fast charging and discharging, avoids battery because of heat accumulation when high current works And security incident occurs.

Cited By (1)

Publication number	Priority date	Publication date	Assignee	Title
CN111525194A *	2020-04-28	2020-08-11	[redacted]	Electrochemical device and electronic device including the same
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
JP5655388B2	2013-08-07	Unit cell for secondary battery having conductive sheet layer and lithium ion secondary battery using the same
CN201845833U	2011-05-25	Novel polymer lithium-ion secondary battery
CN105428578A	2016-03-23	Composite ceramic coating, lithium ion battery composite ceramic diaphragm and lithium ion battery
CN101364644A	2009-02-11	Lithium battery current collecting body, high capacity cylindrical lithium ionic cell and preparation
CN106169617A	2016-11-30	A kind of space safety high power lithium ion accumulator
CN108649182A	2018-10-12	A kind of high security lithium ion battery
CN206878126U	2018-01-12	Secondary cell
CN201247785Y	2009-05-27	Lithium ion battery case with compound structure
KR102152143B1	2020-09-04	Electrode Assembly Comprising Separator Having Insulation-enhancing Part Formed on Edge Portion of Electrode
CN203351704U	2013-12-18	Ultra-high-multiplying-power cylindrical lithium iron phosphate battery containing graphene coating
CN203521496U	2014-04-02	Apple-shaped large-power polymer lithium battery
CN207303263U	2018-05-01	A kind of fast charge polymer lithium ion battery electric core structure
CN203026604U	2013-06-26	Cell structure of soft-package lithium battery
CN202019028U	2011-10-26	Cell core of lithium cell and lithium cell
CN206673036U	2017-11-24	Triangle overlapping lithium ion battery
CN105591151A	2016-05-18	Multiplying power type ternary battery and preparation method thereof
CN206388025U	2017-10-24	Cylindrical lithium ion battery with hollow pole
CN205861781U	2016-11-09	A kind of high safe lithium ion battery
CN105206865B	2018-01-12	A kind of electrodeless ear winding type lithium ion battery cell and its manufacture method
CN204577503U	2015-08-19	Barrier film, battery core and secondary cell
CN101325246A	2008-12-17	Casing of lithium ion battery with composite structure
CN106252572A	2016-12-21	A kind of energy-density lithium ion battery and preparation method thereof
CN104051781A	2014-09-17	Lithium ion power battery and method for manufacturing battery
CN206639863U	2017-11-14	A kind of lithium ion battery with new type lithium ion battery pole piece
CN206056514U	2017-03-29	A kind of cupric lithium piece negative pole poly-lithium battery

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN201720234356.0U	2017-03-12	2017-03-12	A kind of fast charge polymer lithium ion battery electric core structure

Applications Claiming Priority (1)

Application	Filing date	Title

CN201720284356.8U	2017-03-12	A kind of fast charge polymer lithium ion battery electric core structure

Legal Events

Date	Code	Title	Description
2018-05-01	GR01	Patent grant	
2018-05-01	GR01	Patent grant	
2019-03-15	CP01	Change in the name or title of a patent holder	
2019-03-15	CP01	Change in the name or title of a patent holder	**Address after**: 518105 4th Floor, Building A2, Liyuan Bay Industrial Park, 168 Honghu Road, Yanchuan, Songgang, Baoan District, Shenzhen City, Guangdong Province **Patentee after**: Shenzhen Greende Energy Group Co., Ltd. **Address before**: 518105 4th Floor, Building A2, Liyuan Bay Industrial Park, 168 Honghu Road, Yanchuan, Songgang, Baoan District, Shenzhen City, Guangdong Province **Patentee before**: Shenzhen Green's moral limited energy company

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
lithium ion		title,claims,abstract,description	19	0.000
Lithium ion	Li^+	title,claims,abstract,description	17	0.000
polymer		title,claims,abstract,description	10	0.000
copper foil		claims,abstract,description	35	0.000
active material		claims,abstract,description	14	0.000
aluminum foil		claims,abstract,description	12	0.000
negative electrode material		claims,abstract,description	11	0.000
positive electrode material		claims,abstract,description	5	0.000
electrolyte		claims,abstract,description	4	0.000
isolation		claims,abstract	2	0.000
material		claims,description	4	0.000
effects		claims,description	2	0.000
accumulation		abstract,description	4	0.000
discharging		abstract,description	4	0.000
heat dissipation		abstract,description	4	0.000
dispersion		abstract,description	3	0.000

Show all concepts from the description section

Lithium-ion battery and electrolyte thereof

Abstract

The invention provides a lithium-ion battery and an electrolyte thereof. The electrolyte of the lithium-ion battery comprises a non-aqueous organic solvent, a lithium salt and an additive, wherein the lithium salt is dissolved into the non-aqueous organic solvent; the additive is dissolved into the non-aqueous organic solvent and comprises a 1,3-dioxo heterocyclic compound with a structure in a formula I and fluoroethylene carbonate (FEC); in the formula I, R1 and R2 are independently selected from H, methyl or ethyl respectively; n is an integer selected from 1 to 3; the mass percent of the 1,3-dioxo heterocyclic compound with the structure in the formula I in the electrolyte of the lithium-ion battery is 0.05%-5%; and the mass percent of the fluoroethylene carbonate (FEC) in the electrolyte of the lithium-ion battery is 1%-8%. The lithium-ion battery comprises the electrolyte of the lithium-ion battery. The lithium-ion battery provided by the invention has excellent high-temperature storage performance and low-temperature discharge rate capability.

Classifications

- H01M10/0567 Liquid materials characterised by the additives

View 8 more classifications

CN105336984A

China

Download PDF Find Prior Art Similar

Other languages: Chinese

Inventor: 叶士雄, 李伟, 何成华, 姚霞银

Current Assignee : Ningde Amperex Technology Ltd , Dongguan Amperex Technology Ltd , Amperex Technology Ltd

Worldwide applications

2014 CN 2015 WO

Application CN201410374264.3A events

2014-07-31 Application filed by Ningde Amperex Technology Ltd, Dongguan Amperex Technology Ltd

2014-07-31 Priority to CN201410374264.3A

2016-02-17 Publication of CN105336984A

2018-05-22 Application granted

2018-05-22 Publication of CN105336984B

Info: Patent citations (5), Non-patent citations (2), Cited by (6), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (10)

Hide Dependent

1. an electrolyte for lithium ion battery, comprising:

Non-aqueous organic solvent;

Lithium salts, is dissolved in non-aqueous organic solvent; And

Additive, is dissolved in non-aqueous organic solvent;

It is characterized in that,

Described additive package is containing 1,3-dioxane compound and the fluorinated ethylene carbonate (FEC) with formula I structure;

In formula I, R_1, R_2 independently be selected from H, methyl or ethyl separately; N is selected from the integer in 1 ~ 3;

The mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery with formula I structure is 0.05% ~ 5%;

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 1% ~ 8%.

2. the electrolyte of lithium ion battery according to claim 1, is characterized in that, described non-aqueous organic solvent comprises one or more in carbonic ester and carboxylate, and carbonic ester comprises cyclic carbonate and linear carbonate.

3. the electrolyte of lithium ion battery according to claim 2, is characterized in that,

Cyclic carbonate is selected from one or more in propene carbonate (PC), ethylene carbonate (EC);

Linear carbonate is selected from one or more in dimethyl carbonate (DMC), methyl ethyl carbonate (EMC), methyl propyl carbonate (MPC);

Carboxylate is selected from one or more in gamma-butyrolacton (GBL), methyl formate (FA), ethyl acetate (EA), methyl butyrate (BA).

4. the electrolyte of the lithium ion battery according to Claims 2 or 3, is characterized in that,

The volume of linear carbonate is 40% ~ 70% of the cumulative volume of non-aqueous organic solvent.

The volume of carboxylate is 40% ~ 70% of the cumulative volume of non-aqueous organic solvent;

Surplus is cyclic carbonate.

5. the electrolyte of lithium ion battery according to claim 1, it is characterized in that, described have 1 of formula I structure, 3-dioxane compound is selected from 1,3 dioxane (compound 1), 1,3-dioxolane (compound 2), 2-methyl isophthalic acid, 3-dioxane (compound 3), 2-methyl isophthalic acid, 3-dioxolane (compound 4), 2,6-dimethyl-1,3-dioxane (compound 5), 2,5-dimethyl-1, one or more in 3-dioxolane (compound 6)

6. the electrolyte of lithium ion battery according to claim 1, is characterized in that,

The mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery with formula I structure is 0.5% ~ 2%;

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 2% ~ 4%.

7. a lithium ion battery, comprising:

Positive plate, comprises plus plate current-collecting body and is arranged at the positive pole diaphragm containing positive electrode active materials on plus plate current-collecting body;

Negative plate, comprises negative current collector and is arranged at the cathode membrane containing negative active core-shell material on negative current collector;

Barrier film, is interval between positive plate and negative plate;

Electrolyte; And

Battery external packing;

It is characterized in that, described electrolyte is the electrolyte of the lithium ion battery according to any one of claim 1-6.

8. lithium ion battery according to claim 7, it is characterized in that, described positive electrode active materials comprises can be deviate from, accept the material of lithium ion, described by deviate from, the material accepting lithium ion is lithium-transition metal composite oxide, described lithium-transition metal composite oxide is lithium transition-metal oxide, lithium transition-metal oxide adds one or more in the compound that other transition metal or nontransition metal obtain, described lithium-transition metal composite oxide is selected from lithium and cobalt oxides, lithium nickel oxide, lithium manganese oxide, Li, Ni, Mn oxide, lithium nickel cobalt manganese oxide, one or more in lithium nickel cobalt aluminum oxide.

9. lithium ion battery according to claim 8, is characterized in that, described lithium-transition metal composite oxide is selected from $LiCoO_2$(LCO), $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$(NCM333), $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$(NCM523), LiCoO 2(LCO) compound, LiNi that other transition metal obtains is added $_{1/3}$Mn $_{1/3}$Co $_{1/3}$ 2(NCM333) compound, LiNi that other transition metal obtains is added $_{0.5}$Mn $_{0.3}$Co $_{0.2}$ $_2$(NCM523) one or more in the compound that other transition metal obtains are added.

10. lithium ion battery according to claim 7, it is characterized in that, described negative active core-shell material comprises the material that can accept, deviate from lithium ion, the material described by to accept, deviate from lithium ion be selected from soft carbon, hard carbon, Delanium, native graphite, silicon, silicon oxide compound, silicon-carbon compound, lithium titanate, can with lithium formed in the metal of alloy one or more.

Description

Lithium ion battery and electrolyte thereof

Technical field

The present invention relates to cell art, particularly relate to a kind of lithium ion battery and electrolyte thereof.

Background technology

Along with the universal of portable electric appts and application, also more and more higher to the requirement of the applied environment of lithium ion battery.In order to meet the application demand of electrolyte under wider Wen Cheng, the non-aqueous organic solvent in electrolyte conventional is at present primarily of chain ester and cyclic ester composition.

U.S. Patent Application Publication No. disclosed in 25 days February in 1997 is disclose in alkali metal-ion battery in the patent application of US5606524, the short circuit caused to produce bark shape crystal (or skeleton) when preventing from charging, adds fluoroethylene carbonate (FEC) and propylene carbonate in the electrolytic solution But because fluoroethylene carbonate (FEC) is easily reduced, particularly in high temperature environments, so it is easily decomposed on negative pole, and then produce HF gas or organic gas.

In order to solve the aerogenesis problem of fluoroethylene carbonate (FEC), Chinese patent application publication number disclosed in 27 days August in 2008 is disclose in the patent application of CN101252205A in the use pole piece of fluoroethylene carbonate as the rechargeable nonaqueous electrolytic battery of additive or the technical scheme of barrier film surface-coated inorganic insulation stratum granulosum, and it can reduce the aerogenesis that fluoroethylene carbonate (FEC) causes.

But the enforcement of technique scheme obviously can increase the difficulty of lithium ion transport between inside battery pole piece and barrier film, reduces the transmission speed of lithium ion at inside battery.Also likely increase technology difficulty in addition, adverse effect is caused to pole piece pliability and processing characteristics.Inventor also finds, according to the above-mentioned technical scheme at pole piece or barrier film surface-coated inorganic insulation stratum granulosum, want to suppress the decomposition of fluoroethylene carbonate to be difficult to realize completely, its HF gas produced after decomposing can enter into the surface of anode pole piece through the hole on barrier film surface, produce corrosiveness to positive electrode active materials.Particularly under long hot environment, this corrosiveness is especially remarkable, has had a strong impact on high-temperature storage performance and the long life of lithium ion battery.

In addition, fluoroethylene carbonate, as conventional SEI film for additive, can form SEI film on negative active core-shell material surface, can increase the impedance of negative active core-shell material simultaneously, affect the transmission performance of lithium ion, and then affect the low temperature discharge high rate performance of lithium ion battery.Therefore need to find one more reliable and effective method improves performance of lithium ion battery.

Summary of the invention

In view of Problems existing in background technology, the object of the present invention is to provide a kind of lithium ion battery and electrolyte thereof, described lithium ion battery has excellent high-temperature storage performance and low temperature discharge high rate performance.

In order to realize foregoing invention object, in a first aspect of the present invention, the invention provides a kind of electrolyte of lithium ion battery, it comprises: non-aqueous organic solvent; Lithium salts, is dissolved in non-aqueous organic solvent; And additive, be dissolved in non-aqueous organic solvent.Described additive package is containing 1,3-dioxane compound and the fluorinated ethylene carbonate (FEC) with formula I structure,

In formula I, R_1, R_2independently be selected from H, methyl or ethyl separately; N is selected from the integer in 1 ~ 3; The mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery with formula I structure is 0.05% ~ 5%; The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 1% ~ 8%.

In a second aspect of the present invention, the invention provides a kind of lithium ion battery, it comprises: positive plate, comprises plus plate current-collecting body and is arranged at the positive pole diaphragm containing positive electrode active materials on plus plate current-collecting body; Negative plate, comprises negative current collector and is arranged at the cathode membrane containing negative active core-shell material on negative current collector; Barrier film, is interval between positive plate and negative plate; Electrolyte; And battery external packing Wherein, described electrolyte is the electrolyte of lithium ion battery according to a first aspect of the present invention.

Beneficial effect of the present invention is as follows:

1. of the present invention have 1 of formula I structure; 3-dioxane compound is a kind of electrolysis additive that can form stable positive pole diaphragm at positive electrode surface, its special feature is that it can form stable positive pole SEI diaphragm at positive electrode surface at fluorinated ethylene carbonate (FEC) before negative terminal surface reduction forms HF gas; thus avoid positive electrode active materials to be subject to the corrosion of HF gas, and then improve the high-temperature storage performance of lithium ion battery

2. of the present invention have 1 of formula I structure; 3-dioxane compound also can form stable negative pole SEI diaphragm in negative terminal surface with fluorinated ethylene carbonate (FEC) jointly; and due to what contain in negative pole SEI diaphragm, there is 1 of formula I structure; 3-dioxane compound has the oxygen element of higher concentration; the conductibility of the lithium ion at SEI film place, negative active core-shell material surface is also improved; therefore the impedance of lithium ion battery is significantly reduced, thus the low temperature discharge high rate performance of lithium ion battery improves.

Embodiment

The following detailed description of lithium ion battery according to the present invention and electrolyte thereof and embodiment, comparative example and test result.

First the electrolyte of lithium ion battery is according to a first aspect of the present invention described.

The electrolyte of lithium ion battery according to a first aspect of the present invention, comprising: non-aqueous organic solvent; Lithium salts, is dissolved in non-aqueous organic solvent; And additive, be dissolved in non-aqueous organic solvent.Described additive package is containing 1,3-dioxane compound and the fluorinated ethylene carbonate (FEC) with formula I structure,

In formula I, R_1, R_2independently be selected from H, methyl or ethyl separately; N is selected from the integer in 1 ~ 3; The mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery with formula I structure is 0.05% ~ 5%; The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 1% ~ 8%.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, fluorinated ethylene carbonate (FEC) has good filming performance, is conducive to the circulation volume conservation rate of lithium ion battery.But when lithium ion battery is in high temperature storage, fluorinated ethylene carbonate (FEC) can decompose and produces HF, this causes performance of lithium ion battery to decline the main cause of even aerogenesis.And have 1 of formula I structure; 3-dioxane compound is a kind of electrolysis additive that can form stable positive pole diaphragm at positive electrode surface; its special feature is that it can form stable positive pole SEI diaphragm at positive electrode surface at fluorinated ethylene carbonate (FEC) before negative terminal surface reduction forms HF gas; thus avoid positive electrode active materials to be subject to the corrosion of HF gas, and then improve the high-temperature storage performance of lithium ion battery.In addition, have 1 of formula I structure; 3-dioxane compound also can form stable negative pole SEI diaphragm in negative terminal surface with fluorinated ethylene carbonate (FEC) jointly, and due to what contain in negative pole SEI diaphragm, there is 1 of formula I structure, 3-dioxane compound has the oxygen element of higher concentration, the conductibility of the lithium ion at SEI film place, negative active core-shell material surface is also improved, therefore the impedance of lithium ion battery is significantly reduced, thus the low temperature discharge high rate performance of lithium ion battery improves.

Have the mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery of formula I structure lower than 0.05%, then it cannot play one's part to the full; Have 1 of formula I structure; the mass percentage of 3-dioxane compound in the electrolyte of lithium ion battery is higher than 5%; although can obviously suppress HF gas to the corrosiveness of positive electrode active materials; but because the positive pole SEI diaphragm generated is blocked up overstocked, hinder the normal deintercalation process of lithium ion, therefore can play the capacity of lithium ion battery and produce adverse influence, but also the low temperature discharge high rate performance of lithium ion battery can be had a strong impact on.The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is lower than 1%, then fluorinated ethylene carbonate (FEC) cannot form stable SEI film; The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery higher than 8%, then can cause the serogenesis problem worse of lithium ion battery.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, described lithium salts can be selected from LiN ($C_aF_{2a+1}SO_2$) ($C_bF_{2b+1}SO_2$), $LiPF_6$, $LiBF_4$, LiBOB, $LiAsF_6$, Li (CF_3SO_2)$_2N$, $LiCF_3SO_3$and $LiClO_4$in at least one, wherein, a, b are natural number.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, the concentration of described lithium salts can be 0.5M ~ 2.0M.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, described non-aqueous organic solvent can comprise one or more in carbonic ester and carboxylate, and carbonic ester can comprise cyclic carbonate and linear carbonate.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, cyclic carbonate can be selected from one or more in propene carbonate (PC), ethylene carbonate (EC); Linear carbonate can be selected from one or more in dimethyl carbonate (DMC), methyl ethyl carbonate (EMC), methyl propyl carbonate (MPC); Carboxylate can be selected from one or more in gamma-butyrolacton (GBL), methyl formate (FA), ethyl acetate (EA), methyl butyrate (BA).

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, the volume of linear carbonate can be 40% ~ 70% of the cumulative volume of non-aqueous organic solvent; The volume of carboxylate can be 40% ~ 70% of the cumulative volume of non-aqueous organic solvent; Surplus can be cyclic carbonate.If the volume of linear carbonate is greater than 70% of the cumulative volume of non-aqueous organic solvent, although then helpful to the conductivity of

electrolyte, the risk of high temperature aerogenesis can be improved; If the volume of linear carbonate is less than 40% of the cumulative volume of non-aqueous organic solvent, then there is negative impact to low-temperature conductivity, and then affect the low temperature discharge high rate performance of lithium ion battery

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, described have 1 of formula I structure, 3-dioxane compound can be selected from 1,3 dioxane (compound 1), 1,3-dioxolane (compound 2), 2-methyl isophthalic acid, 3-dioxane (compound 3), 2-methyl isophthalic acid, 3-dioxolane (compound 4), 2,5-dimethyl-1,3-dioxane (compound 5), 2, one or more in 5-dimethyl-1,3-dioxolane (compound 6)

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, the mass percentage of 1,3-dioxane compound in the electrolyte of lithium ion battery with formula I structure can be 0.5% ~ 2%.

In the electrolyte of lithium ion battery described according to a first aspect of the present invention, fluorinated ethylene carbonate (FEC) mass percentage in the electrolyte of lithium ion battery can be 2% ~ 4%.

Secondly lithium ion battery is according to a second aspect of the present invention described.

Lithium ion battery according to a second aspect of the present invention, comprising: positive plate, comprises plus plate current-collecting body and is arranged at the positive pole diaphragm containing positive electrode active materials on plus plate current-collecting body; Negative plate, comprises negative current collector and is arranged at the cathode membrane containing negative active core-shell material on negative current collector; Barrier film, is interval between positive plate and negative plate; Electrolyte; And battery external packing.Wherein, described electrolyte is the electrolyte of lithium ion battery according to a first aspect of the present invention.

In lithium ion battery described according to a second aspect of the present invention, described positive electrode active materials can comprise the material deviating from, accept lithium ion.

In lithium ion battery described according to a second aspect of the present invention, the material deviating from, accept lithium ion in positive electrode active materials can be lithium-transition metal composite oxide, one or more in the compound that described lithium-transition metal composite oxide can be lithium transition-metal oxide, lithium transition-metal oxide adds other transition metal or nontransition metal obtains, described lithium-transition metal composite oxide can be selected from

one or more in lithium and cobalt oxides, lithium nickel oxide, lithium manganese oxide, Li, Ni, Mn oxide, lithium nickel cobalt manganese oxide, lithium nickel cobalt aluminum oxide.

In lithium ion battery described according to a second aspect of the present invention, described lithium-transition metal composite oxide can be selected from $LiCoO_2$(LCO), $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$(NCM333), $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$(NCM523), $LiCoO_2$(LCO) compound, LiNi that other transition metal obtains is added $_{1/3}Mn_{1/3}Co_{1/3}O_2$(NCM333) compound, LiNi that other transition metal obtains is added $_{0.5}Mn_{0.3}Co_{0.2}O_2$(NCM523) one or more in the compound that other transition metal obtains are added.

In lithium ion battery described according to a second aspect of the present invention, described negative active core-shell material can comprise the material that can accept, deviate from lithium ion.

In lithium ion battery described according to a second aspect of the present invention, the material that can accept, deviate from lithium ion in negative active core-shell material can be selected from soft carbon, hard carbon, Delanium, native graphite, silicon, silicon oxide compound, silicon-carbon compound, lithium titanate, can with lithium formed in the metal of alloy one or more.

Embodiment 1

1. the preparation of the positive plate of lithium ion battery

By positive electrode active materials $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$(NCM333) after, conductive agent acetylene black, binding agent polyvinylidene fluoride (PVDF) are fully uniformly mixed in 1-METHYLPYRROLIDONE dicyandiamide solution by weight 96:2:2, be coated on collector Al paper tinsel dry, cold pressing, soldering polar ear, obtain the positive plate of lithium ion battery.

2. the preparation of the negative plate of lithium ion battery

After negative active core-shell material graphite, conductive agent acetylene black, binding agent butadiene-styrene rubber (SBR), thickener sodium carboxymethylcellulose (CMC) are fully uniformly mixed in deionized water solvent system by weight 95:2:2:1, be coated on collector Cu paper tinsel dry, cold pressing, soldering polar ear, obtain the negative plate of lithium ion battery.

3. the preparation of the barrier film of lithium ion battery

Using PE porous polymer film as the barrier film of lithium ion battery.

4. the preparation of the electrolyte of lithium ion battery

The electrolyte of lithium ion battery is with the $LiPF_6$ of 1mol/L for lithium salts, with the mixture (volume ratio 30:5:65) of ethylene carbonate (EC), propene carbonate (PC) and methyl ethyl carbonate (EMC) for non-aqueous organic solvent, be the fluorinated ethylene carbonate (FEC) of 1% and the mass percentage in the electrolyte of lithium ion battery with the mass percentage in the electrolyte of lithium ion battery be that 1, the 3-dioxane (compound 1) of 1% is for additive.

5. the preparation of lithium ion battery

Positive plate, barrier film, negative plate are folded in order, buffer action is played in the centre making barrier film be in positive plate and negative plate, and winding obtains naked battery core afterwards, and naked battery core is placed in external packing, injects electrolyte and encapsulates, changes into, obtaining lithium ion battery.

Embodiment 2

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 2%.

Embodiment 3

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 3%.

Embodiment 4

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 4%.

Embodiment 5

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 8%.

Embodiment 6

Method according to embodiment 3 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

1,3-dioxane (compound 1) mass percentage in the electrolyte of lithium ion battery is 0.05%.

Embodiment 7

Method according to embodiment 3 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

1,3-dioxane (compound 1) mass percentage in the electrolyte of lithium ion battery is 0.5%.

Embodiment 8

Method according to embodiment 3 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

1,3-dioxane (compound 1) mass percentage in the electrolyte of lithium ion battery is 2%.

Embodiment 9

Method according to embodiment 3 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

1,3-dioxane (compound 1) mass percentage in the electrolyte of lithium ion battery is 5%.

Embodiment 10

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive is the mass percentage in the electrolyte of lithium ion battery to be the fluorinated ethylene carbonate (FEC) of 3% and the mass percentage in the electrolyte of lithium ion battery be 1% 1,3-dioxolane (compound 2).

Embodiment 11

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive is the mass percentage in the electrolyte of lithium ion battery to be the fluorinated ethylene carbonate (FEC) of 3% and the mass percentage in the electrolyte of lithium ion battery be 1% 2-methyl isophthalic acid, 3-dioxane (compound 3).

Embodiment 12

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive is the mass percentage in the electrolyte of lithium ion battery to be the fluorinated ethylene carbonate (FEC) of 3% and the mass percentage in the electrolyte of lithium ion battery be 1% 2-methyl isophthalic acid, 3-dioxolane (compound 4).

Embodiment 13

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive is the mass percentage in the electrolyte of lithium ion battery be the fluorinated ethylene carbonate (FEC) of 3% and the mass percentage in the electrolyte of lithium ion battery is 1% 2,6-dimethyl-1,3-dioxane (compound 5).

Embodiment 14

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive is the mass percentage in the electrolyte of lithium ion battery be the fluorinated ethylene carbonate (FEC) of 3% and the mass percentage in the electrolyte of lithium ion battery is 1% 2,5-dimethyl-1,3-dioxolane (compound 6).

Embodiment 15

Method according to embodiment 3 prepares lithium ion battery, except following difference:

1. the preparation of the positive plate of lithium ion battery

Positive electrode active materials is $LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$(NCM523).

Embodiment 16

Method according to embodiment 3 prepares lithium ion battery, except following difference:

1. the preparation of the positive plate of lithium ion battery

Positive electrode active materials is $LiCoO_2$(LCO).

Comparative example 1

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Do not add additive.

Comparative example 2

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive to be the mass percentage in the electrolyte of lithium ion battery be 5% fluorinated ethylene carbonate (FEC).

Comparative example 3

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Additive to be the mass percentage in the electrolyte of lithium ion battery be 3% 1,3-dioxane (compound 1).

Comparative example 4

Method according to embodiment 15 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

Do not add additive.

Comparative example 5

Method according to embodiment 3 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

1,3-dioxane (compound 1) mass percentage in the electrolyte of lithium ion battery is 6%.

Comparative example 6

Method according to embodiment 1 prepares lithium ion battery, except following difference:

4. the preparation of the electrolyte of lithium ion battery

The mass percentage of fluorinated ethylene carbonate (FEC) in the electrolyte of lithium ion battery is 10%.

Finally provide the lithium ion battery of embodiment 1-16 and comparative example 1-6 and the performance test process of electrolyte thereof and test result.

(1) the high-temperature storage performance test of lithium ion battery

At 25 DEG C, respectively get 5 lithium ion batteries, with 0.5C multiplying power constant current charge to voltage higher than 4.35V, further with 4.35V constant-potential charge to electric current lower than 0.05C, making it be in 4.35V fully charged state, completely fill the thickness of lithium ion battery before test storage and be designated as D0, being placed in 60 DEG C of baking ovens by completely filling lithium ion battery afterwards, take out after 21 days, the thickness of the lithium ion battery immediately after test storage is also designated as D1.

Thickness swelling ratio=(D1-D0)/D0 × 100% after high-temperature lithium ion battery stores.

The mean value of the thickness swelling after storing with 5 high-temperature lithium ion batteries, the thickness swelling after storing as this high-temperature lithium ion battery.

(2) the low temperature discharge high rate performance test of lithium ion battery

At 25 DEG C, respectively get 5 lithium ion batteries, with 0.5C multiplying power constant current charge to voltage higher than 4.35V, further with 4.35V constant-potential charge to electric current lower than 0.05C, at 25 DEG C and-10 DEG C, leave standstill 60min respectively afterwards, then be discharged to voltage for 3.0V with 0.2C multiplying power constant current.Record lithium ion battery discharge capacity D at different temperatures (25 DEG C) and D (-10 DEG C).

Low temperature discharge multiplying power (%)=D (-10 DEG C)/D (25 DEG C) × 100% of lithium ion battery.

With the mean value of 5 lithium ion battery low temperature discharge multiplying powers, as the low temperature discharge multiplying power of this lithium ion battery.

Table 1 provides relevant parameter and the performance test results of embodiment 1-16 and comparative example 1-6.

Next the performance test results of lithium ion battery is analyzed.

As can be seen from the contrast of embodiment 1-14 and comparative example 1-3, of the present invention comprising has 1 of formula I structure, the lithium ion battery of 3-dioxane compound and fluorinated ethylene carbonate (FEC) than not adding the lithium ion battery (comparative example 1) of any additive, the lithium ion battery (comparative example 2) only adding fluorinated ethylene carbonate (FEC), the lithium ion battery (comparative example 3) that only adds 1, the 3-dioxane compound with formula I structure have lower high temperature thickness swelling and higher low temperature discharge multiplying power.This is because independent has 1 of formula 1 structure, 3-dioxane compound or independent fluorinated ethylene carbonate (FEC) all can worsen high-temperature storage performance and the low temperature discharge high rate performance of lithium ion battery, but work as fluorinated ethylene carbonate (FEC) and there is 1 of formula 1 structure, when 3-dioxane compound uses jointly, have 1 of formula I structure, 3-dioxane compound can form stable positive pole SEI diaphragm at positive electrode surface at fluorinated ethylene carbonate (FEC) before negative terminal surface reduction forms HF gas, thus avoid positive electrode active materials to be subject to the corrosion of HF gas, and then improve the high-temperature storage performance of lithium ion battery.Have 1 of formula I structure; 3-dioxane compound also can form stable negative pole SEI diaphragm in negative terminal surface with fluorinated ethylene carbonate (FEC) jointly; and due to what contain in negative pole SEI diaphragm, there is 1 of formula I structure; 3-dioxane compound has the oxygen element of higher concentration, the conductibility of the lithium ion at SEI film place, negative active core-shell material surface is also improved; therefore the impedance of lithium ion battery is significantly reduced, thus the low temperature discharge high rate performance of lithium ion battery improves.Also similar result can be seen from the contrast of embodiment 15 and comparative example 4.

As can be seen from the contrast of embodiment 1-5 and comparative example 6, along with the mass percentage of FEC increases, the thickness swelling after high-temperature lithium ion battery stores takes the lead in reducing rear increase, and the low temperature discharge of lithium ion battery doubly takes the lead in increasing rear reduction.When the mass percentage in the electrolyte of FEC at lithium ion battery is higher than 8% (comparative example 6), the aerogenesis problem worse of lithium ion battery can be caused.

As can be seen from the contrast of embodiment 3 and embodiment 6-9 and comparative example 5, along with having 1 of formula 1 structure, the mass percentage of 3-dioxane compound increases, thickness swelling after high-temperature lithium ion battery stores takes the lead in reducing rear increase, and the low temperature discharge of lithium ion battery doubly takes the lead in increasing rear reduction.And when the mass percentage of 1,3-dioxane compound with formula 1 structure is too low (embodiment 5), not obvious to the performance improvement of lithium ion battery; When having 1 of formula I structure; when the mass percentage of 3-dioxane compound is too high (comparative example 5); although can obviously suppress HF gas to the corrosiveness of positive electrode active materials, because the positive pole SEI diaphragm generated is blocked up overstocked, hinder the normal deintercalation process of lithium ion; therefore can play the capacity of lithium ion battery and produce adverse influence, but also the low temperature discharge high rate performance of lithium ion battery can be had a strong impact on.

As can be seen from the contrast of embodiment 3, embodiment 11 and embodiment 13, along with the increase of substituent number, high-temperature storage performance and the low temperature discharge high rate performance of lithium ion battery are all deteriorated, this is because substituent structure increases the sterically hindered of component in film forming procedure, and then brings negative effect to the conduction of lithium ion.Also similar result can be seen from the contrast of embodiment 10, embodiment 12 and embodiment 14.

As can be seen from the contrast of embodiment 3, embodiment 15 and embodiment 16, NCM333 and NCM523 is used to have better high-temperature storage performance and low temperature discharge high rate performance as the lithium ion battery of positive electrode active materials than the lithium ion battery using LCO as positive electrode active materials.This may be that 1,3-dioxane compound and FEC owing to having formula I structure is more suitable for ternary positive electrode

active material, thus can form better SEI diaphragm at positive pole; In addition, the pH value of ternary positive electrode active material is higher; catalysis can have 1 of formula I structure better, 3-dioxane compound participates in the formation of positive pole SEI diaphragm; thus make the oxygen solubility in positive pole SEI diaphragm higher, and then improve the transfer rate of lithium ion, improve high-temperature storage performance and the low temperature discharge high rate performance of lithium ion battery.

Patent Citations (5)

The parameter of table 1 embodiment 1-16 and comparative example 1-6 and the performance test results

Publication number	Priority date	Publication date	Assignee	Title
CN101075691A *	2006-05-15	2007-11-21	索尼株式会社	Lithium ion battery
CN102280627A *	2010-06-11	2011-12-14	三星SDI株式会社	Negative active material, electrode including the same, and lithium battery including electrode
Family To Family Citations				
JP2007128242A *	2005-09-28	2007-05-17	Sanyo Electric Co Ltd	Nonaqueous electrolyte secondary battery
JP5044158482 *	2008-09-28	2012-12-12	三洋電機株式会社	Nonaqueous electrolyte secondary battery
CN103515656B *	2012-06-22	2017-03-01	日立麦克赛尔株式会社	Lithium secondary battery

* Cited by examiner, † Cited by third party

Non-Patent Citations (2)

Title
DING FEI等 "Passivating lithium electrodes with 1,3-dioxolane"，《[illegible]》 *
[illegible]等 "1,3-二氧戊环对锂负极的钝化改性机理"，《[illegible]》 *

* Cited by examiner, † Cited by third party

Cited By (6)

Publication number	Priority date	Publication date	Assignee	Title
CN107240711A *	2016-03-28	2017-10-10	上海比亚迪有限公司	A kind of electrolyte and the lithium ion battery containing the electrolyte
WO2018028392A1 *	2016-08-12	2018-02-15	宁德时代新能源科技股份有限公司	Electrolyte solution and secondary battery
CN109309245A *	2017-07-27	2019-02-05	宁德时代新能源科技股份有限公司	Electrolyte and electrochemical energy storage device
CN110416613A *	2019-08-02	2019-11-05	湖州昆仑动力电池材料有限公司	A kind of electrolyte promoting cycle performance of lithium ion battery and security performance
CN111525194A *	2020-04-28	2020-08-11	宁德新能源科技有限公司	Electrochemical device and electronic device including the same
Family To Family Citations				
CN109873205B *	2019-02-27	2021-03-26	杉杉新材料（衢州）有限公司	Electrolyte suitable for silicon-carbon cathode and lithium ion battery containing electrolyte

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
JP5467189B2	2014-04-09	Non-aqueous electrolyte and electrochemical cell including the same
CN104266576B	2017-09-22	A kind of electrolyte and the lithium ion battery using the electrolyte
CN103781408B	2015-04-08	Lithium ion secondary battery and electrolyte thereof
KR101083667B1	2011-05-09	Additive for non-aqueous liquid electrolyte, non-aqueous liquid electrolyte and lithium secondary cell comprising the same
CN103199302B	2015-08-19	Lithium rechargeable battery and electrolyte thereof
CN109193325B	2019-07-12	A kind of low temperature electrolyte for lithium ion battery and low-temperature lithium ion battery
CN103730683B	2016-06-08	Lithium ion battery and electrolyte thereof
JP2009164082A	2009-07-23	Nonaqueous electrolyte secondary battery, and manufacturing method thereof
CN108336398B	2018-05-22	Lithium ion battery and its electrolyte
CN104979586B	2017-08-25	Lithium rechargeable battery and its electrolyte
CN109088099B	2021-01-26	Sulfonyl electrolyte additive giving consideration to high and low temperature performance and electrolyte containing additive
CN109888384B	2021-06-29	Electrolyte and battery containing the same
CN104022310A	2014-09-03	Lithium ion secondary battery electrolyte and lithium ion battery containing electrolyte
US20200099100A1	2020-03-26	Electrolyte and lithium ion battery including the same
KR101431259B1	2014-08-20	Additive for non-aqueous electrolyte and secondary battery using the same
CN105789684A	2016-07-20	Lithium ion secondary battery and electrolyte thereof
CN105006593A	2015-10-28	Lithium ion secondary battery and electrolyte thereof
CN105789685A	2016-07-20	Lithium-ion battery and electrolyte thereof
CN105449274A	2016-03-30	Lithium ion battery and electrolyte solution thereof
CN107017433B	2019-02-22	Nonaqueous electrolytic solution and lithium ion battery

CN102738511A	2012-10-17	Lithium ion battery and electrolyte thereof
CN108400382A	2018-08-14	Electrolyte and secondary cell
CN103078133A	2013-05-01	Lithium ion secondary battery and electrolyte solution thereof
CN109638351B	2021-08-24	High-voltage electrolyte with high and low temperature performance and lithium ion battery thereof
CN109786839A	2019-05-21	A kind of lithium-ion battery electrolytes and its additive

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN201410374264.3A	2014-07-31	2014-07-31	Lithium ion battery and its electrolyte

Applications Claiming Priority (2)

Application	Filing date	Title
CN201410374264.3A	2014-07-31	Lithium ion battery and its electrolyte
US14/810,145	2015-07-27	Lithium-ion battery and electrolyte thereof

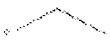
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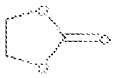
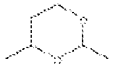
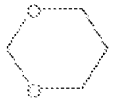
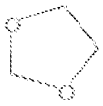
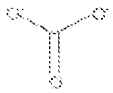
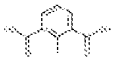
Date	Code	Title	Description
2016-02-17	C06	Publication	
2016-02-17	PB01	Publication	
2016-03-16	C10	Entry into substantive examination	
2016-03-16	SE01	Entry into force of request for substantive examination	
2018-05-22	GR01	Patent grant	
2018-05-22	GR01	Patent grant	

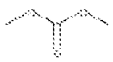
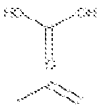
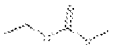
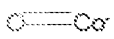
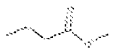
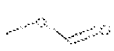
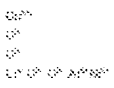
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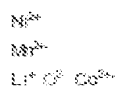
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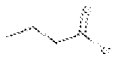
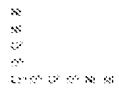
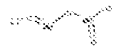
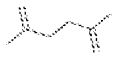
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nickel		claims,description	2	0.000
silicon		claims,description	2	0.800
silicon		claims,description	2	0.000
silicon		claims,description	2	0.000
silicon oxide		claims,description	2	0.000
soft carbon		claims,description	2	0.800
2,5-dimethylhexa-1,5-diene		claims	1	0.800

4-Buom-1,3-dioxolan-2-one 	abstract,description	11	0.960
heterocyclic compounds	abstract	2	0.880

Show all concepts from the description section

A kind of coiled battery and battery pack

Abstract

The utility model provides a kind of coiled battery, and the one face dressing of the first half-turn of plus plate current-collecting body is left white on one side, and the one side setting positive pole ear groove of dressing, positive pole ear is arranged in positive pole ear groove; The one face dressing of the first half-turn of negative current collector, is left white on one side, and dressing is provided with negative lug groove on one side, and negative lug is arranged in negative lug groove; On this basis, cooperation has been carried out to the first insulating cement and the second position insulated to limit.The utility model also provides a kind of battery pack being made of coiled battery provided by the utility model.Coiled battery provided by the utility model is solved in existing coiled battery, the two-sided dressing of negative plate, and grooving processes are complicated, low production efficiency, while the technical issues of can cause a large amount of dressing space wastage, influence battery capacity.

Classifications

- H02J50/10 Energy storage using batteries

View 1 more classifications

CN207602716U

China

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Other languages: Chinese

Inventor: [redacted]

Current Assignee : Shanghai BYD Co Ltd

Worldwide applications

2017 CN

Application CN201721269256.8U events

2017-09-29 Application filed by Shanghai BYD Co Ltd

2017-09-29 Priority to CN201721269256.8U

2018-07-10 Application granted

2018-07-10 Publication of CN207602716U

Info: Cited by (2), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (5)

Hide Dependent

1. a kind of coiled battery including positive plate, negative plate and is arranged between the positive plate and the negative plate Diaphragm, the positive plate includes plus plate current-collecting body and the positive electrode active material layer for being arranged on the plus plate current-collecting body surface, described Negative plate includes negative current collector and the negative electrode active material layer for being arranged on the negative current collector surface, the plus plate current-collecting body The first half-turn of the first half-turn and the negative current collector be oppositely arranged and positioned at the innermost circle of coiled battery, feature exists in the first half-turn of the plus plate current-collecting body closes on being left white on one side for the first half-turn of the negative current collector, the anode collection First half-turn of first half-turn of fluid far from the negative current collector is provided with the first positive electrode active material layer on one side; It is described First half-turn of negative current collector closes on being left white on one side for the first half-turn of the plus plate current-collecting body, and the of the negative current collector First half-turn of one half-turn far from the plus plate current-collecting body is provided with the first negative electrode active material layer on one side; First anode Positive pole ear groove is provided on active material layer, positive pole ear is provided in the positive pole ear groove; First cathode Negative lug groove is provided on active material layer, negative lug is provided in the negative lug groove; The negative pole current collecting First half-turn of body, which is closed in the one side of the first half-turn of the plus plate current-collecting body, is provided with the first insulating cement, first insulation Blue is corresponding with the position of the negative lug groove; In the positive plate one side opposite with first negative electrode active material layer The second insulating cement is provided with, second insulating cement is corresponding with the position of the negative lug groove.

2. coiled battery according to claim 1, which is characterized in that correspond to institute on first positive electrode active material layer The position for stating positive pole ear groove is provided with third insulating cement, is set in the one side that the first half-turn of the negative current collector is left white There is the 4th insulating cement, the 4th insulating cement is corresponding with the position of the positive pole ear groove.

3. coiled battery according to claim 1, which is characterized in that correspond to institute on first positive electrode active material layer The position for stating positive pole ear groove is provided with the 5th insulating cement, is set in the one side that the first half-turn of the plus plate current-collecting body is left white There is the 6th insulating cement, the 6th insulating cement is corresponding with the position of the positive pole ear groove.

4. coiled battery according to claim 1, which is characterized in that the first half-turn of the negative current collector with it is described The coiling direction of first half-turn of plus plate current-collecting body is opposite.

5. a kind of battery pack, including several single batteries in series or in parallel with each other, which is characterized in that be in the single battery Coiled battery described in claim 1-4 any one.

Description

A kind of coiled battery and battery pack

Technical field

The utility model is related to power battery field more particularly to a kind of coiled batteries.

Background technology

With the continuous development of the continuous development of New Energy industry, especially electric vehicle；For as electric vehicle core The power battery of center portion part, it is required that also higher and higher, the composite request especially to safety and specific capacity And for power For battery, capacity, safety and the requirement of cost become the main flow direction that power battery is researched and developed in industry.

Inside coiled battery, the extraction of lug, set-up mode influence whether that coiled battery inner current collector body is two-sided Dressing amount, and then influence coiled battery whole volume；Meanwhile because the extraction location of lug needs rubberizing, insulation, no Good design in process, may result in the loss of a large amount of dressing or lead to the positive electrode covered by insulating cement Or negative material cannot play its effect, cause the waste of dressing, the raising of cost.

In the prior art, a kind of coiled battery is provided, insulating cement, anode are posted in the upper and lower surface of positive pole ear The corresponding positive electrode active material layer of positive plate one side where lug, corresponds to plus plate current-collecting body on one side；That is, positive plate is back and forth One circle of winding, the innermost circle as coiled battery.Negative current collector two sides where negative lug is each coated with negative electrode active Material layer, and the rubberizing on the corresponding positive electrode active material layer of negative lug upper and lower surface, insulation guarantor is carried out to negative lug Shield.

But in said program, the negative current collector two sides where negative lug is each coated with negative electrode active material layer, needs Slot treatment is all carried out in the tow sides of negative plate, negative lug is arranged in slot；Two sides fluting cannot be completely superposed It is good, the loss of dressing area can be increased, influence capacity, while double surface grooving can reduce production efficiency.In addition, positive plate corresponds to At the position of negative lug, positive electrode active material layer is provided with, in this way, can cause capped positive electrode active materials that cannot play Capacity, loss cost are higher.

Invention content

The purpose of this utility model is to provide a kind of coiled batteries, it is intended to solve coiled battery of the prior art in, the two-sided dressing of negative plate, grooving processes are complicated, low production efficiency, while can cause a large amount of dressing space wastage, influence electricity The technical issues of tankage.

In order to solve the above technical problems, the technical solution of the utility model is:

The present invention provides a kind of coiled batteries, including positive plate, negative plate and are arranged on the positive plate and institute The diaphragm between negative plate is stated, the positive plate includes plus plate current-collecting body and the anode work for being arranged on the plus plate current-collecting body surface Property material layer, the negative plate includes negative current collector and is arranged on the negative electrode active material layer on the negative current collector surface, First half-turn of the plus plate current-collecting body is oppositely arranged with the first half-turn of the negative current collector and positioned at coiled battery innermost circle, wherein, the first half-turn of the plus plate current-collecting body closes on being left white on one side for the first half-turn of the negative current collector, institute That states first half-turn of first half-turn far from the negative current collector of plus plate current-collecting body is provided with the first positive electrode active material on one side Matter layer；First half-turn of the negative current collector closes on being left white on one side for the first half-turn of the plus plate current-collecting body, the cathode First half-turn of first half-turn of collector far from the plus plate current-collecting body is provided with the first negative electrode active material layer on one side；Institute it states and positive pole ear groove is provided on the first positive electrode active material layer, positive pole ear is provided in the positive pole ear groove；Institute it states and negative lug groove is provided on the first negative electrode active material layer, negative lug is provided in the negative lug groove；Institute The first insulating cement, institute are provided in the one side of the first half-turn that the first half-turn for stating negative current collector closes on the plus plate current-collecting body The position that the first insulating cement is stated with the negative lug groove is corresponding；The positive plate and the first negative electrode active material layer phase To one side on be provided with the second insulating cement, second insulating cement is corresponding with the position of the negative lug groove.

In some embodiments, the position that the positive pole ear groove is corresponded on first positive electrode active material layer is provided with Third insulating cement is provided with the 4th insulating cement, the 4th insulation in the one side that the first half-turn of the negative current collector is left white Glue is corresponding with the position of the positive pole ear groove.

In some embodiments, the position that the positive pole ear groove is corresponded on first positive electrode active material layer is provided with 5th insulating cement is provided with the 6th insulating cement, the 6th insulation in the one side that the first half-turn of the plus plate current-collecting body is left white Glue is corresponding with the position of the positive pole ear groove.

In some embodiments, the winding of the first half-turn of the negative current collector and the first half-turn of the plus plate current-collecting body Direction is opposite.

The utility model additionally provides a kind of battery pack, including several single batteries in series or in parallel with each other, wherein, institute Single battery is stated as coiled battery provided by the utility model.

The beneficial effects of the utility model：In the utility model, one face dressing of negative plate, not dressing on one side only need to be negative The one side fluting of pole piece, does not need to positive and negative and all slots and align, reduce fluting difficulty, improve production efficiency；Meanwhile Negative plate only has one side setting negative electrode active material layer, reduces the loss to negative electrode active material, improves loss, ensure that Battery capacity.

Description of the drawings

Fig. 1 is the winding-structure schematic diagram of coiled battery in the utility model one embodiment.

Fig. 2 is the front elevational view of positive plate in the utility model one embodiment.

Fig. 3 is the lateral plan of positive plate in the utility model one embodiment.

Fig. 4 is the reverse side front view of positive plate in the utility model one embodiment.

Fig. 5 is the front elevational view of negative plate in the utility model one embodiment.

Fig. 6 is the lateral plan of negative plate in the utility model one embodiment.

Fig. 7 is negative plate reverse side front view in the utility model one embodiment.

Fig. 8 is the winding-structure schematic diagram of coiled battery in the utility model another embodiment.

Fig. 9 is the winding-structure schematic diagram of coiled battery in the utility model another embodiment.

Reference numeral includes:

Positive plate 10; Plus plate current-collecting body 11; Positive electrode active material layer 12; First positive electrode active material layer 121; Positive pole ear groove 122; Positive pole ear 13; Negative plate 20; Negative current collector 21; Negative electrode active material layer 22; First negative electrode active material layer 221; Negative lug groove 222; Negative lug 23; First insulating cement 31; Second absolutely Edge glue 32; Third insulating cement 33; 4th insulating cement 34; 5th insulating cement 35; 6th insulating cement 36; Diaphragm 40。

Specific embodiment

The embodiment of the utility model is described below in detail, the example of the embodiment is shown in the drawings, wherein from beginning Same or similar element is represented to same or similar label eventually or there is the element of same or like function Below by ginseng The embodiment for examining the description of attached drawing 1 ~ 9 is exemplary, it is intended to for explaining the utility model, and it is not intended that new to this practicality The limitation of type.

In the description of the present invention, it is to be appreciated that term " length ", " width ", " on ", " under ", " preceding ", The orientation or position relationship of the instructions such as " rear ", "left", "right", " vertical ", " level ", " top ", " bottom " " interior ", " outer " are based on attached Orientation or position relationship shown in figure are for only for ease of description the utility model and simplify description rather than instruction or imply Signified device or element must have specific orientation, with specific azimuth configuration and operation, therefore it is not intended that this The limitation of utility model.

In addition, term " first ", " second " are only used for description purpose, and it is not intended that instruction or hint relative importance Or the implicit quantity for indicating indicated technical characteristic.Define " first " as a result, the feature of " second " can be expressed or implicitly include one or more this feature." multiple " are meant that two or two in the description of the present invention, More than, unless otherwise specifically defined.

In the utility model unless specifically defined or limited otherwise, term " installation ", " connected ", " connection ", " Gu It is fixed " etc. terms should be interpreted broadly, for example, it may be being fixedly connected or being detachably connected or integral; Can be Mechanical connection or electrical connection; It can be directly connected, can also be indirectly connected by intermediary, can be two The interaction relationship of connection or two elements inside element.It for the ordinary skill in the art, can basis Concrete condition understands concrete meaning of the above-mentioned term in the utility model.

In order to solve 2ll two-sided dressing of negative plate in the prior art, grooving processes are complicated, low production efficiency, while can cause A large amount of dressing space wastage, the technical issues of influencing battery capacity.

In one embodiment of the utility model, as shown in figs. 1-7, a kind of coiled battery, including positive plate 10, cathode Piece 20 and the diaphragm 40 being arranged between the positive plate 10 and the negative plate 20, as shown in Figure 1, positive plate 10 and cathode It is that positive plate 10 described in diaphragm 40 includes plus plate current-collecting body 11 and is arranged on 11 surface of plus plate current-collecting body between piece 20 Positive electrode active material layer 12, the negative plate 20 include negative current collector 21 and are arranged on the negative of 21 surface of negative current collector Pole active material layer 22, the first half-turn of the plus plate current-collecting body 11 and the first half-turn of the negative current collector 21 are oppositely arranged And positioned at the innermost circle of coiled battery, wherein, the first half-turn of the plus plate current-collecting body 11 closes on the negative current collector 21 The first half-turn be left white on one side, first half-turn of the first half-turn of the plus plate current-collecting body 11 far from the negative current collector 21 Be provided with the first positive electrode active material layer 121 on one side; First half-turn of the negative current collector 21 closes on the anode collection First half-turn of body 11 is left white on one side, the first half-turn of the negative current collector 21 far from the plus plate current-collecting body 11 first Half-turn is provided with the first negative electrode active material layer 221 on one side; Anode pole is provided on first positive electrode active material layer 121 Ear groove 122 is provided with positive pole ear 13 in the positive pole ear groove 122; It is set on first negative electrode active material layer 221 Negative lug groove 222 is equipped with, negative lug 23 is provided in the negative lug groove 222; The negative current collector 21 First half-turn, which is closed in the one side of the first half-turn of the plus plate current-collecting body 11, is provided with the first insulating cement 31, first insulation Glue 31 is corresponding with the position of the negative lug groove 222; The positive plate 10 and 221 phase of the first negative electrode active material layer To one side on be provided with the second insulating cement 32, second insulating cement 32 is corresponding with the position of the negative lug groove 222.

In the utility model, 20 1 face dressing of negative plate, on one side not dressing need to only slot, no in the one side of negative plate 20 Positive and negative is needed all to slot and align, fluting difficulty is reduced, improves production efficiency; Meanwhile negative plate 20 only has one side Negative electrode active material layer 22 is set, the loss to negative electrode active material is reduced, improves loss, ensure that battery capacity.

In the utility model, the first positive electrode active material layer 121 refers to being coated in 11 first half-turn of plus plate current-collecting body On active material layer; First negative electrode active material layer 221 refers to the work on the first half-turn coated in negative current collector 21 Property material layer.

As shown in Figure 1, takeup type battery core provided by the utility model, is wound by positive plate 10, diaphragm 40 and negative plate 20 It forms.In order to ensure the capacity of battery, positive plate 10 removes most interior half-turn (That is the first half-turn of plus plate current-collecting body 11) Have and stay on one side in vain (Non- dressing) Outside, rest part all has positive electrode active materials in the dual coating of plus plate current-collecting body 11; Likewise, negative plate 20 Except most interior half-turn (That is the first half-turn of negative current collector 21) Have and be left white on one side (Non- dressing) Outside, rest part is also all in cathode collection The dual coating of fluid 21 has negative electrode active material.

First half-turn of above-mentioned plus plate current-collecting body 11, refer to initiating terminal from battery battery core internal positive collector 11 to Outer winding, positioned at a half-turn of innermost plus plate current-collecting body 11; Likewise, the first half-turn of negative current collector 21, refers to It is wound outward being the initiating terminal by negative current collector 21 inside battery battery core, positioned at the one of innermost negative current collector 21 A half-turn.

It is a coating materials, one in the first half-turn of the plus plate current-collecting body 11 and the first half-turn of negative current collector 21 The non-coating in face.By single side coating, on the one hand ensure the capacity of coiled battery; On the other hand, facilitate positive pole ear groove 122 Processing and fluting with negative lug groove 222, it is only necessary to have in the one side of plus plate current-collecting body 11 or negative current collector 21 and live Property substance slotted on one side, without double surface grooving, do not need to the correspondence process of two sides fluting, facilitate processing.

In addition, in this embodiment, the relatively described plus plate current-collecting body of the first half-turn of above-mentioned " closing on " negative current collector 21 11 the first half-turn or plus plate current-collecting body 11 the first half-turn opposing negative polarity collector 21 the first half-turn while.

In the utility model, positive pole ear groove 122 or negative lug groove 222 can pass through laser cleaning, machinery Either foamed glue cleaning way removes the active material at positive pole ear groove 122 or negative lug groove 222 for cleaning, Form groove.

And the first insulating cement 31, the second insulating cement 32, third insulating cement 33, the 4th insulating cement 34,35 and of the 5th insulating cement 6th insulating cement 36 is intended merely to distinguish different location of the insulating cement in same embodiment or in different embodiments In; And the material of insulating cement in itself, any one of hot melt adhesive layer or green glue-line can be chosen or respectively select different insulation Glue material, such as: Green glue-line, black glue layer, yellow glue layer or white adhesive layer.

Wherein, the material selection of positive plate 10, negative plate 20, positive electrode active material layer 12, negative electrode active material layer 22 etc., It is selection commonly used in the art, does not do particular determination herein, is not also repeating.

As shown in Figure 1, in one embodiment of the utility model, institute is corresponded on first positive electrode active material layer 121 The position for stating positive pole ear groove 122 is provided with third insulating cement 33, the first half-turn of the negative current collector 21 be left white one The 4th insulating cement 34 is provided on face, the 4th insulating cement 34 is corresponding with the position of the positive pole ear groove 122.

It is right on first positive electrode active material layer 121 and as shown in figure 8, in another embodiment of the utility model The position of the positive pole ear groove 122 is answered to be provided with the 5th insulating cement 35, the first half-turn of the plus plate current-collecting body 11 is left white One side on be provided with the 6th insulating cement 36, the 6th insulating cement 36 is corresponding with the position of the positive pole ear groove 122.

In this application, so-called " position correspondence " refers to that insulating cement can cover positive pole ear 13 or negative lug 23 position.

As shown in figure 9, in one embodiment of the utility model, the first half-turn of plus plate current-collecting body 11 compares negative current collector 21 is short, and plus plate current-collecting body 11 does not extend into and 222 corresponding position of negative lug groove; That is, negative lug groove 222 It is directly corresponding with the second half-turn of negative current collector 21 across diaphragm 40, the of negative lug groove 222 and negative current collector 21 There is no plus plate current-collecting body 11 between two half-turns.

And in a specific embodiment of the utility model, as in figure 1 or figure 8, the first the half of negative current collector 21 Circle is opposite with the coiling direction of the first half-turn of plus plate current-collecting body 11, That is, the first half-turn of plus plate current-collecting body 11 and negative First half-turn of pole collector 21 is stacked on top of each other, while is divided into and does not extend and wind in the opposite direction Herein on the contrary, only Refer in the first half-turn everywhere in opposite extending direction, after the second circle or third circle is wound up into, plus plate current-collecting body 11 and negative The coiling direction of pole collector 21 can become consistent.

The utility model additionally provides a kind of battery pack, including several single batteries in series or in parallel with each other, wherein, on Single battery is stated as coiled battery provided by the utility model.

It understands that the utility model is to have above-described good characteristic, is able to enable it on using in summary, promotes The efficiency that does not have in conventional art and with practicability, become the product of a great practical value.

The above is only the preferred embodiment of the utility model only, is not intended to limit the utility model, all at this Any modification, equivalent replacement or improvement made within the thought and principle of utility model etc., should be included in the utility model Protection domain within.

Cited By (2)

Publication number	Priority date	Publication date	Assignee	Title
CN110429228A *	2019-08-09	2019-11-08	[redacted]	A method of improving inside battery temperature rise
CN111525194A *	2020-04-28	2020-08-11	[redacted]	Electrochemical device and electronic device including the same
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
CN207611803U	2018-07-13	A kind of anode slice of lithium ion battery and lithium ion battery
CN202736667U	2012-08-08	Electrical core of lithium ion battery and pole piece thereof
CN202495523U	2012-10-17	Lithium ion battery and electrode plate thereof
CN207602718U	2018-07-10	A kind of coiled battery and battery pack
CN205479303U	2016-11-18	Mix anodal pole piece and lithium ion power batteries
CN103606705A	2014-02-26	Lithium ion battery and preparation method thereof
CN209691836U	2019-11-26	A kind of battery core structure of lithium-ion battery
CN105489395A	2016-04-13	Production method of lithium ion super capacitor, and lithium ion super capacitor
CN104659378A	2015-05-27	Method for manufacturing square power polymer lithium ion battery
CN105742721A	2016-07-06	High-energy-ratio low-internal-resistance cylindrical lithium ion battery
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CN204130649U	2015-01-28	A kind of three-electrode battery
CN205508965U	2016-08-24	Winding - type batteries and book needle
CN205828578U	2016-12-21	Takeup type battery core
CN202423438U	2012-09-05	High-power winding type polymer lithium ion battery
CN205508964U	2016-08-24	Coiling type battery cell
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CN101582521B	2013-01-02	Coiled lithium-ion secondary battery taking winding needle as positive and negative electrodes and manufacturing method thereof
CN202585549U	2012-12-05	Flexible-packaged lithium ion battery
CN201741765U	2011-02-09	Battery cell of power-type lithium ion battery
CN205828572U	2016-12-21	Takeup type battery core

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN201721693256.8U	2017-09-29	2017-09-29	A kind of coiled battery and battery pack

Applications Claiming Priority (1)

Application	Filing date	Title
CN201721693256.8U	2017-09-29	A kind of coiled battery and battery pack

Legal Events

Date	Code	Title	Description
2018-07-10	GR01	Patent grant	
2018-07-10	GR01	Patent grant	

Concepts

machine-extracted

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Name	Image	Sections	Count	Query match
cement		claims,abstract,description	43	0.000
positive electrode material		claims,description	22	0.000
negative electrode material		claims,description	21	0.000
corresponding		claims,description	16	0.000
glue		claims,description	9	0.000
insulation		claims,description	7	0.000
active material		claims,description	5	0.000
fluid		claims,description	2	0.000
manufacturing process		abstract,description	6	0.000
method		abstract,description	5	0.000

Show all concepts from the description section

A kind of lithium ion battery and preparation method thereof

Abstract

The production method that the present invention discloses a kind of lithium ion battery, comprising the following steps: 1. make positive plate and negative electrode tab respectively; 2. chemical conversion: it is fixed after positive plate and negative electrode tab are alternately superimposed, it after heated baking, in water-less environment, is immersed in electrolyte, is melted into the electric current of 0.01C-0.2C, obtains battery semi-finished product; 3. compression molding and encapsulation: the battery semi-finished product after chemical conversion being heated to 60-100 DEG C, is put into prefabricated mould, applies the pressure of 0.2-15MPa, be allowed to form; It places into shell, obtains lithium ion battery after encapsulated The present invention provides a kind of lithium ion battery and preparation method thereof, without processes such as coating, cutting, film-makings, can once form pole piece, production method is simple and efficient.

Classifications

- H01M10/0468 Compression means for stacks of electrodes and separators

View 12 more classifications

CN110459730A

China

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Other languages: Chinese

Inventor: [redacted]

Current Assignee : Zhangzhou Huarui Lithium New Energy Technology Co Ltd

Worldwide applications

2019 CN

Application CN201910688515.8A events

2019-07-29 Application filed by Zhangzhou Huarui Lithium New Energy Technology Co Ltd

2019-07-29 Priority to CN201910688515.8A

2019-11-15 Publication of CN110459730A

Info: Cited by (1), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (9)

Hide Dependent

1. a kind of production method of lithium ion battery, which comprises the following steps:

1. making positive plate and negative electrode tab respectively:

After binder and conductive agent powder and positive active material or negative electrode active material powder are mixed evenly, heating it to 80-200 DEG C, is put into the prefabricated mould of built-in metal net, applies the pressure of 3-20MPa to the powder in mold, be allowed into Type respectively obtains positive formed body and cathode formed body; One end of the metal mesh, which is formed with, stretches out in the positive formed body Or the conductive tab except cathode formed body side;

Positive formed body and cathode formed body are immersed in ceramic solution, the anode formed body and cathode form body surface after drying Bread covers one layer of ceramic layer;

Positive formed body and cathode formed body are immersed in macromolecule polymer solution again, in positive formed body and cathode after drying Formed body surface forms high polymer layer, obtains positive plate and negative electrode tab;

2. chemical conversion: it is fixed after positive plate and negative electrode tab are alternately superimposed, after heated baking, in water-less environment, it is immersed in electrolysis in liquid, it is melted into the electric current of 0.01C-0.2C, obtains battery semi-finished product;

3. compression molding and encapsulation: the battery semi-finished product after chemical conversion being heated to 60-100 DEG C, are put into prefabricated mould, are applied The pressure of 0.2-15MPa is allowed to form; It places into shell, obtains lithium ion battery after encapsulated.

2. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the ceramic layer with a thickness of 5-60μm.

3. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the high polymer layer With a thickness of 3-30 μm.

4. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the positive active material packet include one of cobalt acid lithium, $LiMn_2O_4$, nickle cobalt lithium manganate, $LiFePO_4$, lithium titanate or nickel cobalt lithium aluminate or several.

5. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the negative electrode active material including one of graphite, carbonaceous mesophase spherules, hard carbon, soft carbon, lithium titanate or silicon-carbon or several.

6. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the binder includes PVDF, PTFE, acrylate or butadiene-styrene rubber.

7. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the conductive agent includes charcoal It is black, CNT, graphite, graphene or wire.

8. a kind of production method of lithium ion battery as described in claim 1, which is characterized in that the mesh number of the metal mesh 80-1200 mesh; The metal mesh includes aluminium net, nickel screen, copper mesh or stainless (steel) wire.

9. a kind of lithium ion battery, which is characterized in that including positive plate, negative electrode tab and electrolyte, the positive plate includes anode Formed body further includes the ceramic layer for being coated on anode molding external surface, and the ceramic layer outer surface is also wrapped on one layer of high score Sub-polymeric layer; The metal mesh that the anode formed body includes positive electrode material layer and is arranged in positive electrode material layer;

The negative electrode tab includes cathode formed body, further includes the ceramic layer for being coated on cathode molding external surface, the ceramic layer Outer surface is also wrapped on one layer of high polymer layer; The cathode formed body includes negative electrode material layer and is arranged in negative electrode material Metal mesh in layer;

One end that the anode formed body and cathode form the intracorporal metal mesh, which is respectively formed with, stretches out in the positive material Conductive tab except the side of the bed of material or negative electrode material layer; The positive plate and negative electrode tab are alternately superposed, the electrolysis Liquid infiltration in pole piece and is being filled between pole piece.

Description

A kind of lithium ion battery and preparation method thereof

Technical field

The present invention relates to field of lithium ion battery, and in particular to be a kind of lithium ion battery and preparation method thereof.

Background technique

By the way of traditional lithium ion battery is coated with after solvent dissolution mixing, positive/negative material is coated in gold Belong to and form positive/negative material layer (positive/negative material generally comprises positive/negative active material, binder and conductive agent) on foil, Pole piece is made using processes such as cutting, film-makings, production process is cumbersome, and the production cycle is permanent, and is easy to produce burr, causes Security risk.

In view of this, the applicant furthers investigate in view of the above-mentioned drawbacks in the prior art, there is this case generation then.

Summary of the invention

The main purpose of the present invention is to provide a kind of lithium ion batteries and preparation method thereof, without coating, cutting, system The processes such as piece can once form pole piece, and production method is simple and efficient.

In order to achieve the above objectives, solution of the invention is:

A kind of production method of lithium ion battery, wherein the following steps are included:

1. making positive plate and negative electrode tab respectively:

After binder and conductive agent powder and positive active material or negative electrode active material powder are mixed evenly, it is heated to 80-200 DEG C, is put into the prefabricated mould of built-in metal net, applies the pressure of 3-20MPa to the powder in mold, makes Molding, respectively obtain positive formed body and cathode formed body; One end of the metal mesh be formed with stretch out in it is described anode at Conductive tab except type body or cathode formed body side;

Positive formed body and cathode formed body are immersed in ceramic solution, the anode formed body and cathode molding after drying Body surface bread covers one layer of ceramic layer;

Positive formed body and cathode formed body are immersed in macromolecule polymer solution again, after drying in positive formed body and Cathode formed body surface forms high polymer layer, obtains positive plate and negative electrode tab;

2. chemical conversion: it is fixed after positive plate and negative electrode tab are alternately superimposed, after heated baking, in water-less environment, it is immersed in in electrolyte, it is melted into the electric current of 0.01C-0.2C, obtains battery semi-finished product;

3. compression molding and encapsulation: the battery semi-finished product after chemical conversion being heated to 60-100 DEG C, is put into prefabricated mould, applies The pressure for adding 0.2-15MPa is allowed to form; It places into shell, obtains lithium ion battery after encapsulated.

Further, the ceramic layer with a thickness of 5-60 μm.

Further, the high polymer layer with a thickness of 3-30 μm.

Further, the positive active material include cobalt acid lithium, LiMn2O4, nickle cobalt lithium manganate, LiFePO4, lithium titanate or One of nickel cobalt lithium aluminate is several.

Further, the negative electrode active material includes graphite, carbonaceous mesophase spherules, hard carbon, soft carbon, lithium titanate or silicon-carbon One of or it is several.

Further, the binder includes PVDF, PTFE, acrylate or butadiene-styrene rubber.

Further, the conductive agent includes carbon black, CNT, graphite, graphene or wire.

Further, the mesh number 80-1200 mesh of the metal mesh; The metal mesh includes aluminium net, nickel screen, copper mesh or stainless steel Net.

A kind of lithium ion battery, wherein including positive plate, negative electrode tab and electrolyte, the positive plate includes anode molding Body further includes the ceramic layer for being coated on anode molding external surface, and the ceramic layer outer surface is also wrapped on one layer of polyphosphazene polymer Close nitride layer; The metal mesh that the anode formed body includes positive electrode material layer and is arranged in positive electrode material layer;

The negative electrode tab includes the cathode formed body being made of negative electrode active material, binder and conductive agent powder, is also wrapped The ceramic layer for being coated on cathode molding external surface is included, the ceramic layer outer surface is also wrapped on one layer of high polymer layer; The cathode formed body includes negative electrode material layer and the metal mesh that is arranged in negative electrode material layer;

It is described anode formed body and cathode form the intracorporal metal mesh one end be formed with stretch out in it is described anode at Conductive tab except the side of type body or cathode formed body; The positive plate and negative electrode tab are alternately superposed, the electrolysis Liquid infiltration in pole piece and is being filled between pole piece.

Further, the ceramic layer with a thickness of 5-60 μm.

Further, the high polymer layer with a thickness of 3-30 μm.

Further, the mesh number 80-1200 mesh of the metal mesh.

Further, the metal mesh includes aluminium net, nickel screen, copper mesh or stainless (steel) wire.

After adopting the above structure, the production method of a kind of lithium ion battery of the present invention, at least having following has Beneficial effect.

One, mixed powder is placed on and is heated to the binder that 80-200 DEG C makes in powder before prefabricated mould and softens, To which active material and conductive agent to be bonded together, press to form the anode molding of sheet using the mold of built-in metal net Body or cathode formed body.

Two, step 3. in heating pressure process, high polymer layer on positive plate and negative electrode tab by positive plate and Negative electrode tab is bonded together; It is provided with ceramic layer in the positive plate and negative electrode tab, plays the role of insulating electron, prevents anode Short circuit occurs between piece and negative electrode tab, and lithium ion can be migrated positive plate and negative electrode tab across ceramic layer.

Three, the metal mesh is located in the positive formed body and cathode formed body, is led by what is be connected with metal mesh Electrode ear is connected with extraneous conducting wire.

Four, step 3. in, the battery semi-finished product after chemical conversion are heated to the 60-100 DEG C of viscosity that can reduce electrolyte, rise To the effect for the infiltration rate for accelerating electrolyte, in order to which electrolyte permeability is into positive plate and negative electrode tab; Step is 3. middle to be applied Pole piece is discharged in the gas that the pressure of 0.2-15MPa can generate chemical conversion, prevents from forming dead lithium influence electricity in pole piece Pond effect.

Detailed description of the invention

Fig. 1 is the schematic perspective view of lithium ion battery.

Fig. 2 is the schematic diagram of the section structure of positive plate.

Fig. 3 is the schematic diagram of the section structure of negative electrode tab.

Fig. 4 is the structural schematic diagram of positive plate.

Fig. 5 is the structural schematic diagram of negative electrode tab.

In figure:

Positive plate 1; Positive formed body 11; Positive electrode material layer 111; Negative electrode tab 2; Cathode formed body 21; Negative electrode material layer 211; Metal mesh 3; Conductive tab 31; Ceramic layer 4; High polymer layer 5.

Specific embodiment

In order to further explain the technical solution of the present invention, being explained in detail below by specific embodiment the present invention It states.

It as shown in Figures 1 to 5, is a kind of production method of lithium ion battery of the present invention, comprising the following steps:

1. making positive plate 1 and negative electrode tab 2 respectively: by binder and conductive agent powder and positive active material or cathode After active material powder is mixed evenly, it is heated to 80-200 DEG C, is put into the prefabricated mould of built-in metal net 3, to mold in powder apply 3-20MPa pressure, be allowed to form, respectively obtain positive formed body 11 and cathode formed body 21; It is described just One end of the metal mesh 3 in pole formed body 11 and cathode formed body 21, which is formed with, stretches out in the positive formed body 11 or negative Conductive tab 31 except 21 side of pole formed body; Positive formed body 11 and cathode formed body 21 are immersed in ceramic solution, dried The positive formed body 11 and 21 surface of cathode formed body coat one layer of ceramic layer 4 after dry, the ceramic layer 4 with a thickness of 5-60 μm; Positive formed body 11 and cathode formed body 21 are immersed in macromolecule polymer solution again, in positive formed body 11 after drying High polymer layer 5 is formed with 21 surface of cathode formed body, obtains positive plate 1 and negative electrode tab 2.Preferably, the macromolecule Polymeric layer 5 with a thickness of 3-30 μm.

2. chemical conversion: it is fixed after positive plate 1 and negative electrode tab 2 are alternately superimposed, after heated baking, in water-less environment, immerse into electrolyte, it is melted into the electric current of 0.01C-0.2C, obtains battery semi-finished product.

3. compression molding and encapsulation: the battery semi-finished product after chemical conversion being heated to 60-100 DEG C, is put into prefabricated mould, applies The pressure for adding 0.2-15MPa is allowed to form: it places into shell, obtains lithium ion battery after encapsulated.

In this way, a kind of production method of lithium ion battery of the present invention, is placed on prefabricated mould for mixed powder Before be heated to the binder that 80-200 DEG C makes in powder and soften, so that active material and conductive agent are bonded together, then pass through Mold is pressed to press to form the positive formed body 11 or cathode formed body 21 of sheet.

Step 3. in during heating pressurization, high polymer layer 5 on positive plate 1 and negative electrode tab 2 is by positive plate 1 It is bonded together with negative electrode tab 2; It is provided with ceramic layer 4 in the positive plate 1 and negative electrode tab 2, plays the role of insulating electron, is prevented Short circuit only occurs between positive plate 1 and negative electrode tab 2, and lithium ion can be across ceramic layer 4 positive plate 1 and negative electrode tab 2 Migration.

When lithium ion battery is charged and discharged, the metal mesh 3 is located at the positive formed body 11 and cathode formed body In 21, it is connected by the conductive tab 31 being connected with metal mesh 3 with extraneous conducting wire.

Step 3. in, the battery semi-finished product after chemical conversion are heated to the 60-100 DEG C of viscosity that can reduce electrolyte, are played Accelerate the effect of the infiltration rate of electrolyte, in order to which electrolyte permeability is into positive plate 1 and negative electrode tab 2; Step is 3. middle to be applied Pole piece is discharged in the gas that the pressure of 0.2-15MPa can generate chemical conversion, prevents from forming dead lithium influence electricity in pole piece Pond effect.

Preferably, the positive active material include cobalt acid lithium, LiMn2O4, nickle cobalt lithium manganate, LiFePO4, lithium titanate or One of nickel cobalt lithium aluminate is several.

Preferably, the negative electrode active material includes graphite, carbonaceous mesophase spherules, hard carbon, soft carbon, lithium titanate or silicon-carbon One of or it is several.

Preferably, the binder includes PVDF, PTFE, acrylate or butadiene-styrene rubber.Made by the bonding of binder it is bonded together with by positive active material or negative electrode active material with conductive agent.

Preferably, the conductive agent includes carbon black, CNT, graphite, graphene or wire.

Preferably, the mesh number 80-120 mesh of the metal mesh 3; The metal mesh 3 includes aluminium net, nickel screen, copper mesh or stainless Steel mesh.

A kind of lithium ion battery, including positive plate 1, negative electrode tab 2 and electrolyte, the positive plate 1 include positive formed body 11, further include be coated on positive 11 outer surface of formed body with a thickness of 5-60 μm of ceramic layer 4,4 outer surface of ceramic layer is also it is coated with the high polymer layer 5 that a layer thickness is 3-30 μm; The anode formed body 11 includes positive electrode material layer 111 and sets Set the metal mesh 3 in positive electrode material layer 111;

The negative electrode tab 2 include cathode formed body 21, further include be coated on 21 outer surface of cathode formed body with a thickness of 5- 60 μm of ceramic layer 4,4 outer surface of ceramic layer are also wrapped on the high polymer layer 5 that a layer thickness is 3-30 μm; It is described Cathode formed body 21 includes negative electrode material layer 211 and the metal mesh 3 being arranged in negative electrode material layer 211;

One end for stating metal mesh 3 in the anode formed body 11 and cathode formed body 21, which is formed with, stretches out in the anode Conductive tab 31 except the side of formed body 11 or cathode formed body 21; Alternately superposition is set for the positive plate 1 and negative electrode tab 2.It sets, the electrolyte permeability in pole piece and is being filled between pole piece.

Preferably, the mesh number 80-120 mesh of the metal mesh 3.Further, the metal mesh 3 includes aluminium net, nickel Net, copper mesh or stainless (steel) wire.

In this way, the metal mesh 3 is located in the positive formed body 11 and cathode formed body 21, by with 3 phase of metal mesh The conductive tab 31 of connection is connected with extraneous conducting wire; High polymer layer 5 on positive plate 1 and negative electrode tab 2 is by positive plate 1 It is bonded together with negative electrode tab 2, is provided with ceramic layer 4 in the positive plate 1 and negative electrode tab 2, plays the role of insulating electron, prevented Short circuit only occurs between positive plate 1 and negative electrode tab 2, and lithium ion can be across ceramic layer 4 positive plate 1 and negative electrode tab 2 Migration.The feature that lithium ion battery of the invention has structure simple, easily manufactured.

Above-described embodiment and schema and non-limiting product form and style of the invention, any technical field it is common The appropriate changes or modifications that technical staff does it all should be regarded as not departing from patent category of the invention.

Cited By (1)

Publication number	Priority date	Publication date	Assignee	Title
WO2021217423A1 *	2020-04-28	2021-11-04	宁德[illegible]科技有限公司	Electrochemical device and electronic device comprising electrochemical device
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
CN102610883B	2015-03-04	Lithium ion battery
CN108548898B	2019-02-05	Conductive aqueous binders and preparation method thereof, lithium ion battery
CN104966908B	2018-04-27	Composite particles for electrochemical element electrode, the manufacture method of composite particles for electrochemical element electrode, electro-chemical element electrode and electrochemical element
CN106207092A	2016-12-07	A kind of combined anode slice of lithium ion battery of conductive agent and preparation method thereof
CN105164837B	2017-12-26	Composite particles for electrochemical element electrode, the manufacture method of composite particles for electrochemical element electrode, electro-chemical element electrode and electrochemical element
CN109256555B	2020-12-22	Chalcogenide composite positive electrode material, all-solid-state lithium battery and preparation methods thereof
CN103779581A	2014-05-07	Porous negative pole piece and preparation method thereof, and lithium ion battery
CN104638213A	2015-05-20	Ultrathin secondary battery and preparation method thereof
CN108878878A	2018-11-23	A kind of large capacity high magnification water system lithium iron phosphate battery and preparation method thereof
CN101399368A	2009-04-01	Electric core used for secondary lithium battery and preparation
CN109755557A	2019-05-14	A kind of safe high-voltage high-energy-density lithium ion battery and preparation method thereof
CN108346823A	2018-07-31	A kind of preparation method containing lithium an- ode of mixed type energy storage device

CN110459730A	2019-11-15	A kind of lithium ion battery and preparation method thereof
CN106450479A	2017-02-22	Flexible lithium ion battery and making method thereof
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CN104269556A	2015-01-07	High-energy zinc-manganese battery
CN102623672A	2012-08-01	Lithium ion battery and negative electrode thereof
CN102916219B	2016-08-03	A kind of lithium ion battery cell and preparation method thereof
CN103474623B	2016-06-08	The preparation method of cathode pole piece and electrochemical appliance
FR3173482B1	2017-05-12	System for storing energy in vitro and method for storing energy in vitro
CN105932290A	2016-09-07	Unit high-capacity polymer lithium ion battery positive plate and production method thereof
CN109830745A	2019-05-31	A kind of gel button flexible package lithium cell and preparation process
CN204029923U	2014-12-17	A kind of transparent lithium battery
CN100401565C	2008-07-09	Lithium polymer batteries
CN212062087U	2020-03-27	Lithium ion battery

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN201910688515.8A	2019-07-29	2019-07-29	A kind of lithium ion battery and preparation method thereof

Applications Claiming Priority (1)

Application	Filing date	Title
CN201910688515.8A	2019-07-29	A kind of lithium ion battery and preparation method thereof

Legal Events

Date	Code	Title	Description
2019-11-15	PB01	Publication	
2019-11-15	PB01	Publication	
2019-12-27	SE01	Entry into force of request for substantive examination	
2019-12-27	SE01	Entry into force of request for substantive examination	

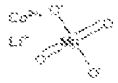
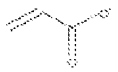
Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
lithium ion	Li^+	title,claims,abstract,description	33	0.000
lithium ion		title,claims,abstract,description	33	0.000
preparation method		title,abstract,description	5	0.000
manufacturing process		claims,abstract,description	17	0.000
electrolyte		claims,abstract,description	13	0.000
chemical reaction		claims,abstract,description	12	0.000
substance		claims,abstract,description	12	0.000

substrate	claims,abstract,description	12	0.000
semifinished product	claims,abstract,description	10	0.000
compression moulding	claims,abstract,description	4	0.000
encapsulation	claims,abstract,description	4	0.000
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metal	claims,description	33	0.000
ceramic	claims,description	29	0.000
polymer	claims,description	18	0.000
negative electrode material	claims,description	16	0.000
positive electrode material	claims,description	15	0.000
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carbon	claims,description	11	0.000
Cl			
conductive agent	claims,description	11	0.000
binding agent	claims,description	10	0.000
nickel	claims,description	10	0.000
Ni			
moulding	claims,description	8	0.000
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nickel cobalt lithium	claims,description	6	0.000
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Butadiene-styrene rubber 	claims,description	3	0.000
LiFePO4	claims,description	3	0.000
Lithium manganese(III,IV) oxide	claims,description	3	0.000
PVDF binder	claims,description	3	0.000
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steel	claims,description	3	0.000
bread	claims,description	2	0.000
charcoal	claims	1	0.000
method	abstract,description	5	0.000
cutting process	abstract,description	3	0.000
coating agent	abstract,description	2	0.000
coating method	abstract,description	2	0.000

Show all concepts from the description section

A kind of high power cylindrical lithium ion cell core

Abstract

The invention belongs to technical field of lithium ion, a kind of more particularly to high power cylindrical lithium ion cell core, it is reserved with the negative pole gap digit of multiple uncoated negative electrode active material layers in the both sides of negative current collector respectively, negative pole gap digit is welded with negative lug, negative pole gap digit is also covered with negative insulation glue and covers negative lug, and exposed 1~10mm of negative plate edge is distinguished at the both ends of negative insulation glue on the width of negative plate; The both sides of plus plate current-collecting body be reserved with respectively multiple uncoated positive active material layers and with the one-to-one positive pole gap digit of negative pole gap digit, positive pole gap digit is welded with positive pole ear, positive pole insulating cement is covered between positive pole gap digit and anode active material layer, exposed 1~10mm of positive plate edge is distinguished at the both ends of positive pole insulating cement on the width of positive plate. The present invention can either ensure the power requirement of battery, avoid battery pole ear position that analysis lithium, and can accurate judgement positive plate and negative plate gap digit alignment situation occurs.

Classifications

H01M10/0431 Cells with wound or folded electrodes

View 6 more classifications

CN107834014A

China

Download PDF Find Prior Art Similar

Other languages: Chinese

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Current Assignee : Dongguan Monair Resinst Of Lithiumion Battery Industry Energy Saving Technology ; Monair Technology Co Ltd ; Dongguan Monair New Power Co Ltd

Worldwide applications

2017 CN

Application CN201711041354.2A events

2017-09-18 Application filed by Dongguan Monair Resinst Of Lithiumion Battery Industry Energy Saving Technology, Monair Technology Co Ltd, Dongguan Monair New Power Co Ltd

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2018-03-23 Publication of CN107834014A

2021-01-15 Application granted

2021-01-15 Publication of CN107834014B

Info: Patent citations (3), Cited by (5), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (9)

Hide Dependent

1. a kind of high power cylindrical lithium ion cell core, its stacked gradually by positive plate, barrier film and negative plate after along same side Formed to winding, it is characterised in that: The negative plate includes negative current collector and the negative pole coated in negative current collector both sides is lived Property material layer, the both sides of the negative current collector are reserved with the negative pole gap digit of multiple uncoated negative electrode active material layers respectively, The negative pole gap digit is welded with negative lug, and the negative pole gap digit is also covered with negative insulation glue and covers the negative pole pole Exposed 1~10mm of negative plate edge is distinguished at ear, the both ends of the negative insulation glue on the width of negative plate;

The positive plate includes plus plate current-collecting body and the anode active material layer coated in plus plate current-collecting body both sides, the positive pole collection The both sides of fluid be reserved with respectively multiple uncoated positive active material layers and with negative pole gap digit positive clearance between poles correspondingly Position, the positive pole gap digit are welded with positive pole ear, also pasted between the positive pole gap digit and the anode active material layer Have a positive pole insulating cement, the both ends of the positive pole insulating cement distinguish on the width of positive plate exposed positive plate edge 1~ 10mm,

2. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: The two of the negative insulation glue Exposed 1~5mm of negative plate edge is distinguished on the width of negative plate in end; The both ends of the positive pole insulating cement are in positive plate Exposed 1~5mm of positive plate edge is distinguished on width.

3. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: The two of the negative insulation glue Side is covered each by 0.5~5mm anode active material layer on the length direction of negative plate.

4. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: The two of the positive pole insulating cement Side is covered each by 0.5~5mm anode active material layer on the length direction of positive plate.

5. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: Along the side of the electric core winding Upwards, the width of the negative pole gap digit of the negative plate both sides all keeps equal.

6. high power cylindrical lithium ion cell core according to claim 5, it is characterised in that: Along the side of the electric core winding Upwards, the width of the positive pole gap digit of the positive plate wherein side keeps equal, the positive clearance between poles of the positive plate opposite side The width of position increases successively.

7. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: Multiple positive pole ear weldeings The same side of positive plate is connected on, multiple negative lugs are welded on the same side of negative plate.

8. high power cylindrical lithium ion cell core according to claim 1, it is characterised in that: The every side of the negative plate The quantity of negative pole gap digit is arranged to three, and three negative pole gap digits are separately positioned on the head, middle part and tail of negative plate Portion.

9. high power cylindrical lithium ion cell core according to claim 8, it is characterised in that: The every side of the positive plate The quantity of positive pole gap digit is arranged to three, and three positive pole gap digits are separately positioned on the head, middle part and tail of positive plate Portion.

Description

A kind of high power cylindrical lithium ion cell core

Technical field

The invention belongs to technical field of lithium ion, more particularly to a kind of high power cylindrical lithium ion cell core.

Background technology

For lithium ion battery due to high with energy density, self discharge is low, has become shifting outstanding advantages of memory-less effect The primary solutions of energy source, and portable type electronic product is widely used in, multiple necks such as electric automobile and energy-accumulating power station Domain.

Wherein, cylindrical battery is typically made up of box hat, top cover, positive plate, negative plate, barrier film, electrolyte etc.. At present, Commercialization cylindrical battery is generally anode ear and drawn from top cover, and negative electrode lug is welded by bottom and is connected with box hat, this design Existing bottleneck is can only to draw both positive and negative polarity by a lug, inevitable if drawn by original structure using both positive and negative polarity multi pole ears Cause the correspondence position of negative electrode lug positive active material occur, so as to cause battery charging analysis lithium, trigger security incident.In business in the application of change, if realizing that multi pole ears contraposition is drawn by changing deriving structure or change other equipment, it is clear that from cost All it is a very big input for technical requirements.In addition, cylindrical batteries are commercialized relative to 18650,26650 etc., 32650 cylindrical battery diameters are bigger, and the length of its pole piece is also longer, if drawn by industry universal using monopole ear, electricity The internal resistance in pond is inevitable very big, is applied on electrokinetic cell and is difficult to meet high power and the low requirement from power consumption.

The content of the invention

It is an object of the invention to: In view of the shortcomings of the prior art, providing a kind of power that can either ensure battery will Ask, avoid battery pole ear position that analysis lithium occurs, and can judges positive plate and the high power cylinder of negative plate gap digit alignment situation Type lithium-ion electric core.

To achieve these goals, the present invention uses following technical scheme:

A kind of high power cylindrical lithium ion cell core, its stacked gradually by positive plate, barrier film and negative plate after along same Direction winding forms, and the negative plate includes negative current collector and the anode active material layer coated in negative current collector both sides. The both sides of the negative current collector are reserved with the negative pole gap digit of multiple uncoated negative electrode active material layers respectively, between the negative pole Gap position is welded with negative lug, and the negative pole gap digit is also covered with negative insulation glue and covers the negative lug, described negative Exposed 1~10mm of negative plate edge is distinguished on the width of negative plate in the both ends of pole insulating cement;

The positive plate includes plus plate current-collecting body and the anode active material layer coated in plus plate current-collecting body both sides, it is described just The both sides of pole collector be reserved with respectively multiple uncoated positive active material layers and with the one-to-one positive pole of negative pole gap digit Gap digit, the positive pole gap digit are welded with positive pole ear, between the positive pole gap digit and the anode active material layer also Positive pole insulating cement is covered with, exposed positive plate edge 1 is distinguished at the both ends of the positive pole insulating cement on the width of positive plate ~10mm.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, the both ends of the negative insulation glue Exposed 1~5mm of negative plate edge is distinguished on the width of negative plate; Width of the both ends of the positive pole insulating cement in positive plate Spend and exposed 1~5mm of positive plate edge is distinguished on direction.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, the both sides of the negative insulation glue 0.5~5mm anode active material layer is covered each by the length direction of negative plate.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, the both sides of the positive pole insulating cement 0.5~5mm anode active material layer is covered each by the length direction of positive plate.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, along the direction of the electric core winding On, the width of the negative pole gap digit of the negative plate both sides all keeps equal.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, along the direction of the electric core winding On, the width of the positive pole gap digit of the positive plate wherein side keeps equal, the positive pole gap digit of the positive plate opposite side Width increase successively.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, multiple positive pole ear welding in the same side of positive plate, multiple negative lugs are welded on the same side of negative plate.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, the negative plate is negative per side The quantity of clearance between poles position is arranged to three, and three negative pole gap digits are separately positioned on the head, middle part and afterbody of negative plate.

As the preferred scheme of high power cylindrical lithium ion cell core of the present invention, the every side of the positive plate is just The quantity of clearance between poles position is arranged to three, and three positive pole gap digits are separately positioned on the head, middle part and afterbody of positive plate.

Compared to prior art, the beneficial effects of the present invention are: 1) battery core of the invention uses multi pole ears structure design, The impedance of battery can be effectively reduced, lifts the dynamic performance of battery, meets high power and the low requirement from power consumption; 2) it is electric After the completion of core winding, the positive pole gap digit of positive plate side and the negative pole gap bit-by-bit of negative plate opposite side, positive plate are another The positive pole gap digit of side is by the negative pole gap bit-by-bit after winding with negative plate opposite side, so that the gap digit of negative plate in the absence of positive active material, therefore the risk that analysis lithium occurs for lug position is prevented; 3) insulation is pasted in both positive and negative polarity gap digit Glue, and make the exposed 1~10mm of pole piece both sides of the edge of insulating cement; Such design, on the one hand, positive plate dressing

edge can be prevented Friction barrier film causes the risk being in contact with negative plate, improves the security of battery; On the other hand, multi pole ears core structure Lug contraposition is certainly existed on the inside of the core, in the case where not disassembling core, typically can not accurate judgement whether in technique in the range of align, and by pasting insulating cement in both positive and negative polarity gap digit, and make the exposed pole piece both sides of the edge 1 of insulating cement~ 10mm, the position that so need to only observe exposed insulating cement can determine whether lug contraposition meets processing range; In addition, work as pole piece When dressing layer edge thickness is inconsistent, pole piece is easily pulled off here, and so as to cause the reduction of battery core yields, and the present invention exists After both positive and negative polarity gap digit pastes insulating cement with dressing layer edge, the mutation of stress between dressing layer and pole piece gap digit can be alleviated, So as to reduce the risk of dressing layer edge broken belt, non-defective unit productivity ratio can be greatly enhanced.

Brief description of the drawings

Fig. 1 is the structural representation before the lithium-ion electric core winding of the present invention

In figure: 1- barrier films; 2- negative plates; 21- negative current collectors; 22- anode active material layers; 23- negative pole gap digits; 24- negative lugs; 25- negative insulation glue; 3- positive plates; 31- plus plate current-collecting bodies; 32- anode active material layers; The positive interpolars of 33- Gap position; 34- positive pole ears; 35- positive pole insulating cements.

Embodiment

To make technical scheme and advantage clearer, below in conjunction with specific embodiment and Figure of description, Technical scheme is clearly and completely described, it is clear that described embodiment is that s part of the invention is implemented Example, rather than whole embodiments.Based on the embodiment in the present invention, those of ordinary skill in the art are not making creativeness The every other embodiment obtained under the premise of work, belongs to the scope of protection of the invention.

Embodiment 1

A kind of high power cylindrical lithium ion cell core of the present embodiment, it is by positive plate 3, barrier film 1 and negative plate 2 successively layer Poststack winds form in the same direction, and negative plate 2 includes negative current collector 21 and the negative pole coated in the both sides of negative current collector 21 Active material layer 22, the both sides of negative current collector 21 are reserved with the negative pole gap of three uncoated negative electrode active material layers 22 respectively Position 23, three negative pole gap digits 23 are separately positioned on the head, middle part and afterbody of negative plate 2, and three negative pole gap digits 23 Width keeps equal; Three negative pole gap digits 23 are respectively welded negative lug 24, and three negative lugs 24 are welded on negative plate 2 The same side, negative pole gap digit 23 is also covered with negative insulation glue 25 and covers negative lug 24, the both ends of negative insulation glue 25 The exposed edge 1mm of negative plate 2 is distinguished on the width of negative plate 2; Length of the both sides of negative insulation glue 25 in negative plate 2 9.5mm anode active material layer 22 is covered each by direction.

Positive plate 3 includes plus plate current-collecting body 31 and the anode active material layer 32 coated in the both sides of plus plate current-collecting body 31, just The both sides of pole collector 31 are reserved with three uncoated positive active material layers 32 and corresponded with negative pole gap digit 23 respectively Positive pole gap digit 33, three positive pole gap digits 33 are separately positioned on the head, middle part and afterbody of positive plate 3, wherein, positive plate The width of the 3 wherein positive pole gap digits 33 of side keeps equal, and the width of the positive pole gap digit 33 of the opposite side of positive plate 3 increases successively Add, to ensure that the positive pole gap digit 33 of the side of positive plate 3 and the negative pole gap digit 23 of the opposite side of negative plate 2 align, positive plate 3 is another The positive pole gap digit 33 of side is aligned by the negative pole gap digit 23 after winding with the opposite side of negative plate 2; Three positive pole gap digits 33 are respectively welded positive pole ear 34, and three positive pole ears 34 are welded on the same side of positive plate 3, positive pole gap digit 33 and positive pole Positive pole insulating cement 35 is also covered between active material layer 32, the both ends of positive pole insulating cement 35 are on the width of positive plate 3 The exposed edge 1mm of positive plate 3 respectively; The both sides of positive pole insulating cement 35 are covered each by 0.5mm's on the length direction of positive plate 3 Anode active material layer 32.

Embodiment 2

A kind of high power cylindrical lithium ion cell core of the present embodiment, it is by positive plate 3, barrier film 1 and negative plate 2 successively layer Poststack winds form in the same direction, and negative plate 2 includes negative current collector 21 and the negative pole coated in the both sides of negative current collector 21 Active material layer 22, the both sides of negative current collector 21 are reserved with the negative pole gap of four uncoated negative electrode active material layers 22 respectively Position 23, four negative pole gap digits 23 are separately positioned on the head, middle part and afterbody of negative plate 2, and four negative pole gap digits 23 Width keeps equal; Four negative pole gap digits 23 are respectively welded negative lug 24, and four negative lugs 24 are welded on negative plate 2 The same side, negative pole gap digit 23 is also covered with negative insulation glue 25 and covers negative lug 24, the both ends of negative insulation glue 25 The exposed edge 5mm of negative plate 2 is distinguished on the width of negative plate 2; Length of the both sides of negative insulation glue 25 in negative plate 2 5mm anode active material layer 22 is covered each by direction.

Positive plate 3 includes plus plate current-collecting body 31 and the anode active material layer 32 coated in the both sides of plus plate current-collecting body 31, just The both sides of pole collector 31 are reserved with four uncoated positive active material layers 32 and corresponded with negative pole gap digit 23 respectively Positive pole gap digit 33, four positive pole gap digits 33 are separately positioned on the head, middle part and afterbody of positive plate 3, wherein, positive plate The width of the 3 wherein positive pole gap digits 33 of side keeps equal, and the width of the positive pole gap digit 33 of the opposite side of positive plate 3 increases successively Add, to ensure that the positive pole gap digit 33 of the side of positive plate 3 and the negative pole gap digit 23 of the opposite side of negative plate 2 align, positive plate 3 is another The positive pole gap digit 33 of side is aligned by the negative pole gap digit 23 after winding with the opposite side of negative plate 2; Four positive pole gap digits 33 are respectively welded positive pole ear 34, and four positive pole ears 34 are welded on the same side of positive plate 3, positive pole gap digit 33 and positive pole Positive pole insulating cement 35 is also covered between active material layer 32, the both ends of positive pole insulating cement 35 are on the width of positive plate 3 The exposed edge 5mm of positive plate 3 respectively; The both sides of positive pole insulating cement 35 are being covered each by 5mm just on the length direction of positive plate 3 Pole active material layer 32.

Comparative example 1

As different from Example 1, the battery core of this comparative example uses Double-pole lug deriving structure, and remaining is with embodiment 1, here Repeat no more.

Comparative example 2

As different from Example 2, the battery core of this comparative example uses Double-pole lug deriving structure, and remaining is with embodiment 2, here Repeat no more.

Electrochemical property test is carried out to the lithium-ion electric core of embodiment 1~2 and comparative example 1~2 respectively, test result is shown in Table 1.

The lithium-ion electric core electrochemical property test result of the embodiment 1~2 of table 1 and comparative example 1~2

From the test result of table 1, compared to existing Double-pole lug core structure, lithium-ion electric core of the invention has Lower impedance and higher voltage improving performance, it can effectively meet electrokinetic cell high power and the low requirement from power consumption.

The announcement and teaching of book according to the above description, those skilled in the art in the invention can also be to above-mentioned embodiment party Formula is changed and changed.Therefore, the invention is not limited in above-mentioned embodiment, every those skilled in the art exist Made any conspicuously improved, replacement or modification belong to protection scope of the present invention on the basis of the present invention.This Outside, although having used some specific terms in this specification, these terms merely for convenience of description, not to the present invention Form any restrictions.

Patent Citations (3)

Publication number	Priority date	Publication date	Assignee	Title
CN105161673A *	2015-10-23	2015-12-16	东莞市凯格电池科技有限公司	Producing process of multi-tab battery cell and multi-tab battery
CN205159450U *	2015-10-15	2016-04-13	东莞市凯格电池科技有限公司	Well play utmost point ear formula electric core of coiling and power type battery
WO2017047353A1 *	2015-09-14	2017-03-23	日立マクセル株式会社	Nonaqueous electrolyte secondary battery
Family To Family Citations				

* Cited by examiner, † Cited by third party

Cited By (5)

Publication number	Priority date	Publication date	Assignee	Title
CN110071252A *	2019-04-22	2019-07-30	佛山市紫宸科技有限公司	A kind of battery and its negative electrode plate, core
CN111525194A *	2020-04-28	2020-08-11	宁德新能源科技有限公司	Electrochemical device and electronic device including the same
CN111554982A *	2020-05-11	2020-08-18	珠海冠宇电池股份有限公司	Winding battery cell, preparation method thereof, battery and electronic product
CN111916666A *	2020-07-27	2020-11-10	珠海冠宇电池股份有限公司	Negative plate with special-shaped structure and lithium ion battery comprising same
WO2021227896A1 *	2020-05-11	2021-11-18	珠海冠宇电池股份有限公司	Battery and electronic device
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
CN107834014A	2018-03-23	A kind of high power cylindrical lithium ion cell core
CN104078246A	2014-10-01	Lithium ion battery capacitor
CN207782023U	2018-05-04	A kind of lithium ion battery negative electrode and lithium ion battery
CN203495523U	2014-03-26	Lithium ion battery and electrode plate thereof
CN202373667U	2012-08-08	Electrical core of lithium ion battery and pole piece thereof
KR101664244B1	2016-10-10	Method forming electrode surface pattern and the electrode manufactured by the method and secondary battery including the same
CN106941150A	2017-07-11	Lithium ion battery plus negative plate piece and preparation method, core and lithium ion battery
CN205159450U	2016-04-13	Well play utmost point ear formula electric core of coiling and power type battery
CN206947451U	2018-01-30	A kind of stacked solid state battery
CN203783873U	2014-08-20	Multi-pole plug battery rolling core and multi-pole multi-rolling core lithium ion battery

CN201904399U	2011-07-20	Tab-electrode piece structure for improving electrical property of battery
CN203774413U	2014-08-13	Polymer lithium ion battery cell structure
CN206186020U	2017-05-17	Novel high safe power battery of structure high magnification
CN202503058U	2012-10-24	Lug position structure for positive electrode piece and negative electrode piece of polymer lithium ion battery
CN209357812U	2019-09-06	A kind of electric core structure of lithium battery that can improve heavy impact and the lithium battery including the core structure
CN207602676U	2018-07-10	Lug, battery core and soft bag lithium ionic cell
CN203644890U	2014-06-11	Three-electrode lithium ion battery
CN207558947U	2018-06-29	A kind of stacked solid-state thin-film battery
CN202259513U	2012-05-30	Combined lithium battery with welded tabs
CN206225478U	2017-06-06	A kind of lithium-ion power battery structure
CN202231105U	2012-05-23	Novel cylinder lithium ion battery
CN204327442U	2015-12-30	Tail welds formula power type battery
CN201340882Y	2009-11-04	High-power laminated lithium ion battery
CN109478692A	2019-03-15	Electrode assembly including being coupled to the contact conductor of its long side
CN203774408U	2014-08-13	Power energy-storage polymer lithium ion battery

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN201710841354.2A	2017-09-18	2017-09-18	High-power cylindrical lithium ion battery cell

Applications Claiming Priority (1)

Application	Filing date	Title
CN201710841354.2A	2017-09-18	High-power cylindrical lithium ion battery cell

Legal Events

Date	Code	Title	Description
2018-03-23	PB01	Publication	
2018-03-23	PB01	Publication	
2018-04-17	SE01	Entry into force of request for substantive examination	
2018-04-17	SE01	Entry into force of request for substantive examination	
2021-01-15	GR01	Patent grant	
2021-01-15	GR01	Patent grant	

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
lithium ion		title,claims,abstract,description	32	0.000
cement		claims,abstract,description	23	0.000
anode active material		claims,abstract,description	17	0.000
glue		claims,abstract,description	17	0.000

insulation	claims,abstract,description	17	0.000
positive electrode material	claims,abstract,description	7	0.000
negative electrode material	claims,abstract,description	5	0.000
winding	claims,description	11	0.000
Clearance	claims,description	4	0.000
clearance	claims,description	4	0.000
fluid	claims	1	0.000
material	claims	1	0.000
Lithium ion	abstract,description	8	0.000
Li^+			
lithium	abstract,description	4	0.000
Li^+			
lithium	abstract,description	4	0.000

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High power lithium ion cell

Abstract

The invention belongs to a high power Li ion battery, comprising anode, cathode, diaphragm and nonaqueous electrolyte, where anode and cathode coatings containing active materials are continuous coatings, one side of each of the anode and cathode in the coiling direction has a current collector margin where anode and cathode ears are arranged. And it is characterized in that: anode ear section area S1, anode ear distance d1 and anode coating width w1 meet: 1*10-5<or=S1/(d1*w1)<or=4*10-5; cathode ear section area S2, cathode ear distance d2 and cathode coating width w2 meet: 1*10-5 ,or=S2/(d2*w2),or=3*10-5. And it effectively controls battery temperature at high power discharging, reduces electrode inner resistance, and improves battery security and prolongs circulating service life. And it can be widely applied to power supplies of mixed power vehicles, electric driven tools and various boosters, and has wide application prospect in the aspect of implementing high power Li ion batteries.

Classifications

- Y02E60/10 Energy storage using batteries

CN1949580A

China

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Other languages: Chinese

Inventor: [illegible]

Current Assignee : Tianjin Zhongdian New Energy Research Institute Co., Ltd.; CETC 18 Research Institute

Worldwide applications

2006 CN

Application CNA2005101153883A events

2005-10-14 Application filed by CETC 18 Research Institute

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2007-04-18 Publication of CN1949580A

2008-11-12 Application granted

2008-11-12 Publication of CN100438400C

Info: Patent citations (6), Cited by (18), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (7)

Hide Dependent

1. a high power lithium ion cell comprises positive pole, negative pole, barrier film and nonaqueous electrolytic solution, and positive pole is made of plus plate current-collecting body and the positive electrode active materials coat that contains that is evenly coated in its two sides; Negative pole is made of negative current collector and the negative active core-shell material coat that contains that is evenly coated in its two sides; The coat that contains active material anodal and negative pole is continuous coat, and leaves the collector blank in the side along coiling direction of positive and negative electrode, in blank space electric current is set and derives positive and negative lug, it is characterized in that: the sectional area S of described positive pole ear $_1$, positive pole ear d at interval $_1$And contain positive electrode active materials coat width w $_1$Satisfy following formula: $1 * 10^{-5} \leq S_1 / (d_1 X w_1) \leq 4 * 10^{-5}$The sectional area S of described negative lug $_2$, negative lug d at interval $_2$And contain negative active core-shell material coat width w $_2$Satisfy following formula: $1 * 10^{-5} \leq S_2 / (d_2 X w_2) \leq 3 * 10^{-5}$

2. high power lithium ion cell according to claim 1 is characterized in that: the described double spread weight that contains the positive electrode active materials coat is 10mg-30mg/cm ^{2}, the described double spread weight that contains the negative active core-shell material coat is 4.8mg-14.5mg/cm ^{2}

3. high power lithium ion cell according to claim 1, it is characterized in that: described positive pole ear and plus plate current-collecting body are that integral structure, described negative lug and negative current collector are integral structure, and lug and collector transitional region are the arc or the triangular structure of being wider than lug.

4. high power lithium ion cell according to claim 1 is characterized in that: described positive pole ear is that ultrasonic bond is welded on the aluminum strip on the plus plate current-collecting body, and the thickness of aluminum strip is not more than 1.5 times of anodal thickness; Described negative lug is that ultrasonic bond is welded on nickel strap or the copper strips on the negative current collector, and its thickness is not more than 1.5 times of negative pole thickness.

5. high power lithium ion cell according to claim 1 is characterized in that: the number of described positive pole ear or the gross area are greater than the number or the gross area of described negative lug.

6. according to the described high power lithium ion cell of claim 1-4, it is characterized in that: the width of described lug is 5mm-20mm, and described lug leaves curtain shape otch with the collector lap at least, and welds with collector one by one.

7. high power lithium ion cell according to claim 6 is characterized in that: the width of described lug is 6-12mm.

Description

A kind of high power lithium ion cell

Technical field

The invention belongs to technical field of lithium ion, particularly relate to a kind of high power lithium ion cell.

Background technology

Compare with secondary cells such as traditional plumbic acid, Ni-G, ni-mhs, because lithium ion battery has the specific energy height, advantage such as self discharge is few has been widely used in electronic apparatus such as mobile phone, notebook, video camera.

Present known small-power lithium ion battery is mainly by the negative plate with interrupted coat, the positive plate with interrupted coat, electrolyte and prevent that between between positive/negative plate the barrier film of its short circuit from forming.Wherein negative plate is that carbonaceous material etc. by negative current collector and embedding/emit lithium ion constitutes; Positive plate is that the composite oxides such as cobalt-lithium oxide by plus plate current-collecting body and embedding/emit lithium ion constitute; Electrolyte is to be dissolved with $LiPF_6$ being the solution of aprotic organic solvent.Aforementioned positive plate and negative plate are made into thin plate or paper tinsel shape, then positive and negative pole plate and intervenient barrier film is stacked in order or helical form spooling and form electric core.Again this electric core is packed in the iron or lighter aluminum metal case or lamination plastic-aluminum flexible packaging film battery case of stainless steel, nickel plating into the electrolyte that reinjects, sealing and make battery.

In recent years, along with hybrid vehicle, the high performance of various boost motors, the high-rate charge-discharge capability of battery is required more and more higher, sometimes even require battery at the above multiplying power discharging of 10C.But the lithium ion battery of general merchandiseization is when the 2C multiplying power discharging, can only emit about 80% of its nominal capacity, and at all can not be at the 10C multiplying power discharging, its main cause is that internal resistance is excessive, particularly when heavy-current discharge, heating such as lug is serious, and cell integrated excessive temperature raises, and causes fail safe and cycle life aspect major hidden danger.The patent No. 02295729.4 square lithium ion secondary battery has disclosed battery positive plate, negative plate and has partly constituted by continuous bearing active material coat main part with non-coat that positive and negative pole plate has a style of one's own, this structure battery is compared with the mini power lithium ion battery, reduce internal resistance and improved multiplying power discharging property, but only be applicable to rectangular cell, and battery temperature is effectively controlled can not guarantee the battery high power discharge time.

Summary of the invention

The present invention is for solving problems of the prior art, provide a kind of and can be made into shapes such as column type, oval, square, button shaped and the folded film flexible package of aluminium, and the high power lithium ion cell that battery temperature is effectively controlled can guarantee the battery high power discharge time.

The present invention for the technical scheme that solves the technical problem employing that exists in the known technology is: high power lithium ion cell, comprise positive pole, negative pole, barrier film and nonaqueous electrolytic solution, positive pole is made of plus plate current-collecting body and the positive electrode active materials coat that contains that is evenly coated in its two sides; Negative pole is made of negative current collector and the negative active core-shell material coat that contains that is evenly coated in its two sides, The coat that contains active material anodal and negative pole is continuous coat, and leaves the collector blank in the side along coiling direction of positive and negative electrode, in blank space electric current is set and derives positive and negative lug, it is characterized in that: the sectional area S of described positive pole ear $_1$, positive pole ear d at interval $_1$And positive pole contains active material coat width w $_1$Satisfy following formula: $1 * 10^{-5} \le S_1 / (d_1 * w_1) \le 4 * 10^{-5}$The sectional area S of described negative lug $_2$, negative lug d at interval $_2$And negative pole contains active material coat width w $_2$Satisfy following formula: $1 * 10^{-5} \le S_2 / (d_2 * w_2) \le 3 * 10^{-5}$

The present invention can also take following technical measures to realize: the described double spread weight that contains the positive electrode active materials coat is 10mg-30mg/cm ^{2}, the described double spread weight that contains the negative active core-shell material coat is 4.8mg-14.5mg/cm ^{2}Described positive pole ear and plus plate current-collecting body are that integral structure, described negative lug and negative current collector are integral structure, and lug and collector transitional region are the arc or the triangular structure of being wider than lug; Described positive pole ear is that ultrasonic bond is welded on the aluminium strip on the plus plate current-collecting body, and the thickness of aluminium strip is not more than 1.5 times of anodal thickness; Described negative lug is that ultrasonic bond is welded on nickel strap or the copper strips on the negative current collector, and its thickness is not more than 1.5 times of negative pole thickness; The number of described positive pole ear or the gross area are greater than the number or the gross area of described negative lug; The width of described lug is 5mm-20mm, and described lug leaves curtain shape otch with the collector lap at least, and welds with collector one by one, The width of described lug is 6-12mm.

Advantage and good effect that the present invention has are: the battery temperature when guaranteeing the battery high power discharge is effectively controlled, reduce the internal resistance of electrode, improve battery security and cycle life, manufacture method economy, easy guarantees that the active material utilization height of battery, big multiplying power discharging property are good in large-scale production, be easy to realize, be with a wide range of applications aspect the realization lithium ion battery high powerization.

Description of drawings

Fig. 1 is a high power lithium ion cell positive plate active material coated structure schematic diagram of the present invention;

Fig. 2 is a high power lithium ion cell negative plate active material coated structure schematic diagram of the present invention;

Fig. 3 is high power lithium ion cell of the present invention battery surface temperature changing curve diagram when different multiplying is discharged.

Label among the figure is respectively: 1, positive plate active material coat; 2, plus plate current-collecting body; 3, positive pole ear; 4, positive pole ear riveted holes; 5, positive pole ear sheared edge; 6, negative plate active material coat; 7, negative current collector; 8, negative lug; 9, negative lug riveted holes; 10, negative lug sheared edge.

Embodiment

For further understanding summary of the invention of the present invention, characteristics and effect, enumerate following examples now, and conjunction with figs. is described in detail as follows:

With reference to accompanying drawing 1-3, arrow is the coiling direction of electrode.Positive electrode active materials coat 1 of the present invention adopts the cobalt-lithium oxide active material, A kind of active material that negative active core-shell material coat 6 comprises carbon fiber and selects from spherical graphite or flaky graphite at least, wherein the content of carbon fiber is greater than 1wt%, less than 5wt%; The double spread weight of described positive electrode active materials coat 1 and negative active core-shell material coat 6 is respectively 10mg-30mg/cm ^{2}, 4.8mg-14.5mg/cm ^{2}

For takeup type electricity core, because the influence of inner ring curvature, positive pole ear 3 and negative lug 8 can not be too wide, according to battery capacity and lug the difference of density are set, and the width of positive pole ear 3 and negative lug 8 is 5mm-20mm, and optimum width is 6-12mm; Simultaneously for preventing to use wide outside weld lug when bending is reeled, to cause damage even short circuit to electrode, positive pole ear 3 and negative lug 8 are left corner shape positive pole ear sheared edge 5 and negative lug sheared edge 10 with plus plate current-collecting body 2 and negative current collector 7 laps respectively, and weld with corresponding collector one by one.Positive pole ear 3 and negative lug 8 ends are respectively equipped with positive pole ear riveted holes 4 and negative lug riveted holes 9.When positive pole ear 3 and plus plate current-collecting body 2, negative lug 8 and negative current collector 7 were integral structure, its transitional region was the class arc or the triangular structure of being wider than lug.

Positive pole ear 3 is an aluminium strip, is welded on the plus plate current-collecting body 2 its sectional area S by ultrasonic bond $_1$With adjacent positive lug 3 interval d $_1$And positive electrode active materials coat 1 width w $_1$Satisfy following formula: $1 * 10^{-5} \leq S_1 / (d_1 * w_1) \leq 4 * 10^{-5}$, and the thickness of positive pole ear 3 is not more than 1.5 times of anodal thickness.Because if $S_1 / (d_1 * w_1) < 1 * 10^{-5}$Then cause internal resistance bigger, it is too high to understand temperature rise during heavy-current discharge, influences fail safe and cycle life.$S_1 / (d_1 * w_1) > 4 * 10^{-5}$The time, the then excessive preparation that influences battery of lug.If the thickness of positive pole ear 3 is greater than 1.5 of anodal thickness, welding and other operations then are difficult to carry out.Certainly, the blank of electrode is reserved enough width, also can determine lug from reserving blank space, and its width satisfies the following formula requirement with same requirement the at interval, and but, because aluminium foil is thinner, therefore the preferred ratio lower limit promptly adopts the lug of broad in above-mentioned scope.

Negative lug 8 is nickel matter or copper strip, is welded on the negative current collector 7 the sectional area S of nickel strap or copper strips by ultrasonic bond $_2$With adjacent cathode lug 4 interval d $_2$And negative active core-shell material coat 6 width w $_2$Satisfy following formula: $1 * 10^{-5} \leq S^2 / (d^2 * w^2) \leq 3 * 10^{-5}$, and the thickness of lug is not more than 1.5 times of negative pole thickness.Similar with positive pole, because if $S_2 / (d_2 * w_2) < 1 * 10^{-5}$Then cause internal resistance bigger, it is too high to understand temperature rise during heavy-current discharge, influences fail safe and cycle life.$S_2 / (d_2 * w_2) > 4 * 10^{-5}$The time, the then negative lug 8 excessive preparations that influence battery.The thickness of negative lug 8 is not more than 1.5 times of negative pole thickness for well in addition, if greater than 1.5 times then blocked up, welding and other operations are difficult to carry out.Certainly, the blank of electrode is reserved enough width, also can determine negative lug 8 from reserving blank space, and its width satisfies the following formula requirement with same requirement the at interval, and but, because Copper Foil is thinner, therefore the preferred ratio lower limit promptly adopts the lug of broad in above-mentioned scope.

Because aluminium very easily forms oxide-film, influence its electric conductivity, so the number of positive pole ear 3 or the gross area are greater than the number or the gross area of negative lug 8.

Though adopted cobalt-lithium oxide as positive electrode active materials herein simultaneously, the present invention is not limited in cobalt-lithium oxide, the composition formula that can be used for positive electrode active materials of the present invention is Li_xMO_2, $Li_yM_2O_4$The composite oxides of (M is more than one transition metal in the formula, $0 \leq x \leq 1$, $0 \leq y \leq 2$), and chalcogen compound or oxide with tunnel or layer structure.Its instantiation can be enumerated as $LiNiO_2$, $LiCo_xNi_{1-x}O_2$, $LiNi_xCo_yNi_{1-x-y}O_2$, $LiMn_2O_4$, $Li_2Mn_2O_4$, $LiNi_{0.5}Mn_{1.5}O_4$, $LiFePO_4$, MnO_2, FeO_2, V_2O_5, V_6O_{13}, TiO_2, TiS_2Deng.Certainly the derivative that also comprises the above-claimed cpd that elements such as aluminium, Mg mix.In addition, organic compound also can be used as positive electrode active materials of the present invention such as conducting polymers such as polypyrrole, polyanilines.And no matter be inorganic compound or organic compound, above-mentioned all cpds also can mix use.

As lithium ion battery of the present invention, positive pole preferably comprises the carbon nano-fiber of failing to grow up in 20 microns, and its addition is no more than 10wt% with respect to anodal coating gross weight.This is because a certain amount of by adding, the carbon nano-fiber of certain-length, can fully guarantee in the electrode between active material and and collector between conductivity.Simultaneously, can make that again the combination property of electrode is guaranteed.The length of fiber surpasses 20 microns, then might make the part fiber pass barrier film and arrive electrode, causes the micro-short circuit between positive/negative plate.In addition, if addition surpasses 10wt%, then must add the adhesive force that a large amount of binding agents could keep electrode material layer simultaneously.Excessive binding agent then is the reason that causes the electrode internal resistance to raise.Therefore, the addition of carbon nano-fiber is to be no more than 10wt% for well.

The present invention has used gas-phase grown nanometer carbon fibre (VGCF), acetylene black (AB), also can use carbon black and stable metal nano fiber such as Ni etc. in addition.Optimum fiber shape electric conducting material.Because fibrous electric conducting material is suitable for the conduction approach of keeping.

Though enumerated spherical graphite and scale shape graphite, can be used for that negative active core-shell material of the present invention is not limited only to this, other can be listed below as can be used for negative material of the present invention, can form the metallic element such as the aluminium of alloy with Li, Si, Pb, Sn, Zn etc., transition metal oxide such as NiO, CoO, Co_2O_3, CuO etc., also have $LiFe_2O_3$, Nb_2O_3, WO_2, MoO_2, the metal oxide of SiO etc., the easily carbonaceous material of graphitized carbon material and hard carbon etc and the mixture of above-mentioned material.That considers battery discharges and recharges life-span and fail safe, preferred carbonaceous material.

As electrolyte of the present invention, can comprise one or more mixture of following organic solvent.Ethyl carbonate (EC), propene carbonate (PC), dimethyl carbonate (DMC), ethyl-methyl carbonic ester (EMC), diethyl carbonate (DEC), gamma-butyrolacton (GBL), sulfolane, methyl-sulfoxide, second month green grass or young crops (AN), dimethyl formamide, diethylformamide, 1,2-dimethoxy-ethane, 1,2-diethoxyethane, oxolane (THF), 2-methyltetrahydrofuran, dioxolanes, methyl acetic acid ester isopolarity solvent.For obtaining good cell discharge performance and life-span, preferably make and in above-mentioned solvent, contain ethylene carbonate (EC).

The electrolytic salt that is dissolved in the electrolyte solvent can comprise following single electrolytic salt and composition thereof.LiPF for example $_6$, $LiClO_4$, $LiBF_4$, $LiAsF_6$, $LiCF_3CO_3$, $LiCF_3(CF_3)_3$, $LiCF_3(CF_2F_5)_3$, $LiCF_3SO_3$, $LiN(SO_2CF_3)_2$, $LiN(SO_2CF_2CF_3)_2$, $LiN((COCF_2CF_3)_2$And $LiPF_3(CF_2CF_3)_3$The preferably in and partly contain LiPF in the electrolytic salt $_6$Or $LiBF_4$ and can on negative pole, form good epithelium and obtain good flash-over characteristic and life-span.

Grow up, preferably add additive vinylene carbonate (VC) and derivative thereof for the transition that suppresses irreversible capacity and negative material surface SEI epithelium simultaneously, as 4,5-dimethyl vinylene carbonate, 4,5-diethyl vinylene carbonate, 4,5-dipropyl vinylene carbonate, 4-ethyl-5-methyl carbonic acid vinylene, 4-ethyl-5-propyl group vinylene carbonate.Annular in addition sulfuric ester also helps forming good SEI, as glycol sulfate, 1,2-propylene glycol sulfuric ester, 1,2-butanediol sulfuric ester, 1,3-butanediol sulfuric ester, 2,3-butanediol, benzoglycols sulfuric ester etc.

Barrier film of the present invention can adopt braid, non-woven fabric, micropore synthetic resin film etc.In the above-mentioned diaphragm material, the polyolefin micro-porous film of special preferred microporous synthetic resin film, especially preferably polyethylene and microporous polypropylene membrane or their composite micro porous film etc.The adopted reason of these TPO micro-porous films is that it is better than thickness preferably, film-strength, film resistance characteristic.

If the employing colloidal electrolyte, then it can doubtlely do separator again.In this case, can use porose copolymer solid electrolyte, make it contain electrolyte again.

Battery of the present invention can be made into column type, oval, square, button shaped and the folded film flexible package of aluminium etc.Capacity can be tens of mAh to tens of Ah even more than the 100Ah.But when making high capacity lithium ion battery, with column type, oval, square for well.

Embodiment 1

Anodal preparation:

Take by weighing the LiCoO of the 93wt% of positive electrode active materials $_2$N-N-methyl-2-2-pyrrolitone N-(NMP) solution of polyvinylidene fluoride (PVdF) bonding agent and to make the content of PVdF be 4.5wt%, 2.5wt% (VGCF) as electric conducting material, the three is mixed the formation cathode mix, in mixture, add NMP and prepare pastel with mixer, then this pastel is coated onto equably continuously the two sides that thickness is 20 μ m aluminium foils, the width of filming is 220mm, leave the blank of 20mm at side tow sides of aluminium foil, drying again, after the roll-in, branch cuts away an opposite side (not blanking) of 20mm blank and makes the wide 200mm of coating, the positive plate of the wide blank of 20mm.Coating weight is 22mg/cm ^{2}

The preparation of negative pole:

In weight 60% carbonaceous mesophase spherules MCMB, 30% flaky graphite, weight is that 2% VGCF and weight are that 8% PVdF (the solution mode with NMP adds) makes pastel, it is identical with positive pole then this pastel to be coated onto equably continuously two sides, coating method that thickness is 10 μ m Copper Foils, drying again, roll-in and make negative plate.Coating weight is 10mg/cm ^{2}

The welding of positive pole ear:

As shown in Figure 1: at first selecting for use thick is 180 microns, wide be the aluminium strip of 10mm as positive pole ear 3, opening the 30mm mouth, make aluminium strip one side be divided into two parts with plus plate current-collecting body 2 welding one side, opposite side is provided with positive pole ear riveted holes 4, is used for riveted and fixed in Positive Poles.With ultrasonic bonder two parts aluminium strip four means of spot welds of dividing equally are fixed on the plus plate current-collecting body 2 then,, weld next positive pole ear 3 again at interval 200mm place, by that analogy with same method.The lug parameter 5 that obtains thus $_1$/ (d $_1$* w $_1$) be 2.5 * 10 $^{-5}$

The welding of negative lug:

As shown in Figure 2: selecting for use thick is 100 microns, wide be the nickel strap of 10mm as negative lug 8, opening the 30mm mouth, make negative lug 8 one sides be divided into 2 parts with negative current collector 7 welding one side, opposite side is provided with negative lug riveted holes 9, is used for riveted and fixed at the negative pole pole With ultrasonic bonder two parts nickel strap four means of spot welds of dividing equally are fixed on the negative current collector 7 then,, weld next negative lug 8 again at interval 200mm place, by that analogy with same method.The lug parameter 5 that obtains thus $_2$/ (d $_2$* w $_2$) be 2.5 * 10 $^{-5}$

The microporous polyethylene film that is about 25 microns with thickness is made diaphragm body.

The nonaqueous electrolyte that uses is for being dissolved with 1mol/l LiPF $_6$ 1: 1: 1 EC+DEC+DMC mixed solvent solution of volume ratio adds the vinylene carbonate of relative electrolyte total amount 1.0wt% on this basis.The assembling of 35Ah battery.

The active material coating is faced with the alternate positive of barrier film, positive and negative, lug is in an opposite side.Stack that positive pole, barrier film, negative pole are entwined electric core, insert cylinder, the good lug of riveting, weld electrode cap, fluid injection is sealed again after 60 ℃ of vacuumize.So be assembled into the 35Ah battery as battery A1, and carry out electro-chemical test and temperature survey as follows.

Discharge and recharge and the case temperature test:

At first carry out volume test: be charged as the CC-CV pattern; Discharge is the CC pattern.Promptly use 0.2C multiplying power constant current charge to 4.2V, the 4.2V constant voltage is 2 hours then; Discharge ends to 2.75V with 0.2C multiplying power constant current discharge equally.The discharge capacity that obtains in order to last method is as initial capacity.Carry out the multiplying power discharging experiment then, promptly same with volume test, all be charged to 4.2V with CC-CV, respectively to be equivalent to 5C, the 10C constant current discharge is to 2.5V, with the capacity of this capacity that obtains as each multiplying power discharging again.And, when big multiplying power discharging, detect the variations in temperature of housing outer wall central part with thermistor.All treat again residual capacity to be carried out recharging after low range (0.2C) discharges into 2.75V after voltage (CCV) recovers at every turn.Discharging and recharging by above method and temperature detection result is organized in the table 1.Fig. 3 is each multiplying power discharging and the battery surface temperature variation of battery.

Embodiment 2

Except d1, d2 changes into beyond the 300mm, other all identical and made battery A2 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Embodiment 3

Except d2 changes 50.8mm into, other all identical and made battery A3 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Embodiment 4

Except d1 changes 500mm into, other all identical and made battery A4 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Embodiment 5

Except the positive and negative electrode lug changes 50 micron thickness (S1, S2=0.5mm into ^{2}), other all identical and made battery A5 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Comparative Examples 1

Except d2 changes 600mm into, other all identical and made battery B1 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Comparative Examples 2

Except d1, d2 changes into beyond the 600mm, other all identical and made battery B2 of the present invention with embodiment 1, its measurement result is recited in the table 1 equally.

Table 1

Battery	d1(mm)	w1(mm)	S1(mm^2)	S1/((d1×w1)(×10^{-5})	d2(mm)	w2(mm)	S2(mm^2)	S2/((d2×w2)(×10^{-5})	Capacity (Ah)	Voltage platform (V)	Temperature (℃)
Embodiment A 1	200	200	1	2.5	200	200	1	2.5	34.2	3.34	68
Embodiment A 2	300	200	1	1.67	300	200	1	1.67	38.8	3.32	71
Embodiment A 3	200	200	1	2.5	500	200	1	1.0	32	3.25	73
Embodiment A 4	500	200	1	1.0	200	200	1	2.5	30	3.29	74.3
Embodiment A 5	200	200	0.5	1.25	200	200	0.5	1.25	28	3.16	76
Comparative Examples B1	200	200	1	2.5	600	200	1	0.83	25	2.95	81
Comparative Examples B2 (7C)	600	200	1	0.83	600	200	1	0.83	16	2.71	82

Can know clearly from the result of table 1, adopt film continuously, embodiment battery A1-A4 discharge capacity that the side goes out extreme ear structure is big, voltage platform is very high (> 3.2V), high temperature rise is little But when the lug spacing is excessive, internal resistance increases, big multiplying power discharging capacity is little, voltage platform is low, temperature rise, surface temperature even be higher than 80 ℃, though in table, do not show simultaneously, but know that very it is after 50 circulations that the A1 capacity is reduced to 80% of initial capacity, and only circulated 3 times, B2 of B1 are that 10 times (7C), B3 are 15 times (7C).So the coating that contains active material of anodal and negative electrode is continuous coated, and leaves the collector blank in the side along coiling direction of electrode, leave electric current in blank space and derive lug, and the lug of positive pole is aluminium strip, the sectional area S of aluminium strip lug $_1$With lug interval d $_1$And anodal coating width w $_1$Satisfy following formula: $1 * 10^{-5} \leq S_1/(d_1 * w_1) \leq 4 * 10^{-5}$, and the thickness of lug is not more than 1.5 times of anodal thickness; The lug of negative pole is nickel matter or copper strip, is welded on the negative current collector sectional area S of nickel or copper strips lug by ultrasonic bond $_2$With lug interval d $_2$And negative pole coating width w $_2$Satisfy following formula: $1 * 10^{-5} \leq S_2/(d_2 * w_2) \leq 3 * 10^{-5}$, and the thickness of lug is not more than 1.5 times of negative pole thickness, to the high-multiplying power discharge capacity of battery, to suppress temperature rise and improve cycle life be effective.

Patent Citations (5)

Publication number	Priority date	Publication date	Assignee	Title
Family To Family Citations				
DE69434633T2 *	1993-06-18	2006-12-07	Hitachi Maxell, Ltd., Ibaraki	Cell with organic electrolyte solution
JP2000387 44A *	1998-07-14	2000-01-28	Ngk Insulators Ltd	Lithium secondary battery
CN2598160Y *	2002-12-30	2004-01-07	比亚迪股份有限公司	Square lithium ion secondary cell
JP2004234994A *	2003-01-30	2004-08-19	Hitachi Ltd	Lithium secondary battery, battery pack of same, and electrode of same
US7402016B2 *	2003-09-17	2008-10-07	Hitachi Maxell, Ltd.	Electrode for non-aqueous secondary battery and non-aqueous secondary battery using the same

* Cited by examiner, † Cited by third party

Cited By (13)

Publication number	Priority date	Publication date	Assignee	Title
WO2009079961A1 *	2007-12-25	2009-07-02	Byd Company Limited	Optimized dimensional relationships for an electrochemical cell having coiled core
US8007935B2	2006-10-30	2011-08-30	Byd Co., Ltd.	Plate assembly, core and lithium ion battery
US8092936B2	2007-12-25	2012-01-10	Byd Co. Ltd.	Electrochemical cell having a coiled core
US8178236B2	2007-12-18	2012-05-15	Byd Co., Ltd.	Battery pack
US8178225B2	2007-11-29	2012-05-15	Byd Co., Ltd.	Battery and preparation method thereof
US8193770B2	2007-12-25	2012-06-05	BYD Co. Ltd	Battery system for a vehicle having an over-current/over-temperature protective feature
US8276695B2	2007-12-25	2012-10-02	Byd Co. Ltd.	Battery electrode sheet
US8420254B2	2007-12-25	2013-04-16	Byd Co. Ltd.	End cover assembly for an electrochemical cell
CN105990612A *	2015-02-05	2016-10-05	宁德时代新能源科技有限公司	Electrical core
CN106299233A *	2015-05-13	2017-01-04	深圳市沃特玛电池有限公司	A kind of battery pole piece and ultra-thin flexible-packed battery
CN108878777A *	2018-07-02	2018-11-23	宁德时代新能源科技股份有限	Battery core and secondary cell including the battery core

			公司	
CN112117424A *	2019-06-21	2020-12-22	比亚迪股份有限公司	Single battery, power battery pack and vehicle
WO2021217423A1 *	2020-04-28	2021-11-04	宁德新能源科技有限公司	Electrochemical device and electronic device comprising electrochemical device
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
CN100433440C	2008-11-12	High power lithium ion cell
EP2840638B1	2017-02-22	Lithium secondary battery
US8486566B2	2013-07-16	Positive electrode for lithium-ion secondary battery, manufacturing method thereof, and lithium-ion secondary battery
EP1093954B1	2016-06-22	Positive electrode material for non-aqueous electrolyte lithium ion battery and battery using the same
JP5150966B2	2013-02-27	Non-aqueous electrolyte secondary battery positive electrode and non-aqueous electrolyte secondary battery using the same
JP5402411B2	2014-01-29	Lithium ion secondary battery and manufacturing method thereof
US9484568B2	2016-11-01	Electrolyte for secondary battery and lithium secondary battery including the same
JP2011060520A	2011-03-24	Lithium ion secondary battery and its manufacturing method
CN1790799A	2006-06-21	High power lithium ion battery and method for preparing amorphous carbon coated anode material
KR20110066164A	2011-06-16	Nonaqueous electrolyte secondary battery
US10141576B2	2018-11-27	Electrode structure for lithium secondary battery and lithium secondary battery having the electrode structure
KR102071489B1	2020-01-30	Electrode Comprising Active Material Layers Having Active Material Particles of Different Average Particle Sizes
JP2010192230A	2010-09-02	Nonaqueous electrolyte secondary battery
JP3526786B2	2004-05-17	Lithium secondary battery
JP2005119312A	2005-01-28	Electrode for nonaqueous electrolyte secondary battery and nonaqueous electrolyte secondary battery
EP3367478A1	2018-08-29	Electrode and manufacturing method therefor
CN100466364C	2009-03-04	Safety lithium-ion battery
US20200335783A1	2020-10-22	Positive Electrode Material for Lithium Secondary Battery, Positive Electrode Including Same, and Lithium Secondary Battery
EP2806491B1	2017-08-30	Lithium secondary battery exhibiting excellent performance
KR102158681B1	2020-09-22	Method for preparing positive electrode for secondary battery
KR20210034984A	2021-03-31	Battery system, method for using the same, and battery pack comprising the same
US20210257603A1	2021-08-19	Secondary battery
US10686227B2	2020-06-09	Lithium ion secondary battery electrode and lithium ion secondary battery
KR20210001708A	2021-01-06	Negative electrode and secondary battery comprising the same
KR102148509B1	2020-08-26	Negative electrode for lithium secondary battery, method for preparing the same and lithium secondary battery comprising the same

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
CN200510019388A	2005-10-14	2005-10-14	High power lithium ion cell

Applications Claiming Priority (1)

Application	Filing date	Title

CN1281361001338834	2005-10-14	High power lithium ion cell

Legal Events

Date	Code	Title	Description
2007-04-18	PB01	Publication	
2007-04-18	C06	Publication	
2007-10-03	SE01	Entry into force of request for substantive examination	
2007-10-03	C10	Entry into substantive examination	
2008-11-12	GR01	Patent grant	
2008-11-12	C14	Grant of patent or utility model	
2019-11-12	TR01	Transfer of patent right	**Effective date of registration**: 20191023 **Address after**: Binhai New Area 300384 Tianjin Huake Binhai hi tech Industrial Development Zone seven road No. 6 **Co-patentee after**: Tianjin Zhongdian New Energy Research Institute Co., Ltd **Patentee after**: No.18 Inst., China Electronic Sci-Tech Group Corp. **Address before**: Chuang-tzu 300381 Tianjin city Nankai District Iqichuang Ling Road No. 18 **Patentee before**: No.18 Inst., China Electronic Sci-Tech Group Corp.
2019-11-12	TR01	Transfer of patent right	

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
lithium ion		title,claims,abstract,description	28	0.000
Lithium ion	Li^+	title,description	13	0.000
active material		claims,abstract,description	16	0.000
nickel	Ni	claims,description	21	0.000
aluminum		claims,description	16	0.000
aluminum	Al	claims,description	16	0.000
aluminium		claims,description	15	0.000
positive electrode material		claims,description	12	0.000
core-shell material		claims,description	9	0.000
nickel		claims,description	9	0.000
copper	Cu	claims,description	6	0.000
copper		claims,description	6	0.000

copper	claims,description	6	0.003
electrolyte solution	claims,description	2	0.003
discharging	abstract,description	12	0.005
coating method	abstract,description	11	0.005
coating agent	abstract,description	10	0.010
nonaqueous electrolyte	abstract,description	2	0.010

Show all concepts from the description section

专 利 合 作 条 约

PCT

国际检索报告

(PCT第18条和细则43和44)

申请人或代理人的档案号 LV33035	关于后续行为	见PCT/ISA/220表和 适用时，见下面第5项
国际申请号 PCT/CN2020/087515	国际申请日 (年/月/日) 2020年 4月 28日	(最早的)优先权日 (年/月/日)
申请人 宁德新能源科技有限公司		

按照条约第18条，本国际检索报告由本国际检索单位做出并送交申请人。报告副本送交国际局。

本国际检索报告总计 3 页。

☐ 它还附有本报告所引用的各现有技术文件的副本。

1. 报告的基础

a. 关于语言，进行国际检索基于：

☑ 国际申请提交时使用的语言。

☐ 该国际申请的_____语言译文，为了国际检索的目的提供该种语言的译文(细则12.3(a)和23.1(b))。

b. ☐ 本国际检索报告考虑了本单位许可或被通知的根据细则91所做出的**明显错误更正**(细则43.6之二(a))。

c. ☐ 关于国际申请中公开的任何**核苷酸和/或氨基酸序列**，见第I栏。

2. ☐ **某些权利要求被认为是不能检索的**(见第II栏)。

3. ☐ **缺乏发明的单一性**(见第III栏)。

4. 关于**发明名称**，

☑ 同意申请人提出的发明名称。

☐ 发明名称由本单位确定如下：

5. 关于**摘要**，

☑ 同意申请人提出的摘要。

☐ 根据细则38.2(b)，摘要由本单位制定，如第IV栏中所示。自本国际检索报告发文日起一个月内，申请人可以向本单位提出意见。

6. 关于**附图**，

a. 随摘要一起公布的**附图**是： 4

☑ 按照申请人建议的。

☐ 由本单位选择的，因为申请人没有建议一幅图。

☐ 由本单位选择的，因为该图能更好地表示发明的特征。

b. ☐ 没有与摘要一起公布的附图

国际检索报告

国际申请号
PCT/CN2020/087515

A. 主题的分类

H01M 10/0587(2010.01)i；H01M 4/13(2010.01)i；H01M 10/0525(2010.01)i

按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

H01M

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

CNTXT, DWPI, CNKI, SIPOABS, CNABS：极耳，正极，集流体，硅，负极，含量，重量，tab，positive，pole，anode，negative，cathode，current，collector，Si，content，percentage

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN 1949580 A (中国电子科技集团公司第十八研究所) 2007年 4月 18日 (2007-04-18) 权利要求1-6，说明书第3页第1行至第7页第12行，图1	1-10
A	CN 110459730 A (漳州华锐锂能新能源科技有限公司) 2019年 11月 15日 (2019-11-15) 全文	1-10

☐ 其余文件在C栏的续页中列出。

☑ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件（如具体说明的）

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
2021年 1月 21日	2021年 2月 3日
ISA/CN的名称和邮寄地址 中国国家知识产权局(ISA/CN) 中国北京市海淀区蓟门桥西土城路6号 100088 传真号 (86-10)62019451	受权官员 常莎莎 电话号码 010-62412320

PCT/ISA/210 表(第2页) (2015年1月)

国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2020/087515

检索报告引用的专利文件			公布日 (年/月/日)	同族专利			公布日 (年/月/日)
CN	1949580	A	2007年 4月 18日	CN	100433440	C	2008年 11月 12日
CN	110459730	A	2019年 11月 15日		无		

TRANSLATION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/087515

A. CLASSIFICATION OF SUBJECT MATTER

H01M 10/0587(2010.01)i; H01M 4/13(2010.01)i; H01M 10/0525(2010.01)i

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)

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)

CNTXT, DWPI, CNKI, SIPOABS, CNABS: 极耳, 正极, 集流体, 硅, 负极, 含量, 重量, tab, positive, pole, anode, negative, cathode, current, collector, Si, content, percentage

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1949580 A (NO.18 INST., CHINA ELECTRONIC SCIENCE AND TECHNOLOGY GROUP CORP.) 18 April 2007 (2007-04-18) claims 1-6, description page 3 line 1 to page 7 line 12, figure 1	1-10
A	CN 110459730 A (ZHANGZHOU HUARUI LITHIUM NEW ENERGY TECHNOLOGY CO., LTD.) 15 November 2019 (2019-11-15) entire document	1-10

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"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)
"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
"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
"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
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 January 2021	**03 February 2021**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088** **China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

TRANSLATION

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/087515

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 1949580 A	18 April 2007	CN 100433440 C	12 November 2008
CN 110459730 A	15 November 2019	None	

PTO/SB/08a (01-22)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	
	Filing Date	
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					
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U.S.PATENT APPLICATION PUBLICATIONS						
Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					
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FOREIGN PATENT DOCUMENTS								
Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	204809314	CN	U	2015-11-25	Contemporary Amperex Technology Co Ltd	para 4-98, figs 1-10	☒
	2	205828514	CN	U	2016-12-21	Ningde Amperex Technology Ltd		☒
	3	205828573	CN	U	2016-12-21	Ningde Amperex Technology Ltd		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

	4	207459051	CN	U	2018-06-05	Dongguan Poly New Energy Co Ltd	para 2-14, fig 1	☒
	5	110753674	CN	A	2020-02-04	Nexeon Ltd	para 16-166	☒
	6	207303263	CN	U	2018-05-01	Shenzhen Greende Energy Group Co., Ltd.	para 4-19	☒
	7	105336984	CN	A	2016-02-17	Ningde Amperex Technology Ltd		☒
	8	207602716	CN	U	2018-07-10	Shanghai BYD Co Ltd		☒
	9	110459730	CN	A	2019-11-15	Zhangzhou Huarui Lithium New Energy Technology Co		☒
	10	107834014	CN	A	2018-03-23	Dongguan Mcnair Resinst Of Lithiumion Battery Indu		☒
	11	1949580	CN	A	2007-04-18	Tianjin Zhongdian New Energy Research Institute Co	claims 1-6, p. 3, line 1 to p. 7, line 12, fig 1	☒

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	ISR for International Application PCT/CN2020/087515 issued 03 FEBRUARY 2021	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

	2	Chinese First OA for counterpart application 202010349336.4 dated January 8, 2021	☐
	3	Chinese SECOND OA for counterpart application 202010349336.4 dated November 17, 2021	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Shiming Wu/	Date (YYYY-MM-DD)	2022-03-21
Name/Print	Shiming Wu	Registration Number	56885

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS
First Named Inventor/Applicant Name:	Xiaojing LIU
Filer:	Janet I. Cord/Geraldine Marti
Attorney Docket Number:	020968-8

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1820**

Electronic Acknowledgement Receipt

EFS ID:	45275168
Application Number:	17699555
International Application Number:	
Confirmation Number:	3466
Title of Invention:	ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS
First Named Inventor/Applicant Name:	Xiaojing LIU
Customer Number:	140
Filer:	Janet I. Cord/Geraldine Marti
Filer Authorized By:	Janet I. Cord
Attorney Docket Number:	020968-8
Receipt Date:	21-MAR-2022
Filing Date:	
Time Stamp:	14:05:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1820
RAM confirmation Number	E20223KE07232300
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	020968-8_Application_Transmittal.pdf	280376 a4d4290e0d26e7490ffd1307873df780375fb087	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	020968-8_Fee_Transmittal.pdf	241922 f2aa27f5de4e87f2b82e0b7d50959ecc02964ac7	no	2
Warnings:					
Information:					
3	Application Data Sheet	020968-8_ADS.pdf	1822362 d29cf23fd500bf278c9ff2092613d66db07af464	no	8
Warnings:					
Information:					
4		020968-8_PAT201909051US1_Application.pdf	10415306 c69f66acbd00c0bd830a0e0fc372450c0f2509e4	yes	35

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	26
Claims	27	29
Abstract	30	30
Drawings-only black and white line drawings	31	35

Warnings:

Information:

5	Oath or Declaration filed	020968-8_PAT201909051US1_Declaration.pdf	1060174 61fa6e1df254c25c8d95ac72e1b996a9d7ba3869	no	2
Warnings:					
Information:					
6	Power of Attorney	020968-8_Transmittal_with_POA.pdf	222022 d5471423d1f5a79859ff880309f38f1196df8763	no	2
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Information:					
7	Foreign Reference	1-CN204809314U.pdf	1669486 2eb3118838b401584f3943dcb79f54cea7212a29	no	22
Warnings:					
Information:					
8	Foreign Reference	2-CN205828514U.pdf	733639 5ac5165aa4be71f0a742e4145eeedd256db8c7c5	no	7
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9	Foreign Reference	3-CN205828573U.pdf	1786962 ec4f1a54bd49fe0fce22ca3baac2cc41fd6ff5c8	no	19
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10	Foreign Reference	4-CN207459051U.pdf	737631 b4f60922ce92849fc73ab36c5bac91cef25d91ee	no	9
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11	Foreign Reference	5-CN110753674A.pdf	20469169 a9aa737a2254aef673349e93fa04eb3056c65849	no	32
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12	Foreign Reference	6-CN207303263U.pdf	410354 39d64b50f1231b35f8b8053e55f50aa399cd5bb8	no	6
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13	Foreign Reference	7-CN105336984A.pdf	1185749 fd3299fe9f3c1455225b20df10a6f66d104c0138	no	13
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14	Foreign Reference	8-CN207602716U.pdf	926620 eb415aaee09109656389 07c9365178148c162ce9	no	10
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15	Foreign Reference	9-CN110459730A.pdf	3597836 4a6a179674ee3a9c8e33632e389762c278090c97	no	9
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16	Foreign Reference	10-CN107834014A.pdf	648134 1f764ca55b56801cd34ede92c06c0b137258bbbc	no	7
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17	Foreign Reference	11-CN1949580A.pdf	1270511 b3299eb57a76cde981c22a110df7194838a11ea4	no	13
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18	Non Patent Literature	1-CN204809314U_English_Translation.pdf	2934341 48c1c91729d5e1e61911291f3e498a5ee38a9301	no	9
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19	Non Patent Literature	2-CN205828514U_English_Translation.pdf	1718156 6024bad83580558f29d1b1f4e60550542dffe05b	no	6
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20	Non Patent Literature	3-CN205828573U_English_Translation.pdf	2781603 c4a83c3162e82e0c5613d03ce100834f9d8a1f6a	no	8
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21	Non Patent Literature	4-CN207459051U_English_Translation.pdf	1508655 6b17b81cf49ad6018239dc41c4a890caceb6edb0	no	5
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22	Non Patent Literature	5-CN110753674A_English_Translation.pdf	7468064 473a97aa61814148a9e604f58236c8c7b5c247fd	no	22
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23	Non Patent Literature	6-CN207303263U_English_Translation.pdf	1162391 1cd775a95d42d2b895e43712aeea0ade3921c612	no	4
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24	Non Patent Literature	7-CN105336984A_English_Translation.pdf	2974523 cc0ffa81e91939a234a5314c9405289653bb1b5d	no	13
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Information:					

26	Non Patent Literature	9-CN110459730A_English_Translation.pdf	2094425 6e6c8a73683dbffad47be4bb475587fda00a3d45	no	8
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Information:					
27	Non Patent Literature	10-CN107834014A_English_Translation.pdf	1952903 7f0da10cc85bb0ee27d4a1cd79167b822e5c3073	no	6
Warnings:					
Information:					
28	Non Patent Literature	11-CN1949580A_English_Translation.pdf	2482498 98c24f2f61eefeb2bffab1e34cb36c25bdcacc32	no	8
Warnings:					
Information:					
29	Other reference-Patent/Application/ Search Documents	ISR_for_International_Application_PCTCN2020087515.pdf	136567 0afd97346edfc7979c5ee374fcc015ba3d1cc12b	no	3
Warnings:					
Information:					
30	Other reference-Patent/Application/ Search Documents	ISR_for_International_Application_PCTCN2020087515_English_Translation.pdf	96183 13174fd2a5da3c9aec1e2c13f8f4e7c98199dcf0	no	2
Warnings:					
Information:					
31	Other reference-Patent/Application/ Search Documents	Chinese_First_OA_for_counterpart_application_202010349336-4.pdf	539805 2e7ff4f634a18c88018edcbc27a037655946432f	no	7
Warnings:					
Information:					
32	Other reference-Patent/Application/ Search Documents	Chinese_Second_OA_for_counterpart_application_202010349336-4.pdf	636116 322d962a8cb54d009932b17f4063cc388f600ac1	no	7
Warnings:					
Information:					

33	Information Disclosure Statement (IDS) Form (SB08)	020968-8_PTO_SB80a_IDS_21 MARCH2022.pdf	380288 209499b83374a76ffaa2884a9c048d5027e224d9	no	5
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Information:					
This is not an USPTO supplied IDS fillable form					
34	Fee Worksheet (SB06)	fee-info.pdf	43777 530b7057417f594762af384dab9f8ab9c56dc434	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	78163542		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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DocCode – SCORE

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Application Number: 17699555 Document Date: 03/21/2022

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/699,555	03/21/2022	1726	1820	U 020968-8	14	2

CONFIRMATION NO. 3466

FILING RECEIPT

140
Ladas & Parry LLP
1040 Avenue of the Americas
New York, NY 10018

OC000000132708988

Date Mailed: 03/28/2022

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Xiaojing Liu, Ningde, CHINA;

Applicant(s)

Ningde Amperex Technology Limited, Ningde City, CHINA;

Assignment For Published Patent Application

Ningde Amperex Technology Limited, Ningde City, CHINA

Power of Attorney: The patent practitioners associated with Customer Number 00140

Domestic Priority data as claimed by applicant

This application is a CON of PCT/CN2020/087515 04/28/2020

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/25/2022

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/699,555**

Projected Publication Date: 07/07/2022

Non-Publication Request: No

Early Publication Request: No

Title

ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS

Preliminary Class

429

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/699,555

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	14 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/699,555	03/21/2022	Xiaojing Liu	U 020968-8

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NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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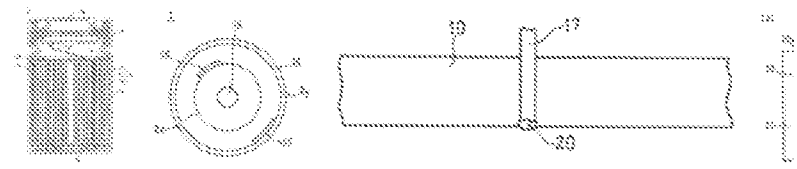
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Nonaqueous electrolyte secondary battery

Abstract

PROBLEM TO BE SOLVED: To restrict a partial separation or rupture of an anode lead from a silicon based anode in a nonaqueous electrolyte secondary battery which includes a wound electrode group using the silicon based anode consisting of an anode current collector and an anode lead which are connected via an alloy layer containing a copper-silicon alloy.SOLUTION: A nonaqueous electrolyte secondary battery includes a wound electrode group 2 formed by winding in substantially cylindrical form a laminate of a belt-like anode 10 and a belt-like cathode 11 with a belt-like separator 12 interposed between the two and a nonaqueous electrolyte. The wound electrode group 2 is 3 mm or more in radius, and the anode 10 includes a current collector, an active material layer comprised of a silicon based active material stuck to the surface of the current collector, and a strip-shaped lead 17 connected to the current collector via an alloy layer 20 containing a copper-silicon alloy, in which configuration the lead 17 is connected to a wound periphery in radius of 3 mm or more from the center of the wound electrode group 2 and comprised of a copper foil or a copper alloy foil whose tensile strength per 1 mm in short side width is 3 N to 50 N.

Images (12)



Classifications

- H01M10/0587 Construction or manufacture of accumulators having only wound construction elements, i.e. wound positive electrodes, wound negative electrodes and wound separators

View 9 more classifications

JP2012084412A

Japan

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Other languages: Japanese

Inventor: Yasutaka Furuyui, 康隆 古結, Hitoshi Katayama, 仁 片山

Current Assignee : Panasonic Corp

Worldwide applications

2010 JP 2011 US CN

Application JP2010230053A events

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Status Pending

Info: Patent citations (4), Cited by (6), Similar documents, Priority and Related Applications

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Claims (8)

Hide Dependent
translated from Japanese

A non-aqueous electrolyte secondary battery comprising: a wound electrode group in which a laminate in which a strip-shaped separator is interposed between a strip-shaped positive electrode and a strip-shaped negative electrode is wound into a substantially cylindrical shape; and a non-aqueous electrolyte. There,
The radius of the wound electrode group is 3 mm or more,
The negative electrode comprises a current collector, an active material layer made of a silicon-based active material deposited on the surface of the current collector, and a strip connected to the current collector through an alloy layer containing a copper-silicon alloy. Shaped leads, and
The lead is connected to a winding circumference having a radius of 3 mm or more from the center of the wound electrode group, and is made of a copper foil or a copper alloy foil having a tensile force per 1 mm of a short side width of 3N to 50N. A non-aqueous electrolyte secondary battery. The nonaqueous electrolyte secondary battery according to claim 1, wherein a short side width of the lead is 3 mm or less. 3. The nonaqueous electrolyte secondary battery according to claim 1, wherein the lead is made of a tough pitch copper foil, and the tough pitch copper foil is a tough pitch copper foil that has been annealed to a thickness of 0.05 mm to 0.30 mm. 3. The nonaqueous electrolyte secondary battery according to claim 1, wherein the lead is made of a tough pitch copper foil, and the tough pitch copper foil is a tough pitch copper foil that has not been annealed to a thickness of 0.12 mm or less. The non-aqueous electrolyte secondary battery according to claim 1, wherein the lead is made of a zirconium copper alloy foil having a thickness of 0.1 mm or less. The non-aqueous electrolyte secondary battery according to claim 1, wherein the lead is made of a Corson copper alloy foil having a thickness of 0.08 mm or less. The nonaqueous electrolyte secondary battery according to any one of claims 1 to 6, wherein the connection between the current collector and the lead is formed by plasma welding.
The current collector has a plurality of protrusions spaced from each other on a surface thereof, and the active material layer includes a plurality of columnar bodies made of a silicon-based active material supported by the surface of the protrusions. The nonaqueous electrolyte secondary battery of any one of -7.

Description

translated from Japanese

The present invention relates to a non-aqueous electrolyte secondary battery. More specifically, the present invention relates to an improved connection between a negative electrode and a negative electrode lead in a nonaqueous electrolyte secondary battery using a silicon-based negative electrode active material.

A non-aqueous electrolyte secondary battery (hereinafter referred to as "alloy based secondary battery") using a silicon-based active material as a negative electrode active material that occludes lithium by forming an alloy with lithium is known. Alloy-based secondary batteries have higher capacity and energy density than conventional non-aqueous electrolyte secondary batteries using graphite as a negative electrode active material. Therefore, the alloy-based secondary battery is expected not only as a power source for electronic devices but also as a main power source or auxiliary power source for transportation equipment, machine tools, and the like.

In a conventional negative electrode, for example, an active material layer including an active material such as graphite and a binder is formed on the surface of a current collector made of copper foil or the like, and an input / output terminal is provided at an end of the current collector. The lead is spot welded at several welds. The active material layer is not formed in the portion where the lead on the current collector surface is welded, and the current collector is exposed. The lead is directly welded to the exposed portion.

FIG. 11 is a top view schematically showing the connection state of the conventional electrode 100 in which the leads are spot-welded in this way. In the portion where the current collector 101 of the electrode 100 is exposed, the longitudinal direction of the electrode 100 and the longitudinal direction of the lead 103 are orthogonal to each other, and one end portion in the width direction of the electrode 100 and one end portion in the longitudinal direction of the lead 103 overlap. Thus, the electrode 100 and the lead 103 are arranged. And these are welded by the some welding part 104 by spot welding.

By the way, as a negative electrode used in an alloy-based secondary battery, instead of forming an active material layer using a binder, a silicon-based active material is deposited on the surface of a current collector made of copper foil or the like by vacuum deposition or the like. Known silicon-based negative electrodes are known. In such a silicon-based negative electrode, there is a problem that it is complicated to connect the lead to the current collector. Specifically, in order to form a lead connection portion where a current collector such as a conventional negative electrode is exposed, for example, by masking the formation region of the lead connection portion during vacuum deposition or the like, a silicon-based region is formed in the region. It was necessary to prevent the active material from being deposited. Such a mask operation becomes very complicated in the process.

For such problems, the present inventors are selected from the group consisting of a current collector provided with active material layers made of silicon-based active material or the like on both side surfaces, and nickel, nickel alloy, copper, and copper alloy. A method of connecting a lead containing at least one kind by arc welding has been proposed (see Patent Document 1). Specifically, by overlapping a part of the lead on the active material layer formed on the surface of the current collector and arc welding the overlapped part, a silicon-based alloy layer is formed between the current collector and the lead. The current collector and the lead are connected with good conductivity. Such a silicon-based alloy layer is formed by melting and resolidifying the active material layer together with a part of each of the current collector and the lead.

FIG. 12 is a top view schematically showing a connection state of the silicon-based negative electrode 10 by arc welding. The current collector of the silicon-based negative electrode 10 and the lead 117 are connected via the alloy layer 120 by arc welding the silicon-based negative electrode 10 and the lead 117. In this way, by overlapping a part of the lead on the silicon-based active material layer formed on the surface of the current collector and arc welding the overlapped portion, welding can be performed without forming the exposed portion of the current collector. It becomes industrially advantageous.

In addition, as a prior art related to leads, Patent Document 2 discloses that a lead layer made of nickel, a nickel alloy or an iron alloy and a base layer made of copper or a heat-resistant copper alloy are laminated in order to reduce the thickness and weight of the lead. Disclosed leads. Patent Document 3 discloses a technique for suppressing disconnection between an electrode terminal and a lead by forming a crease in a flat electrode terminal in a thin battery used as a driving power source for an electric vehicle or the like.

International Publication No. 2010/041399 JP 11-297300 A JP 2007-73485 A

According to the technique disclosed in Patent Document 1, it is apparently easy to weld a lead to a silicon-based negative electrode. However, the present inventors have found the following new problem.

In the silicon-based negative electrode, a brittle alloy layer is formed between the current collector and the lead by arc welding, although the mechanical strength is high. On the other hand, when producing a wound electrode group, the lead bends along the curvature of the wound electrode group. However, when a silicon-based negative electrode in which the lead is arc-welded is used as the negative electrode, if the curvature of the connecting portion of the lead becomes large, the alloy layer has brittleness. There was a possibility that breakage would easily occur.

An object of the present invention is to provide a wound electrode group using a silicon-based negative electrode to which a lead is connected via an alloy layer containing a copper-silicon alloy, and suppressing partial peeling and breakage of the lead from the silicon-based negative electrode. An improved nonaqueous electrolyte secondary battery is provided.

The non-aqueous electrolyte secondary battery of the present invention includes a wound electrode group obtained by winding a laminate in which a strip-shaped separator is interposed between a strip-shaped positive electrode and a strip-shaped negative electrode into a substantially cylindrical shape, a non-aqueous electrolyte, A wound electrode group having a radius of 3 mm or more, a negative electrode comprising a current collector, an active material layer made of a silicon-based active material deposited on the current collector surface, and a copper-silicon alloy A strip-shaped lead connected to a current collector through an alloy layer including the lead, and the lead is connected to a winding circumference having a radius of 3 mm or more from the center of the wound electrode group, and a short side width of 1 mm It consists of the copper foil or copper alloy foil whose tensile force of 3N-50N.

According to such a configuration, in the wound electrode group using the silicon-based negative electrode, the negative electrode lead and an alloy mainly composed of a copper-silicon alloy are formed by connecting the negative electrode lead to a winding circumference having a radius of 3 mm or more. It can suppress that a layer curves greatly. Moreover, the rigidity of a lead falls by using the copper foil or copper alloy foil whose tensile force per short side width 1mm is 3-50N as a lead material. For this reason, the internal stress generated in the lead connecting portion due to the bending of the lead is reduced, and the followability of the negative electrode lead and the alloy layer to the bending of the wound electrode group is improved. As a result, it is possible to suppress partial peeling or breakage of the lead from the silicon-based negative electrode during assembly or use.

According to the present invention, in a non-aqueous electrolyte secondary battery having a wound electrode group using a silicon-based negative electrode having a lead connected via an alloy layer mainly composed of a copper-silicon alloy, the battery is assembled. Occurrence of partial peeling or breakage of the lead from the silicon-based negative electrode at the time and during use can be suppressed.

It is a longitudinal section showing typically the composition of the nonaqueous electrolyte secondary battery which is a 1st embodiment of the present invention. FIG. 2 is a partial perspective view from the upper surface of the nonaqueous electrolyte secondary battery shown in FIG. 1. It is a top view which shows typically the connection state of the negative electrode and lead | read | reed by arc welding. It is a side view for demonstrating the connection method to the negative electrode of a negative electrode lead. It is a schematic diagram of an electrode group manufacturing apparatus. It is a perspective view which shows the driving | running state of the negative electrode to which the lead in the feed roller surface was connected. It is a side view which shows typically the state of the negative electrode to which the lead in the feed roller surface was connected. It is side surface perspective drawing which shows the structure of an electron beam type vacuum evaporation system typically. It is side surface perspective drawing which shows typically the structure of the electron beam type vacuum evaporation system of another form. 6 is a longitudinal sectional view schematically showing a configuration of a negative electrode produced in Example 6. FIG. It is a top view which shows the connection state of the conventional electrode typically. It is a top view which shows typically the connection state of the silicon type negative electrode by the conventional arc welding.

FIG. 1 is a longitudinal sectional view schematically showing a configuration of a nonaqueous electrolyte secondary battery 1 according to the first embodiment of the present invention. FIG. 2 is a partial perspective view from the top surface of the nonaqueous electrolyte secondary battery 1 shown in FIG. In FIG. 2, only the connection

positions of the negative electrode lead 17 and the positive electrode lead 18 in the wound electrode group 2 of the battery 1 are illustrated, and the other configurations are not illustrated.

The nonaqueous electrolyte secondary battery 1 includes a strip-shaped silicon-based negative electrode 10 (hereinafter simply referred to as "negative electrode 10"), a strip-shaped positive electrode 11 and a strip-shaped separator 12 interposed therebetween, and an electrode group insulating plates 13 and 14 attached to both ends in the longitudinal direction of 2 respectively, and a bottomed cylindrical battery can 15 that accommodates the electrode group 2 and a nonaqueous electrolyte (not shown) therein and functions as a negative electrode terminal; A sealing plate 16 that seals the opening of the battery can 15 and functions as a positive electrode terminal; a negative electrode lead 17 that conducts the negative electrode 10 and the battery can 15; and a positive electrode lead 18 that conducts the positive electrode 11 and the sealing plate 16; It is a cylindrical battery provided with a gasket 19 interposed between the battery can 15 and the sealing plate 16 to insulate them.

The electrode group 2 is a wound electrode group in which a laminated body in which a strip-shaped separator 12 is interposed between a strip-shaped negative electrode 10 and a strip-shaped positive electrode 11 is wound into a substantially cylindrical shape. When viewed from above, it has a substantially perfect circle shape. The outermost winding of the electrode group 2 is fixed by, for example, an adhesive tape.

The electrode group 2 has a substantially circular shape when observed from above, and has a radius (radius of the outermost winding circle) of 3 mm or more, preferably 3 mm to 30 mm, more preferably 5 mm to 30 mm. . The radius of the electrode group 2 is the radius of the outermost circular circle, and is half the diameter. When there is some distortion in the circle, the radius of the electrode group 2 means the radius of a perfect circle having the same area as the area surrounded by the outermost circle.

The negative electrode lead 17 has a strip shape, and is connected to the end on the long side of the negative electrode 10 by, for example, plasma arc welding as described later. Note that an alloy layer 20 mainly composed of a copper-silicon alloy as described later is interposed between the current collector and the negative electrode lead 17 by plasma arc welding. Specifically, as shown in FIG. 3, the longitudinal direction of the negative electrode 10 and the longitudinal direction of the negative electrode lead 17 are orthogonal to each other, and one end portion in the width direction of the negative electrode 10 and one end portion in the longitudinal direction of the negative electrode lead 17 overlap. So connected.

The negative electrode lead 17 is connected to a winding circumference having a radius of 3 mm or more, preferably in the range of 3 mm to 30 mm from the center of the electrode group 2. When the negative electrode lead 17 is connected at such a position, since the curvature (curvature) of the wound negative electrode 10 is reduced, the internal stress generated in the lead connection portion during battery assembly or use is reduced. . As a result, it is possible to suppress partial peeling or fracture of the negative electrode lead 17 from the negative electrode 10 during assembly or use. The center of the electrode group 2 is the center of the true circle when the shape of the orthographic projection from above the electrode group 2 is a perfect circle, and the center of the orthographic view when the orthographic projection is not a perfect circle. The shape of the projection is the center of the largest perfect circle that can be contained.

In the present embodiment, the positive electrode lead 18 is connected to the positive electrode 11 that is wound around the inner side of the negative electrode lead 17, but is not limited thereto. You may connect to the positive electrode 11 of the winding periphery outside 17.

The negative electrode lead 17 consists of strip-shaped copper foil or copper alloy foil, and the tensile force per 1 mm of short side widths is 3N-50N. The tensile force per 1 mm of the short side width is a value obtained by obtaining the maximum tensile force of the negative electrode lead 17 and dividing the obtained maximum tensile force by the short side width (mm) of the negative electrode lead 17. The maximum tensile force is obtained as follows. Using a universal testing machine (trade name, manufactured by Shimadzu Corporation), the negative electrode lead 17 (length 80 mm, width 3 mm) was pulled under specified conditions (tensile speed 5 mm / second, environmental temperature 25 ° C.), and the negative electrode lead 17 Measure the load when ruptures and take it as the maximum tensile force. The measurement of the maximum tensile force is performed based on JIS Z-2241.

The tensile force per 1 mm short side width of the negative electrode lead 17 is 3 N / mm to 50 N / mm, preferably 20 N / mm to 45 N / mm. When the tensile force is less than 3 N / mm, the rigidity of the negative electrode lead 17 itself is lowered, and there is a possibility of breaking depending on the use state. Further, when the tensile force exceeds 50 N / mm, the followability of the electrode group 2 with respect to the curve decreases, and the internal stress generated in the lead connection portion increases, so partial peeling or breakage is likely to occur. Become.

In the conventional non-aqueous electrolyte secondary battery, a Ni foil having a thickness of about 100 μm or a metal foil obtained by coating the Ni foil with copper is widely used as the negative electrode lead. Such a Ni-based metal foil has a relatively high tensile force of about 55 N / mm. This is because the conventional technology attempts to increase the connection strength between the negative electrode current collector and the negative electrode lead by increasing the mechanical strength of the negative electrode lead. On the other hand, in this embodiment, the connection strength between the negative electrode 10 and the negative electrode lead 17 is increased by reducing the mechanical strength of the negative electrode lead 17.

Examples of the copper foil and copper alloy foil constituting the negative electrode lead 17 include tough pitch copper foil, zirconium copper alloy foil, and Corson copper alloy foil. In the battery 1 including the negative electrode 10 containing a silicon-based active material, the current collection performance is significantly improved by using the negative electrode lead 17 made of such copper foil and copper alloy foil. As a result, the high output characteristics of the battery 1 are improved, and the battery 1 is useful as a power source for electric tools and transportation equipment that require high output.

Examples of a method for obtaining a copper foil and an alloy copper foil having a tensile force in a predetermined range include a method for adjusting the thickness. For example, a tough pitch copper foil has a thickness of 0.12 mm or less (preferably 0.02 mm to 0.12 mm), a zirconium copper alloy foil has a thickness of 0.1 mm or less (preferably 0.01 mm to 0.1 mm), and a Corson copper alloy foil has If the thickness is adjusted to 0.06 mm or less (preferably 0.01 mm to 0.06 mm), a copper foil having a tensile force in a predetermined range can be obtained.

Moreover, the tensile force of copper foil and alloy copper foil can be adjusted also by annealing foil. For example, when a tough pitch copper foil is annealed, the tough pitch copper foil having a thickness of 0.33 mm or less, preferably 0.05 to 0.33 mm, has a predetermined range of tensile force. At this time, annealing conditions are 1 hour at 200 ° C. in an argon atmosphere. Thus, the copper foil which has the tensile force of a predetermined range is obtained by selecting thickness, annealing conditions, etc. suitably.

Furthermore, the negative electrode lead 17 of the present embodiment preferably has a short side width (length in the width direction) of 3 mm or less, and more preferably 2 mm to 3 mm. Thereby, in the production process of the electrode group 2, partial peeling or breakage of the negative electrode lead 17 from the negative electrode 10 is less likely to occur.

The connection of the negative electrode lead 17 to the negative electrode 10 can be performed, for example, by the method shown in FIG. FIG. 4 is a side view for explaining a method of connecting the negative electrode lead 17 to the negative electrode 10. The method shown in FIG. 4 includes the steps (a) and (b).

In the step (a), first, the negative electrode 10 and the negative electrode lead 17 are overlapped so that the longitudinal direction of the negative electrode 10 and the longitudinal direction of the negative electrode lead 17 are orthogonal to each other. The end face 10a in the width direction of the negative electrode 10 and the end face 17a in the longitudinal direction of the negative electrode lead 17 face the same direction, and the end face 17a of the negative electrode lead 17 protrudes from the end

face 10a of the negative electrode 10 by about 0.1 mm to 3 mm. Deploy. Thereafter, the negative electrode 10 and the negative electrode lead 17 are sandwiched and fixed by the holding jig 21. In the present embodiment, the end faces 10a and 17a face upward in the vertical direction, but the present invention is not limited to this, and the end faces 10a and 17a may face in the horizontal direction, the diagonally upward direction, and the like.

In the step (b), arc welding is performed from above in the vertical direction of the negative electrode 10 and the negative electrode lead 17 held and fixed by the holding jig 21. Specifically, the end faces 10a and 17a are irradiated with energy in the direction of the arrow 22 from the welding torch of the electrode for arc welding, and arc welding is performed. As a result, an alloy layer 20 mainly composed of a copper-silicon alloy is formed at a predetermined position on the long side of the negative electrode 10, and the negative electrode current collector present in the negative electrode 10 and the negative electrode lead 17 are connected.

As arc welding, plasma welding is preferable. Plasma welding is performed using a commercially available plasma welding machine. Plasma welding is carried out by appropriately selecting conditions such as welding current value, welding speed (moving speed of welding torch), welding time, types of plasma gas and shield gas, and their flow rates. A welding current value is selected from the range of 1A-150A, for example. The sweep speed of the welding torch is selected from a range of 1 mm / second to 100 mm / second, for example. Argon gas or the like can be used as the plasma gas. The plasma gas flow rate is selected from a range of 10 ml / min to 10 liters / min, for example. Argon, hydrogen, etc. can be used for the shielding gas. The shield gas flow rate is selected from a range of 10 ml / min to 10 liters / min, for example.

In addition to the negative electrode lead 17, the negative electrode 10 of the present embodiment connects the negative electrode current collector, the negative electrode active material layer supported by the negative electrode current collector, the negative electrode current collector, and the negative electrode lead 17 to form a copper-silicon alloy. The alloy layer 20 which has as a main component is included

As the negative electrode current collector, a non-porous conductive substrate for a nonaqueous electrolyte secondary battery can be used. Examples of the form of the non-porous conductive substrate include a foil, a sheet, and a film. Among these forms, foil is preferable. Examples of the material of the conductive substrate include stainless steel, titanium, nickel, copper, and copper alloy. Among these materials, copper and copper alloys are preferable. Copper foil includes rolled copper foil and electrolytic copper foil. The thickness of the conductive substrate is not particularly limited, but is usually 1 μm to 500 μm, preferably 5 μm to 50 μm, and more preferably 10 to 30 μm.

The negative electrode active material layer is formed on both surfaces in the thickness direction of the negative electrode current collector and is made of a silicon-based active material. The negative electrode active material layer may contain a known negative electrode active material other than the silicon based active material, additives, and the like, together with the silicon-based active material, as long as the characteristics are not impaired. The negative electrode active material layer in a preferred form is an amorphous or low crystalline thin film made of a silicon-based active material and having a thickness of 3 μm to 50 μm.

The silicon-based active material contains silicon, occludes lithium by being alloyed with lithium at the time of charging under a negative electrode potential, and releases lithium at the time of discharging. Although it does not specifically limit as a silicon type active material, Silicon, a silicon compound, the partial substitution body of silicon, the partial substitution body of a silicon compound, the solid solution of a silicon compound, etc. are mentioned. Specific examples of the silicon compound include silicon oxide represented by the formula: SiO_a (0.05 <a <1.95), silicon carbide represented by the formula: SiC_b (0 <b <1), formula : Silicon nitride represented by SiN_c (0 <c <4/3), silicon alloy which is an alloy of silicon and a different element A, and the like. In the silicon alloy, the different element A includes at least one element selected from the group consisting of Fe, Co, Sb, Bi, Pb, Ni, Cu, Zn, Ge, In, Sn, and Ti.

The partially substituted body is a compound in which a part of silicon contained in silicon and a silicon compound is substituted with a different element B. The different element B is at least selected from the group consisting of B, Mg, Ni, Ti, Mo, Co, Ca, Cr, Cu, Fe, Mn, Nb, Ta, V, W, Zn, C, N, and Sn. One element is mentioned. Among these silicon-based active materials, silicon compounds are preferable, and silicon oxide is more preferable. A silicon type active material can be used individually by 1 type, or can be used in combination of 2 or more type.

The negative electrode active material layer is formed in a thin film on the surface of the negative electrode current collector by a vapor phase method. Examples of the vapor phase method include vacuum vapor deposition, sputtering, ion plating, laser ablation, chemical vapor deposition, plasma chemical vapor deposition, and thermal spraying. Among these gas phase methods, the vacuum deposition method is preferable.

The negative electrode active material layer may be a solid film made of a silicon-based active material, or may be an aggregate of columnar bodies made of a silicon-based active material. When the negative electrode active material layer is the latter, it is preferable to provide a plurality of convex portions regularly arranged on the surface of the negative electrode current collector and form one columnar body on one convex portion. The height of the convex portion is preferably 3 μm to 20 μm. The width of the convex portion is preferably 5 μm to 20 μm. Examples of the arrangement of the convex portions include a staggered lattice arrangement, a lattice arrangement, and a close-packed arrangement.

Further, an amount of lithium corresponding to the irreversible capacity may be occluded in the negative electrode active material layer. The insertion of lithium into the negative electrode active material layer is preferably performed before the negative electrode lead 17 is connected to the negative electrode 10. Thereby, the connection strength and electrical conductivity between the negative electrode current collector of the negative electrode 10 and the negative electrode lead 17 are further improved. The insertion of lithium into the negative electrode active material layer is performed, for example, by supplying lithium vapor to the surface of the negative electrode active material layer by vacuum deposition.

The alloy layer 20 is interposed between the negative electrode current collector of the negative electrode 10 and the negative electrode lead 17, connects the negative electrode current collector and the negative electrode lead 17, and conducts the negative electrode current collector and the negative electrode lead 17. In the present embodiment, the alloy layer 20 is formed only at one place on one long side of the negative electrode 10.

The alloy layer 20 is formed by arc welding the contact portion in a state where one negative electrode active material layer of the negative electrode 10 and the negative electrode lead 17 are in contact with each other. When arc welding is performed, the negative electrode active material layer, at least a part of the negative electrode current collector in contact with the negative electrode active material layer, and at least a part of the negative electrode lead 17 in contact with the negative electrode active material layer are melted. In this melted portion, the metal element and the metalloid element contained in the negative electrode current collector, the negative electrode active material layer, and the negative electrode lead 17 are dispersed, and then re-solidification occurs to form the alloy layer 20. The alloy layer 20 contains a silicon-copper alloy as a main component, and may further contain metal elements and metalloid elements that have not been alloyed.

Next, components other than the negative electrode 10 and the negative electrode lead 17 of the nonaqueous electrolyte secondary battery 1 will be described.
The positive electrode 11 includes a positive electrode current collector, a positive electrode active material layer formed on both surfaces in the thickness direction of the positive electrode current collector, and a positive electrode lead 18 connected to the positive electrode current collector.

As the positive electrode current collector, a conductive substrate for a non-aqueous electrolyte secondary battery can be used. Examples of the material for the conductive substrate include metal materials such as stainless steel, titanium, aluminum, and aluminum alloys, and conductive resins. Examples of the form of the conductive substrate include a porous conductive substrate and a non-porous conductive substrate. Examples of the porous conductive substrate include a mesh body, a

net body, a punching sheet, a lath body, a porous body, a foam, and a nonwoven fabric. Examples of the non-porous conductive substrate include a foil and a film. The thickness of the conductive substrate is not particularly limited, but is usually 1 μm to 500 μm, preferably 5 μm to 50 μm, and more preferably 10 μm to 30 μm.

The positive electrode active material layer includes a positive electrode active material, and may further include a conductive agent, a binder, and the like. As the positive electrode active material, a material that can occlude and release lithium ions can be used without particular limitation, but lithium-containing composite oxides, olivine-type lithium phosphate, and the like are preferable.

The lithium-containing composite oxide is a metal oxide containing lithium and a transition metal element or a metal oxide in which a part of the transition metal element in the metal oxide is substituted with a different element. Examples of the transition metal element include at least one transition metal element selected from the group consisting of Sc, Y, Mn, Fe, Co, Ni, Cu, and Cr. Among these transition metal elements, Mn, Co, Ni and the like are preferable. Examples of the different element include at least one different element selected from the group consisting of Na, Mg, Zn, Al, Pb, Sb, and B. Among these different elements, Mg, Al, etc. are preferable.

Specific examples of the lithium-containing composite $_{\text{oxide Li Y CoO 2 LiY}}$ NiO 2, Li X MnO 2, Li X Co m Ni 1-m O 2, Li X Co m A 1-m O n, Li X $_{\text{Mn 2 O 4}}$, Li X Mn 2 O 4, Li X Mn 2-m A n O 4 (in each of the formulas above, A is Sc, Y, Mn, Fe, Co, Ni, Cu, Cr, It represents at least one element selected from the group consisting of Na, Mg, Zn, Al, Pb, Sb and B. 0 < X ≦ 1.2, m = 0 to 0.9, n = 2.0 to 2. 3) and the like. Among these lithium-containing composite oxide, the $_{\text{Li Co m A n O}}$ n more preferred. The lithium-containing composite oxide may include an oxygen defect portion or an oxygen excess portion.

Specific examples of the olivine type lithium phosphate include LiYPO $_4$, Li $_2$ YPO $_4$ F (wherein Y represents at least one element selected from the group consisting of Co, Ni, Mn, and Fe). There is.
In each of the above formulas, the value indicating the molar ratio of lithium is a value immediately after the production of the positive electrode active material, and increases or decreases due to charge / discharge. A positive electrode active material can be used individually by 1 type, or can be used in combination of 2 or more type.

As the conductive agent, a conductive agent for a non-aqueous electrolyte secondary battery can be used, and graphites such as natural graphite and artificial graphite, carbon such as acetylene black, ketjen black, channel black, furnace black, lamp black, and thermal black Blacks; conductive fibers such as carbon fibers and metal fibers, carbon fluorides, metal powders such as aluminum; conductive whiskers such as zinc oxide whiskers, conductive metal oxides such as titanium oxide; organic conductivity such as phenylene derivatives Materials and the like. A conductive agent can be used individually by 1 type, or can be used in combination of 2 or more type.

As the binder, binders for non-aqueous electrolyte secondary batteries can be used, such as polyvinylidene fluoride, polytetrafluoroethylene, polyhexafluoropropylene, polyethylene, polypropylene, polyamide, polyimide, polyamideimide, polyacrylonitrile, poly Acrylic acid, polymethyl acrylate, polyethyl acrylate, polyhexyl acrylate, polymethacrylic acid, polymethyl methacrylate, polyethyl methacrylate, polyhexyl methacrylate, polyvinyl acetate, polyvinyl pyrrolidone, polyether, polyether mon Resin materials such as von, rubber materials such as styrene-butadiene rubber and modified acrylic rubber; water-soluble polymer compounds such as carboxymethyl cellulose; and the like.

A copolymer containing two or more types of monomer compounds can be used as a binder. Examples of the monomer compound include tetrafluoroethylene, hexafluoropropylene, perfluoroalkyl vinyl ether, vinylidene fluoride, chlorotrifluoroethylene, ethylene, propylene, pentafluoropropylene, fluoromethyl vinyl ether, acrylic acid, hexadiene and the like. A binder can be used individually by 1 type, or can be used in combination of 2 or more type.

The positive electrode active material layer can be formed, for example, by applying a positive electrode mixture slurry to the surface of the positive electrode current collector, and drying and rolling the resulting coating film. The positive electrode mixture slurry can be prepared by dissolving or dispersing a positive electrode active material and, if necessary, a conductive agent, a binder and the like in a dispersion medium. As the dispersion medium, dimethylformamide, dimethylacetamide, methylformamide, N-methyl-2-pyrrolidone, dimethylamine, acetone, cyclohexanone, and the like can be used.

One end of the positive electrode lead 18 is connected to the current collector exposed portion of the positive electrode current collector, and the other end is connected to the sealing plate 16. These connections are made by welding such as resistance welding and ultrasonic welding. Examples of the material of the positive electrode lead 18 include aluminum and an aluminum alloy. Specific examples of the aluminum alloy include an aluminum-silicon alloy, an aluminum-iron alloy, an aluminum-copper alloy, an aluminum-manganese alloy, an aluminum-magnesium alloy, and an aluminum-zinc alloy

The separator 12 is disposed between the negative electrode 10 and the positive electrode 11. As the separator 12, a porous sheet having predetermined ion permeability, mechanical strength, insulation, and the like and having a plurality of pores inside can be used. Examples of the porous sheet include a microporous film, a woven fabric, and a non-woven fabric. Various resin materials can be used for the material of the separator 12, but polyolefins such as polyethylene and polypropylene are preferable in view of durability, shutdown function, battery safety, and the like. The thickness of the separator 12 is usually 10 μm to 300 μm, preferably 10 μm to 40 μm. The porosity of the separator 12 is preferably 30% to 70%. The porosity is a percentage of the total volume of the pores of the separator 12 with respect to the volume of the separator 12.

By using the negative electrode 10, the positive electrode 11, and the separator 12 described above, the electrode group 2 can be manufactured. The electrode group 2 can be produced by, for example, an electrode group manufacturing apparatus shown in FIG. FIG. 5 is a schematic diagram of an electrode group manufacturing apparatus. FIG. 6 is a perspective view showing a running state of the negative electrode 10 to which the negative electrode lead 17 is connected on the surfaces of the feed rollers 38a and 38b. FIG. 7 is a side view showing a state of the negative electrode 10 to which the negative electrode lead 17 is connected on the surface of the feeding roller 38a.

As shown in FIG. 5, the negative electrode 10 supplied from the negative electrode feed roller 30 is overlapped with the negative electrode lead 17 supplied from the negative electrode lead feed roller 31 while traveling toward the feed roller 38a, and is plasma welded. 32 is arc welded. The negative electrode 10 to which the negative electrode lead 17 is connected travels on the surfaces of the feed rollers 38a and 38b as shown in FIG. 6, and is then introduced into the gap between the pair of regulating rollers 39a and 39b. In this gap, the negative electrode 10 is laminated with the positive electrode 11 to which the positive electrode lead 18 is connected and the two separators 12 to produce a laminate. An electrode group is produced by rubbing this laminated body on the surface of the core roller 46. Then, when the electrode group has a predetermined diameter, the laminate is cut by the cutter 47. When the laminate is rubbed against the surface of the core roller 46, a tension of 1N to 100N is applied to the laminate.

In such a manufacturing process, when the negative electrode 10 to which the negative electrode lead 17 is connected travels on the surface of the feed roller 38a, the problem shown in FIG. 7 may occur. Since the negative electrode 10 has a longitudinal direction that coincides with the traveling direction, the negative electrode 10 can easily follow the circular shape of the feed roller 38a. On the other hand, since the width direction of the negative electrode lead 17 coincides with the traveling direction, the negative electrode lead 17 cannot follow the circular shape of the feeding roller 38a when the negative electrode lead 17 and the alloy layer 20 have high mechanical strength. . As a result, one end of the negative electrode lead 17 in the width direction may partially peel from the negative electrode 10 in the direction of the arrow 48 or the negative electrode lead 17 may break. However, since the negative electrode lead 17 is made of copper foil or copper alloy foil and has a predetermined range of tensile force, partial peeling or breakage of the negative electrode lead 17 from the negative electrode 10 on the surface of the feeding roller 38a is sufficiently suppressed. can do.

The electrode group 2 thus produced is impregnated with a non-aqueous electrolyte having lithium ion conductivity. The non-aqueous electrolyte contains a lithium salt and a non-aqueous solvent, and may further contain an additive.

As the lithium salt, a lithium salt for a nonaqueous electrolyte secondary battery can be used. For example, $LiClO_4$, $LiBF_4$, $LiPF_6$, $LiAlCl_4$, $LiSbF_6$, LiSCN, $LiCF_3SO_3$, $LiCF_3CO_2$, $LiAsF_6$, Examples include $LiB_{10}Cl_{10}$, lower aliphatic lithium carboxylate, LiCl, LiBr, LiI, $LiBCl_4$, borates, and imide salts. A lithium salt can be used individually by 1 type, or can be used in combination of 2 or more type. The amount of lithium salt dissolved in the non-aqueous solvent is preferably 0.5 to 2 mol / L.

As the non-aqueous solvent, a non-aqueous solvent for a non-aqueous electrolyte secondary battery can be used. For example, cyclic carbonates such as propylene carbonate and ethylene carbonate; chain carbonates such as diethyl carbonate, ethyl methyl carbonate, and dimethyl carbonate; γ -Cyclic carboxylic acid esters such as butyrolactone and γ-valerolactone; A non-aqueous solvent can be used individually by 1 type or in combination of 2 or more types.

Additives such as vinylene carbonate, vinylene carbonate substituted with one or two alkyl groups having 1 to 2 carbon atoms, vinyl ethylene carbonate, divinyl ethylene carbonate, etc. are decomposed on the negative electrode and have high lithium ion conductivity. And benzene compounds that decompose when the battery is overcharged to form a film on the electrode surface and inactivate the battery, such as carbonate compounds, cyclohexylbenzene, biphenyl, diphenyl ether, etc. .

The insulating plates 13 and 14 and the gasket 19 can be produced by molding an electrically insulating material, preferably a resin material or a rubber material, into a predetermined shape. The battery case 15 and the sealing plate 16 can be produced by molding a metal material such as iron or stainless steel into a predetermined shape.

In the present embodiment, the non-aqueous electrolyte secondary battery 1 is a cylindrical battery including the electrode group 2, but is not limited thereto and can take various forms. Specific examples thereof include a rectangular battery including the electrode group 2 and a rectangular battery including a flat electrode group obtained by forming the electrode group 2 into a flat shape. In the electrode group 2, when the negative electrode lead 17 is connected to the negative electrode 10 at a predetermined position, even if the electrode 2 is formed into a flat shape, partial peeling or breakage of the negative electrode lead 17 from the negative electrode 10 does not occur. Absent.

Hereinafter, the present invention will be specifically described with reference to Examples and Comparative Examples.

Example 1

(1) Preparation $NiSO_4$ aqueous solution of the positive electrode, Ni: Co = 8.5: 1.5 to $CoSO_4$ so that the (molar ratio) was added to prepare an aqueous solution of metal ion concentration 2 mol / L in. A ternary precipitate having a composition represented by $Ni_{0.85}Co_{0.15}(OH)_2$ was generated by a coprecipitation method by gradually dropping a 2 mol / L sodium hydroxide solution into the aqueous solution while stirring. . This precipitate was separated by filtration, washed with water, and dried at 80 ° C. to obtain a composite hydroxide.

The obtained composite hydroxide was heated in the atmosphere at 500 ° C. for 10 hours to obtain a composite oxide having a composition represented by $Ni_{0.85}Co_{0.15}O_2$. The obtained composite oxide and lithium hydroxide monohydrate were mixed so that the sum of the number of Ni and Co atoms and the number of Li atoms were equal. The obtained mixture was heated in the atmosphere at 800 ° C. for 10 hours to have a composition represented by $LiNi_{0.85}Co_{0.15}O_2$ and a lithium nickel-containing composite oxide having an average secondary particle size of 10 μm. The product (positive electrode active material) was obtained.

A positive electrode mixture slurry was prepared by mixing 93 g of the positive electrode active material powder obtained above, 3 g of acetylene black (conductive agent), 4 g of polyvinylidene fluoride powder (binder) and 50 ml of N-methyl-2-pyrrolidone. . This positive electrode mixture slurry was applied to both sides of an aluminum foil (positive electrode current collector) having a thickness of 15 μm, and the obtained coating film was dried and rolled to form a positive electrode active material layer having a thickness of 5040 μm per side, A positive electrode plate of 56 mm × 10 m was produced. Part of the positive electrode active material layer (56 mm × 5 mm) on both sides of this positive electrode plate was cut out at an interval of 800 mm to provide a current collector exposed portion.

(2) Positive electrode lead As the positive electrode lead, a positive electrode lead having a width of 4 mm and a length of 70 mm cut from an aluminum foil having a thickness of 0.15 mm was used.

(3) Production of Negative Electrode FIG. 8 is a side perspective view schematically showing the configuration of an electron beam vacuum deposition apparatus 50 (hereinafter referred to as "deposition apparatus 50"). In FIG. 8, members inside the vapor deposition apparatus 50 are indicated by solid lines. The vapor deposition apparatus 50 includes a chamber 51, a transfer means 52, a gas supply means 58, a plasma generation means 59, silicon targets 60a and 60b, a shielding plate 61, an electron beam generator (not shown), and an internal structure thereof. And a chamber 51 which is a pressure-resistant container accommodated in the container.

The conveying means 52 includes an unwinding roller 53, a can 54, a winding roller 55, and conveying rollers 56 and 57. A strip-shaped negative electrode current collector 62 is wound around the unwinding roller 53. The can 54 includes a cooling means (not shown) inside. A negative electrode current collector 62 having a negative electrode active material layer formed on one surface is wound around the winding roller 55.

The gas supply means 58 supplies a source gas such as oxygen or nitrogen into the chamber 51. When the gas supply means 58 supplies the source gas, a negative electrode active material layer made of silicon oxide, nitride or the like is formed. When the source gas is not supplied, a negative electrode active material layer made of silicon is formed. The plasma generating means 59 converts the raw material gas into plasma. The silicon targets 60a and 60b are used to form a negative electrode active material layer containing silicon.

The shielding plate 61 is disposed between the can 54 and the silicon targets 60a and 60b and moves in the horizontal direction. The horizontal position of the shielding plate 61 is adjusted according to the formation state of the negative electrode active material layer on the surface of the negative electrode current collector 62. The electron beam generator irradiates the silicon targets 60a and 60b with an electron beam to generate silicon vapor.

According to the vapor deposition apparatus 50, silicon vapor generated by irradiating the silicon targets 60 a and 60 b with the electron beam rises toward the can 54. On the other hand, the negative electrode current collector 62 running on the surface of the can 54 is cooled by the can 54. The silicon vapor reaching the surface of the negative electrode current collector 62 is cooled and deposited on the surface of the negative electrode current collector 62. When the gas supply means 58 supplies the source gas, a reaction product of silicon and the source gas is deposited on the surface of the negative electrode current collector 62. Thereby, a negative electrode active material layer is formed.

A negative electrode active material layer (silicon thin film, solid film) having a thickness of 5 μm was formed on both surfaces of the negative electrode current collector 62 using the vapor deposition apparatus 50 under the following conditions, thereby preparing a negative electrode plate.

Pressure in chamber 51: 8.0×10^{-5} Torr

Negative electrode current collector 62: roughened electrolytic copper foil (Furukawa Electric Co., Ltd., thickness 35 μm, width 59 mm, length 10 m)

Winding speed of the negative electrode current collector 62 by the winding roller 55 (conveying speed of the negative electrode current collector 62): 2 cm / min

Source gas: Not supplied.
Targets 60a, 60b: silicon single crystal with a purity of 99.9999% (manufactured by Shin-Etsu Chemical Co., Ltd.)
Electron beam acceleration voltage: -8 kV
Electron beam emission: 300 mA

Lithium metal was vapor-deposited on the surface of the negative electrode active material layer of the obtained negative electrode plate. By depositing lithium metal, lithium corresponding to the irreversible capacity stored in the negative electrode active material layer during the initial charge / discharge of the battery was supplemented. Lithium metal was deposited using a resistance heating vapor deposition apparatus (manufactured by ULVAC, Inc.) in an argon atmosphere. Lithium metal is loaded into a tantalum boat in a resistance heating vapor deposition apparatus, the negative electrode plate is fixed so that the negative electrode active material layer faces the tantalum boat, and a 50 A current is passed through the tantalum boat in an argon atmosphere. For 10 minutes.

(4) Negative Electrode Lead As the negative electrode lead, a negative electrode lead cut out from a tough pitch copper foil (trade name: TPC, thickness: 0.1 mm, manufactured by Hitachi Cable Ltd.) to a length of 80 mm and a width of 3 mm was used. Here, since the maximum tensile force of the negative electrode lead was 120 N and the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of the negative electrode lead was 40 N / mm.

(5) Separator As the separator, a polyethylene microporous membrane (trade name: Hypore, thickness 20 μm, manufactured by Asahi Kasei E-Materials Co., Ltd.) was used. The separator had a width of 62 mm and a length of 10 m.

(6) Production of electrode group The negative electrode, negative electrode lead, positive electrode, positive electrode lead and separator obtained above were used as the negative electrode 10, negative electrode lead 17, positive electrode 11, positive electrode lead 18 and separator 12, respectively, as shown in FIG. It was rubbed against predetermined feed rollers 30, 31, 33, 34, 36, and 37 of the group manufacturing apparatus. Then, the negative electrode lead 17 was supplied from the negative electrode lead supply roller 31 to the negative electrode 10 stretched by the negative electrode supply roller 30 and the supply roller 30a.

At this time, at a position of 900 mm from the winding axis side end of the negative electrode 10 in the longitudinal direction, the longitudinal direction of the negative electrode 10 and the longitudinal direction of the negative electrode lead 17 are superimposed so as to be orthogonal to each other and to the long side of the negative electrode 10 The negative electrode lead 17 was arranged so that the end in the longitudinal direction protruded by 0.1 mm. In this state, the negative electrode 10 and the negative electrode lead 17 were fixed by a single-axis robot (pressing jig, manufactured by IAI Corporation, not shown).

Next, energy is obtained under the following conditions from a direction perpendicular to the adjacent end faces of the negative electrode 10 and the negative electrode lead 17 by a plasma welding machine (trade name: PW-50NR, manufactured by Koike Oxygen Industry Co., Ltd.) 32. And plasma welding was performed to form an alloy layer 20. Thereby, the negative electrode 10 and the negative electrode lead 17 were connected as shown in FIG. Similarly, the negative electrode lead 17 was connected every 900 mm from the winding shaft side end in the longitudinal direction of the negative electrode 10.

[Plasma welding conditions]
Electrode rod: Diameter 1.0mm
Electrode nozzle: Diameter 1.6mm
Torch distance: 2.0mm
Torch sweep speed: 30 mm / s

Plasma gas: Argon Plasma gas flow rate: 100 (sccm)
Shield gas: hydrogen, argon Shield gas flow rate (hydrogen): 500 (sccm)
Shielding gas flow rate (argon): 1 (slm)
Welding current: 8.0A

In this way, the negative electrode 10 to which the negative electrode lead 17 was connected was caused to travel on the surfaces of the feeding rollers 38a and 38b (both were iron rollers having a diameter of 60 mm) at a traveling speed of 30 mm / second. As a result, when the negative electrode 10 traveled on the surface of the feed roller 38a, partial peeling or breakage of the negative electrode lead 17 from the negative electrode 10 did not occur.

Thereafter, the negative roller 10 connected to the negative electrode lead 17, the separator 12, and the positive electrode 11 connected to the positive electrode lead 18 and the separator 12 are overlapped in this order by the regulating rollers 39 a and 39 b. Together, a laminate was obtained. The laminate was wound around the core roller 46 while applying a tensile force of 10 N to the laminate, and the laminate was cut by a cutter 47 when the electrode group had a predetermined diameter. Thus, the negative electrode lead 17 is connected to the winding circumference at a radius of 8 mm from the center, and the positive electrode is connected to the winding circumference at a radius of 11 mm from the center. A wound electrode group to which the lead 18 was connected was produced. The negative electrode lead 17 and the positive electrode lead 18 were arranged so as to protrude from the wound electrode group in opposite directions in the longitudinal direction of the wound electrode group.

(7) Production of Battery Polyethylene insulating plates were respectively attached to both ends in the longitudinal direction of the wound electrode group obtained above. The other end of the positive electrode lead was welded to the sealing plate, and the other end of the negative electrode lead was welded to the bottom inner surface of the bottomed cylindrical iron battery case. Next, the wound electrode group was accommodated in a battery case, and a nonaqueous electrolyte was injected into the battery case. As the non-aqueous electrolyte, a non-aqueous electrolyte in which $LiPF_6$ was dissolved at a concentration of 1.0 mol / L in a mixed solvent containing ethylene carbonate and ethyl methyl carbonate at a volume ratio of 1: 1 was used. Further, a sealing plate was attached to the opening of the battery case via a polyethylene gasket, and the battery case was sealed by crimping the opening end of the battery case inward to produce a cylindrical non-aqueous electrolyte secondary battery.

(Example 2)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
Tough pitch copper foil (trade name: TPC, thickness 0.15 mm, manufactured by Hitachi Cable Ltd.) was annealed at 200 ° C. for 1 hour in an argon atmosphere. A negative electrode lead having a length of 80 mm and a width of 3 mm was cut out from the tough pitch copper foil after annealing. The maximum tensile force of this negative electrode lead was 90N. Since the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of the negative electrode lead was 30 N / mm.

(Example 3)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
A negative electrode lead having a length of 80 mm and a width of 3 mm was cut out from a zirconium copper alloy foil (trade name: HCL-022, thickness 0.05 mm,

manufactured by Hitachi Cable Ltd.). The maximum tensile force of this negative electrode lead was 66N. Since the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of the negative electrode lead was 22 N / mm.

Example 4
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
From a Corson copper alloy foil (trade name: HCL-305, thickness 0.05 mm, manufactured by Hitachi Cable Ltd.), a negative electrode lead having a length of 80 mm and a width of 3 mm was cut out. The maximum tensile force of this negative electrode lead was 111N. Since the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of the negative electrode lead was 37 N / mm.

(Example 5)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the width of the negative electrode lead was changed from 3 mm to 3.5 mm. The maximum tensile force of this negative electrode lead was 140 N, and the tensile force per 1 mm short side width was 40 N / mm.

(Example 6)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode produced by the method described below was used.

(1) Production of Negative Electrode FIG. 9 is a side perspective view schematically showing the configuration of an electron beam vacuum deposition apparatus 70 (hereinafter referred to as "deposition apparatus 70"). FIG. 10 is a longitudinal sectional view schematically showing the configuration of the negative electrode 80 produced in this example.

On the surface of a forged steel roller (Daido Machinery Co., Ltd., diameter 50 mm, roll width 100 mm), a plurality of recesses were formed by laser processing. The plurality of recesses were in a close-packed arrangement in which the distance between the axes of a pair of adjacent recesses was 20 μm. The opening shape of the concave portion was almost rhombus with a long diagonal of 19.5 μm and a short diagonal of 9.8 μm. The depth of the concave portion was 8 μm, and the bottom portion thereof was substantially flat at the center, and the portion where the peripheral edge of the bottom portion and the side surface of the concave portion were connected was rounded. In this way, a convex roller was produced. The two convex rollers were brought into pressure contact at a linear pressure of 1 t / cm so that their axes were parallel to form a pressure nip portion.

On the other hand, an alloy copper foil (trade name: HCL-02Z, thickness 20 μm, manufactured by Hitachi Cable Ltd.) containing zirconium in a proportion of 0.03% by mass with respect to the total amount is 30 at 600 ° C. in an argon gas atmosphere. Heated for minutes and annealed. The alloy copper foil was passed through the pressure nip portion, and the alloy copper foil was pressure-molded to produce a negative electrode current collector 81 shown in FIG. The average height of the protrusions 82 was about 8 μm. The shape of the convex portion 82 is approximately rhombus. The plurality of convex portions 82 were arranged in a close-packed manner on the surface of the negative electrode current collector 81. 10 shows only one surface of the negative electrode current collector 81, the negative electrode current collector 81 has a plurality of convex portions 82 on both surfaces.

Next, using the vapor deposition apparatus 70, one columnar body 84 was formed on the surface of each convex portion 82 of the negative electrode current collector 81 obtained above, and the negative electrode 80 was produced.

The vapor deposition apparatus 70 includes a feed roller 72 around which a negative electrode current collector 81 is wound, conveyance rollers 73a, 73b, 73c, 73d, 73e, and 73f, vapor deposition sources 76a and 76b, and a silicon-based surface on each convex portion 82. A winding roller 75 for winding the negative electrode current collector 81 on which the active material layer is formed, a pair of shielding plates 77 and 78 for regulating the supply region of the silicon-based active material vapor, and an oxygen nozzle for supplying oxygen (non- And an electron beam irradiation device (not shown), a chamber 71 for accommodating these, and a vacuum pump 79 for reducing the pressure in the chamber 71. The shielding plate 77 includes shielding pieces 77a, 77b, and 77c. The shielding plate 78 includes shielding pieces 78a, 78b, and 78c.

In the vapor deposition apparatus 70, in the conveyance direction of the negative electrode current collector 81, a first vapor deposition region is provided between the shielding pieces 77a and 77b, a second vapor deposition region is provided between the shielding pieces 77b and 77c, and the shielding pieces 78c and 78b. A third vapor deposition region is provided therebetween, and a fourth vapor deposition region is provided between the shielding pieces 78b and 78a.

Scrap silicon (silicon single crystal, purity 99.9999%, manufactured by Shin-Etsu Chemical Co., Ltd.) was used as the silicon-based active material raw material, and this was accommodated in vapor deposition sources 76a and 76b. After evacuating the chamber 71 to 5×10^{-3} Pa by the vacuum pump 79, oxygen was supplied into the chamber 71 by 50 sccm from an oxygen nozzle (not shown) installed in each of the first to fourth vapor deposition regions. Next, the vapor deposition sources 76a and 76b were irradiated with an electron beam (acceleration voltage: 10 kV, emission: 500 mA) to generate silicon vapor.

On the other hand, the negative electrode current collector 81 is fed from the feed roller 72 at a feed rate of 2 cm / min, and a mixture of silicon vapor and oxygen is vapor-deposited on the surface of each convex portion 82 of the negative electrode current collector 81 running in the first vapor deposition region. Thus, a mass 84a shown in FIG. 11 was formed. Next, a lump 84b was formed on the surface of the convex portion 82 and the lump 84a of the negative electrode current collector 81 running in the second vapor deposition region. Further, in the third and fourth vapor deposition regions, the masses 84a and 84b are stacked on the surface of each convex portion 82 on the surface opposite to the surface where the masses 84a and 84b are formed in the first and second vapor deposition regions.

Next, the feeding direction of the negative electrode current collector 81 is reversed by reversing the rotation direction of the feed roller 72 and the take-up roller 75, and the lump 84 c is formed on the surfaces of the lumps 84 a and 84 b on both sides of the negative electrode current collector 81. , 84d. Thereafter, one reciprocal deposition is performed in the same manner, and the columnar body 84 which is a laminate of the lumps 84a, 84b, 84c, 84d, 84e, 84f, 84g, and 84h is formed on the surface of both the convex portions 82 of the negative electrode current collector 81. Formed. Thereby, the negative electrode 80 was obtained.

The columnar body 84 was supported by the surface of the convex portion 82 and grew to extend outward from the negative electrode current collector 81. The three-dimensional shape of the columnar body 84 was substantially cylindrical. The columnar body 84 had an average height of 20 μm and an average width of 40 μm. Further, when the amount of oxygen contained in the columnar body 84 was quantified by a combustion method, the composition of the columnar body 84 was $SiO_{0.25}$.

The negative electrode active material layer 83 composed of the plurality of columnar bodies 84 of the negative electrode 80 obtained above was supplemented with irreversible capacity lithium using a resistance heating vacuum deposition apparatus. The vapor deposition apparatus includes: a feed roller around which the strip-shaped negative electrode 80 is wound in advance; a can in which the cooling device is disposed; a take-up roller that winds up the negative electrode 80 supplemented with lithium; and a transport roller that transports the negative electrode 80; A tantalum evaporation source that contains metallic lithium, a shielding plate that restricts the supply of lithium vapor to the surface of the negative electrode 80, and a pressure-resistant chamber that contains these.

First, the inside of the chamber of the vapor deposition apparatus was replaced with an argon atmosphere, and the degree of vacuum in the chamber was set to 1×10^{-1} Pa by a vacuum pump (not shown). Next, a current of 50 A is supplied to the evaporation source to generate lithium vapor, and the negative electrode 80 is fed from the

feed roller at a speed of 2 cm / min. When the negative electrode 80 passes through the can surface, the negative electrode active of the negative electrode 80 is activated. Lithium for the irreversible capacity was deposited on the surface of the material layer. Lithium was deposited on both negative electrode active material layers 83 of the negative electrode 80. In this way, a negative electrode 80 supplemented with lithium was produced.

(Comparative Example 1)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
A negative electrode lead having a length of 80 mm and a width of 3 mm was cut out from a tough pitch copper foil (trade name: TPC, thickness: 0.15 mm, manufactured by Hitachi Cable Ltd.). Since the maximum tensile force of this negative electrode lead was 180 N and the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of this negative electrode lead was 60 N / mm.

(Comparative Example 2)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
A negative electrode lead having a length of 80 mm and a width of 3 mm was cut out from a zirconium copper alloy foil (trade name: HCL-022, thickness 0.15 mm, manufactured by Hitachi Cable Ltd.). Since the maximum tensile force of this negative electrode lead was 175.5 N and the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of this negative electrode lead was 58.5 N / mm.

(Comparative Example 3)
A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that the negative electrode lead shown below was used.
A negative electrode lead having a length of 80 mm and a width of 3 mm was cut out from a Corson copper alloy foil (trade name: HCL-305, thickness 0.1 mm, manufactured by Hitachi Cable Ltd.). Since the maximum tensile force of this negative electrode lead was 225 N and the width of the negative electrode lead was 3 mm, the tensile force per 1 mm short side width of this negative electrode lead was 75 N / mm.

(Comparative Example 4)
The innermost winding having a diameter of 16 mm and a radius of 1.5 mm from the center of the electrode group is the same as in Example 1 except that the negative electrode lead is connected to the winding side end in the longitudinal direction of the negative electrode. A wound electrode group with a negative electrode lead connected to the periphery was produced. A cylindrical nonaqueous electrolyte secondary battery was produced in the same manner as in Example 1 except that this wound electrode group was used.

(Evaluation)
The following evaluation was implemented about the battery of Examples 1-6 and Comparative Examples 1-4.
[Partial peeling and breakage of negative electrode lead from negative electrode]
100 batteries of Examples 1 to 6 and Comparative Examples 1 to 4 were produced. In this production process, the presence or absence of partial peeling or breakage of the negative electrode lead from the negative electrode was visually determined.
First, the presence or absence of partial peeling or breakage of the negative electrode lead from the negative electrode when the negative electrode connected to the negative electrode lead traveled on the surface of the feed roller was determined. The number of negative electrodes in which partial peeling or breakage of the negative electrode lead did not occur was counted, and the percentage (%) with respect to the total number (100) was determined. The results are shown in Table 1.

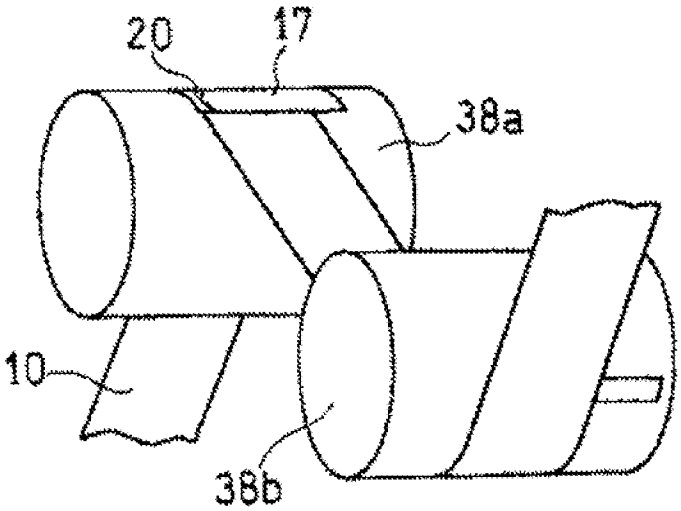
Next, the negative electrode connected with the negative electrode lead, the separator, the positive electrode connected with the positive electrode lead, and the laminate laminated with the separator are wound, and after the winding is finished, the obtained wound electrode group is unwound and the negative electrode of the negative electrode lead The presence or absence of partial peeling from or breakage was determined. The number of negative electrodes in which partial peeling or breakage of the negative electrode lead did not occur was counted, and the percentage (%) with respect to the total number (100) was determined. The results are shown in Table 1. In addition, the evaluation at the time of winding was not implemented about the individual | solid which the partial peeling or fracture | rupture from the negative electrode of the negative electrode lead generate | occur | produced at the time of driving | running | working of the feed roller surface.

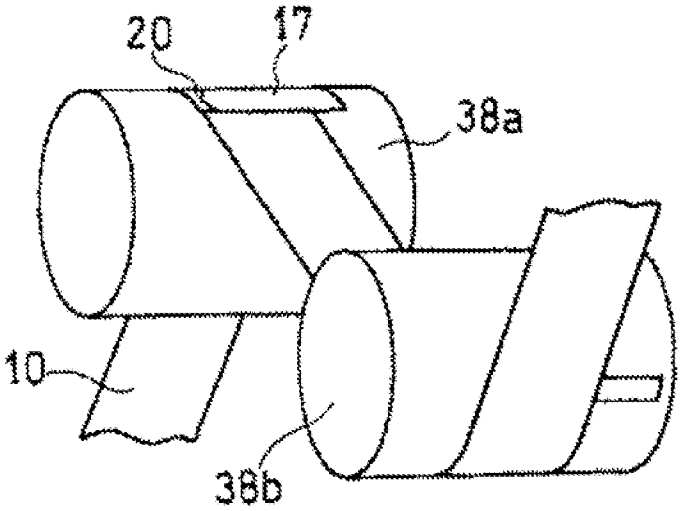
Furthermore, 10 batteries each of Examples 1 to 6 and Comparative Examples 1 to 4 were prepared, and after charging and discharging (25 ° C.) of the following (a) to (d) were repeated 100 cycles, each battery was disassembled. The presence or absence of partial peeling or breakage of the negative electrode lead from the negative electrode was determined. The number of negative electrodes in which partial peeling or breakage of the negative electrode lead did not occur was counted, and the percentage (%) with respect to the total number (10) was determined. The results are shown in Table 1.

(A) Constant current charging: current value 1C, end-of-charge voltage 4.2V
(B) Constant voltage charge: Voltage value 4.2V, charge end current 0.05C.
(C) Pause for 20 minutes (d) Constant current discharge: Current value 1C, end-of-charge voltage 2.5V.

[Cycle characteristics]
About each battery of Examples 1-6 and Comparative Examples 1-4, charging / discharging (25 degreeC) of said (a)-(d) was repeated 100 cycles. The percentage of the total discharge capacity at the 100th cycle with respect to the total discharge capacity at the first cycle was determined and is shown in Table 1 as the capacity maintenance rate (%).

Regarding the capacity retention ratios of Comparative Examples 1 to 4, the batteries in which the negative electrode lead did not break inside during 100 cycles of charge / discharge showed a relatively high value of 89 to 90%, and the negative electrode lead inside The battery in which the rupture occurred was 0%.





From Table 1, the batteries of Examples 1 to 6 are almost free from partial peeling and breakage from the negative electrode of the negative electrode lead in the production process, and can significantly reduce the defective product rate even in industrial scale production. It is obvious. In particular, it is clear that the batteries of Examples 1 to 4 and 6 have a very large effect of suppressing partial peeling and breakage of the negative electrode lead from the negative electrode. Moreover, it is clear that the batteries of Examples 1 to 6 are excellent in battery performance such as cycle characteristics.

On the other hand, in the batteries of Comparative Examples 1 to 3, since the tensile force per 1 mm short side width of the negative electrode lead exceeds the range specified in the present invention, there are many partial peelings and breaks of the negative electrode lead from the negative electrode. It is thought that it became. In particular, since the battery of Comparative Example 3 had a very large tensile force per 1 mm short side width of the negative electrode lead, the negative electrode could be used at any time during running on the feed roller surface, at the time of winding, and at the end of charge / discharge. Many partial peeling and breakage of the lead from the negative electrode occurred. In the battery of Comparative Example 4, the negative electrode lead connection position was within a radius of 8 mm from the center of the electrode group. It is thought that sometimes partial peeling and breakage of the negative electrode lead from the negative electrode occurred frequently.

The non-aqueous electrolyte secondary battery of the present invention can be used in the same applications as conventional non-aqueous electrolyte secondary batteries, and in particular, the main power source or auxiliary power for electronic devices, electrical devices, machine tools, transportation devices, power storage devices, etc. Useful as a power source. Examples of the electronic device include a personal computer, a mobile phone, a mobile device, a portable information terminal, and a portable game device. Examples of the electric device include a vacuum cleaner and a video camera. Examples of the machine tool include an electric tool and a robot. Examples of the transportation equipment include an electric vehicle, a hybrid electric vehicle, a plug-in hybrid electric vehicle, and a fuel cell vehicle. An example of the power storage device is an uninterruptible power supply

DESCRIPTION OF SYMBOLS 1 Nonaqueous electrolyte secondary battery 2 Winding type electrode group 10, 80 Negative electrode 11 Positive electrode 12 Separator 13, 14 Insulating plate 15 Battery case 16 Sealing plate 17 Negative electrode lead 18 Positive electrode lead 19 Gasket 20 Alloy layer

Patent Citations (4)

Publication number	Priority date	Publication date	Assignee	Title
Family To Family Citations				
JP4895503B2 *	2004-12-28	2012-03-14	三洋[illegible]式会社	Lithium secondary battery

JP2007095566A *	2005-09-29	2007-04-12	Sanyo Electric Co Ltd	Lithium secondary battery and method of manufacturing same
JP4432871B2 *	2003-10-16	2010-03-17	ソニー株式会社	Negative electrode, method for producing the same, and battery
KR101539788B1 *	2006-08-22	2015-07-27	미쓰비시 가가꾸 가부시키가이샤	2 2 2 2 2 lithium difluorophosphate electrolytic solution containing lithium difluorophosphate process for producing lithium difluorophosphate process for producing nonaqueous electrolytic solution nonaqueous electrolytic solution and nonaqueous electrolytic solution secondary cell employing the same

* Cited by examiner, † Cited by third party

Cited By (6)

Publication number	Priority date	Publication date	Assignee	Title
WO2022270868AA1 *	2021-06-23	2022-12-29	Ａｐｂ株式会社	Battery electrode manufacturing device and battery electrode manufacturing method
Family To Family Citations				
JP4274256B2 *	2006-08-25	2009-06-03	トヨタ自動車株式会社	Electrode for power storage device and power storage device
JP6219073B2 *	2012-05-22	2017-10-25	三洋電機株式会社	Negative electrode for lithium secondary battery, lithium secondary battery, and method for producing negative electrode for lithium secondary battery
US9692086B2 *	2013-10-03	2017-06-27	The Regents Of The University Of California	Co-solvents with high coulombic efficiency in propylene carbonate based electrolytes
CN110429320B *	2014-06-26	2022-09-23	松下知识产权经营株式会社	Winding type battery
US11024927B2 *	2016-10-26	2021-06-01	Sanyo Electric Co., Ltd.	Electrode for non-aqueous electrolyte secondary battery and non-aqueous electrolyte secondary battery

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
JP5318761B2	2013-10-09	Lithium ion battery
JP5378728B2	2013-12-25	Lithium ion secondary battery
JP5173181B2	2013-03-27	Lithium ion secondary battery and method for producing negative electrode plate for lithium ion secondary battery
JP5231557B2	2013-07-10	Anode for non-aqueous electrolyte secondary battery and non-aqueous electrolyte secondary battery
US9620778B2	2017-04-11	Negative electrode for lithium secondary batteries, lithium secondary battery, and method for producing the negative electrode for lithium secondary batteries
WO2010092815A1	2010-08-19	Anode for nonaqueous electrolyte secondary battery and nonaqueous electrolyte secondary battery
US20100075217A1	2010-03-25	Lithium ion secondary battery and method for producing the same
US20100099029A1	2010-04-22	Lithium ion secondary battery
JP5419685B2	2014-02-19	Negative electrode, method for producing the same, and nonaqueous electrolyte secondary battery
US11456447B2	2022-09-27	Predoping method for negative electrode active material, manufacturing method for negative electrode, and manufacturing method for power storage device
WO2011105092A1	2011-09-01	Lithium-ion secondary battery
US20110111293A1	2011-05-12	Method for producing negative electrode for lithium ion battery and lithium ion battery
JP2011096638A	2011-05-12	Secondary battery
JP5923217B2	2016-05-18	Secondary battery
JP2009295289A	2009-12-17	Lithium-ion secondary battery and method of manufacturing the same
JP2009266737A	2009-11-12	Lithium ion secondary battery and its manufacturing method
JP2012064412A	2012-03-29	Nonaqueous electrolyte secondary battery

JP2009301943A	2009-12-24	Anode and lithium-ion secondary battery
WO2013080459A1	2013-06-06	Negative electrode for lithium ion battery, and lithium ion battery
JP4894965B2	2012-12-08	Negative electrode current collector for lithium ion secondary battery, negative electrode for lithium ion secondary battery, and lithium ion secondary battery
JP2013030431A	2013-02-07	Nonaqueous electrolyte secondary battery
WO2013021646A1	2013-02-14	Electrode plate for electrochemical element, method for manufacturing electrode plate for electrochemical element, and electrochemical element
JP2013137946A	2013-07-11	Nonaqueous electrolyte secondary battery
JP5582573B2	2014-09-03	Secondary battery and electrolyte for secondary battery used therefor
JP2011108643A	2011-05-19	Manufacturing method of anode for lithium ion battery, and lithium ion battery

Priority And Related Applications

Priority Applications (3)

Application	Priority date	Filing date	Title
JP2010230065A	2010-10-12	2010-10-12	Nonaqueous electrolyte secondary battery
US13/232,562	2010-10-12	2011-09-14	Non-aqueous electrolyte secondary battery
CN201110296174.3A	2010-10-12	2011-09-27	Non-aqueous electrolyte secondary battery

Applications Claiming Priority (1)

Application	Filing date	Title
JP2010230065A	2010-10-12	Nonaqueous electrolyte secondary battery

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
nonaqueous electrolyte		title,claims,abstract,description	55	0.000
copper foil		claims,abstract,description	37	0.000
copper-silicon		claims,abstract,description	37	0.000
alloy		claims,abstract,description	34	0.000
alloy		claims,abstract,description	34	0.000
aluminium(3+)		claims,abstract,description	34	0.000
foil		claims,abstract,description	28	0.000
winding		claims,abstract,description	25	0.000
Cu alloy		claims,abstract,description	24	0.000
silicon-based active material		claims,abstract,description	19	0.000
active material		claims,abstract,description	15	0.000
Si alloy		claims,abstract,description	14	0.000
welding		claims,description	38	0.000
Plasma		claims,description	17	0.000
Dexamethasone		claims,description	6	0.000
silicon		abstract,description	46	0.000
silicon		abstract,description	46	0.000

silicon	abstract,description	46	0.000
partial	abstract,description	28	0.000
separation method	abstract	1	0.000

Show all concepts from the description section

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H01M	***4/38***	***(2006.01)***	H01M	4/38	Z	
H01M	***4/587***	***(2010.01)***	H01M	4/587		
H01M	***4/36***	***(2006.01)***	H01M	4/36	E	
H01M	***4/133***	***(2010.01)***	H01M	4/133		

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(22)出願日　平成26年7月8日 (2014.7.8)

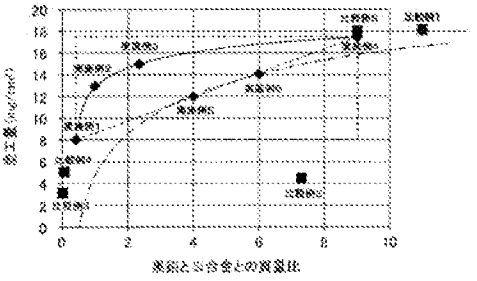
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最終頁に続く

(54)【発明の名称】リチウムイオン二次電池

(57)【要約】
【課題】負極にＳｉ合金を適用したリチウムイオン二次電池において、塗工量を多くして初期容量を高め、かつ、容量維持率を向上する。
【解決手段】正極活物質を含む正極と、負極活物質、導電助材及びバインダを含む負極活物質合材を負極集電体の表面に塗工して得た負極と、正極と負極との間に配置されたセパレータと、電解質と、を備えたリチウムイオン二次電池において、負極活物質は、黒鉛とＳｉ合金とを含み、黒鉛とＳｉ合金との質量比をｘとし、負極活物質合材の塗工量をｙ（ｍｇ／ｃｍ^2）としたとき、０．４３≦ｘ≦９．０、かつ、８≦ｙ＜１８を満たす。
【選択図】図３

図３



【特許請求の範囲】
【請求項１】
正極活物質を含む正極と、負極活物質、導電助材及びバインダを含む負極活物質合材を負極集電体の表面に塗工して得た負極と、前記正極と前記負極との間に配置されたセパレータと、電解質と、を備え、
前記負極活物質は、黒鉛とＳｉ合金とを含み、
前記黒鉛と前記Ｓｉ合金との質量比をｘとし、前記負極活物質合材の塗工量をｙ（ｍｇ／ｃｍ^2）としたとき、０．４３≦ｘ≦９．０、かつ、８≦ｙ＜１８を満たすことを特徴とするリチウムイオン二次電池。
【請求項２】
前記ｘとｙとの関係は、下記式（１）を満たす、請求項１記載のリチウムイオン二次電池。
ｙ≦－４．２９ｘ$^{-1}$＋１７．９８　　…式（１）
【請求項３】
前記ｘとｙとの関係は、下記式（２）を満たす、請求項１又は２に記載のリチウムイオン二次電池。
ｙ≧１．１１ｘ＋７．５　　…式（２）
【請求項４】
前記ｘとｙとの関係は、下記式（３）を満たす、請求項１記載のリチウムイオン二次電池。
ｙ＜１．１１ｘ＋７．５　　…式（３）
【請求項５】
前記ｘは、０．６≦ｘ≦２．０を満たす、請求項１～４のいずれか一項に記載のリチウムイオン二次電池。
【請求項６】
１Ｃ放電容量を０．２Ｃ放電容量で除して算出した値を容量維持率と定義したとき、前記負極の前記容量維持率は、前記正極の前記容量維持率以上である、請求項１記載のリチウムイオン二次電池。
【請求項７】
前記Ｓｉ合金は、Ｓｉと、Ａｌ、Ｎｉ、Ｃｕ、Ｆｅ、Ｔｉ及びＭｎからなる群から選択される１種類以上の元素と、を含む、請求項１～６のいずれか一項に記載のリチウムイオン二次電池。
【請求項８】
前記Ｓｉ合金の組成は、原子数比で５０～９０％である、請求項７記載のリチウムイオン二次電池。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、リチウムイオン二次電池に関する。
【背景技術】
【０００２】
近年、高エネルギー密度を有する二次電池として、特にリチウムイオン二次電池が着目され、その研究、開発及び商品化が急速に進められている。現在では、携帯電話やノートパソコン向けに小型民生用リチウムイオン二次電池が幅広く普及している。さらに、地球温暖化、枯渇燃料、脱原発などの問題から、家庭用、産業用、車載用などの蓄電池として、従来用よりも高容量の大型二次電池が求められている。
【０００３】
従来、リチウムイオン二次電池の高容量化策としては、負極材料にケイ素（Ｓｉ）やＳｉを含む化合物を適用することや電極塗工量を多くすることが知られている。しかし、Ｓｉは、粉体抵抗が黒鉛より２桁高いため、レート特性に課題がある。また、サイクル寿命

に課題があるため、電極塗工量を多くする検討がなされていない。
【０００４】
特許文献１には、リチウム二次電池の初期充放電容量を大きくし、かつ、充放電サイクル特性を向上するために、黒鉛粒子、Ｓｉ微粒子及び非晶質炭素（Ａ）を含む複合粒子の表面に、黒鉛又はカーボンブラックから選ばれる少なくとも一種以上を含む炭素質物質粒子が配置されるとともに、該炭素質物質粒子が非晶質炭素（Ｂ）によって被覆されているリチウム二次電池用負極材料を用いることが記載されている。上記構成により、充放電時のＳｉ微粒子の体積変化を緩和し、活物質の電気的接触を維持して、充放電サイクル特性を改善することが可能となる。
【先行技術文献】
【特許文献】
【０００５】
【特許文献１】特開２００８－２７７２３２号公報
【発明の概要】
【発明が解決しようとする課題】
【０００６】
しかしながら、さらなる高容量化のためには，さらにＳｉの混合割合を多く、かつ，塗工量を多くする必要がある。また、Ｓｉの混合量、塗工量を多くすると、高容量化が達成されるものの、容量維持率が低下する。
【０００７】
本発明の目的は、負極にＳｉ合金を適用し、初期容量を高め、かつ、容量維持率を向上したリチウムイオン二次電池を提供することにある。
【課題を解決するための手段】
【０００８】
本発明は、正極活物質を含む正極と、負極活物質、導電助材及びバインダを含む負極活物質合材を負極集電体の表面に塗工して得た負極と、正極と負極との間に配置されたセパレータと、電解質と、を備えたリチウムイオン二次電池であって，負極活物質は、黒鉛とＳｉ合金とを含み、黒鉛とＳｉ合金との質量比をｘとし、負極活物質合材の塗工量をｙ（ｍｇ／ｃｍ^2）としたとき、０．４３≦ｘ≦９．０、かつ、８≦ｙ＜１８を満たすことを特徴とする。
【発明の効果】
【０００９】
本発明によれば、負極にＳｉ合金を適用したリチウムイオン二次電池において，塗工量を多くして初期容量を高め、かつ、容量維持率を向上することができる。
【図面の簡単な説明】
【００１０】
【図１】一実施形態のリチウムイオン二次電池を示す模式断面図である。
【図２】Ｓｉ合金と黒鉛との質量比に対する負極容量を示すグラフである。
【図３】黒鉛とＳｉ合金との質量比に対する塗工量と、その容量維持率，負極容量を示すグラフである。
【発明を実施するための形態】
【００１１】
本発明者は、鋭意検討した結果、負極にＳｉ合金を適用した場合に、Ｓｉ合金と黒鉛との質量比、及び負極活物質合材の塗工量を適切な範囲とすることが有効であることを見出した。
【００１２】
負極活物質における黒鉛粒子とＳｉ合金粒子とは、質量比で３０：７０～９０：１０の範囲とする。即ち，黒鉛の質量をＳｉ合金の質量で割った値（黒鉛質量／Ｓｉ合金質量）が０．４３～９．０の範囲とする（以下、この値を黒鉛とＳｉ合金との質量比ｘという。）。また、負極における負極活物質合材の塗工量は，正極の容量と負極の容量が等しくな

るようにするとともに、その塗工量ｙ（ｍｇ／ｃｍ^2）が、８～１８ｍｇ／ｃｍ^{2}とする。その結果、初期容量を高め、かつ、容量維持率を向上させることが可能となる。

【００１３】

特に、ｘとｙとの関係は、ｙ≦－４．２９ｘ$^{-1}$＋１７．９８であると、高レート特性となり好ましい。さらに、負極活物質合材の塗工量ｙが、ｙ≧１．１１ｘ＋７．５となるように調整すると、更に高容量が達成でき好ましい。

【００１４】

（リチウムイオン二次電池の構成）

以下、図１を参照して、リチウムイオン二次電池の一実施形態について説明する。

【００１５】

リチウムイオン二次電池２０は、正極板１（正極）及び負極板２（負極）がセパレータ３を介して捲回された電極群Ｇ並びにニッケルメッキが施されたスチール製で有底円筒状の電池缶４を備えている。電極群Ｇは、電池缶４に収容されている。

【００１６】

電極群Ｇの上側には、捲回中心のほぼ延長線上に正極板１からの電位を集電するためのアルミニウム製の正極集電リード部７が配されている。正極集電リード部７には、正極板１から導出された正極集電リード片５の端部が超音波接合されている。正極集電リード部７の上方には、正極外部端子となる円盤状の電池蓋９が配置されている。

【００１７】

電池蓋９は、スチール製の円盤状で中央部が上方に向けて突出した端子板と、アルミニウム製の円環状で中央部にガス排出用の開口が形成された平板とで構成されている。端子板の突出部と平板との間には、円環状の正極端子部１１が配されている。正極端子部１１は上面および下面がそれぞれ端子板の下面および平板の上面に接触している。正極端子部１１の内径は、平板に形成された開口の内径より大きく形成されている。平板の開口の上側には、電池内圧の上昇時に開裂する破裂弁１０が開口を塞ぐように配されている。破裂弁１０の周縁部は、正極端子部１１の内縁部下面と平板とで挟まれている。端子板の周縁部と、平板の周縁部とが固定されている。平板の下面、すなわち、電池蓋９の底面（電極群Ｇ側の面）には、正極集電リード部７の上面が抵抗溶接で接合されている。

【００１８】

一方、電極群Ｇの下側には負極板２からの電位を集電するためのニッケル製の負極集電リード部８が配置されている。負極集電リード部８には、負極板２から導出された負極集電リード片６の端部が超音波接合されている。負極集電リード部８は、負極外部端子を兼ねる電池缶４の内底部に抵抗溶接で接合されている。

【００１９】

また、電池缶４内には、非水電解液が注液されている。非水電解液には、本例では、エチレンカーボネート（ＥＣ）とエチルメチルカーボネート（ＥＭＣ）との体積比１：２の混合有機溶媒中に６フッ化リン酸リチウム（ＬｉＰＦ$_6$）を１モル／リットルの濃度になるように溶解させたものが用いられている。電池缶４の上部には、電池蓋９がガスケット１２を介してカシメ固定されている。このため、リチウムイオン二次電池２０の内部は密封されている。

【００２０】

電池缶４内に収容された電極群Ｇは、正極板１と負極板２とが、例えばポリエチレン製等の微多孔性のセパレータ３を介して正極板１、負極板２が互いに接触しないように捲回されている。正極集電リード片５と負極集電リード片６とはそれぞれ、電極群Ｇの互いに反対側の両端面に配されている。電極群Ｇの外周面全周には、電池缶４との電気的接触を防止するために絶縁被覆が施されている。

【００２１】

正極板１は、正極集電体との両面に、正極活物質を含む正極合材が略均等に塗着されている。リチウムイオン二次電池の正極活物質には従来使用されている種々のリチウム遷移金属複合酸化物を用いることができる。たとえば、ニッケル酸リチウム、コバルト酸リチ

ウム、マンガン酸リチウムなどの正極活物質のＮｉ、Ｃｏ、Ｍｎなどの一部を１種あるいはそれ以上の遷移金属で置換して用いることができる。

【００２２】

正極活物質合材には、正極活物質以外に、導電材およびバインダ（結着材）を用いる。導電材としては黒鉛などの炭素材料、バインダとしてはポリフッ化ビニリデン（以下、ＰＶＤＦと略記する。）など、従来使用されているものを適宜使用できる。

【００２３】

例えば、正極集電体として厚さ２０μｍのアルミニウム箔、正極活物質としてリチウム含有遷移金属複酸化物の$LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$を用い、正極活物質、黒鉛及びＰＶＤＦの配合割合が、９０：５：５の重量比に調整された正極合材を両面に塗布して正極を作製する。

【００２４】

一方、負極板２は、負極集電体の両面に，負極活物質を含む負極合材が略均等に塗着されている。合材の塗工層を形成するには、負極活物質としてのＳｉ合金粒子及び天然黒鉛粒子に加えて，バインダと導電助剤とを溶媒中に分散した負極活物質合材を作製し、これを負極集電体の表面に塗工する。バインダとしては、ポリアミドイミド、ポリイミド若しくはポリアミド等、又はこれらを１種類以上含むものを使用できる。

【００２５】

負極活物質としては、天然黒鉛及びＳｉ合金の混合物を用いている。黒鉛は、適宜好ましいものを選択でき、天然黒鉛は安価であって好ましい。

【００２６】

Ｓｉ合金は，通常、複数の相が混在する微細構造を有する。言い換えると、Ｓｉ合金は，ケイ素（Ｓｉ）の微細な粒子が他の構成元素の各粒子中に分散された状態、又は他の構成元素がＳｉの各粒子中に分散された状態となっている。他の構成元素は、Ａｌ、Ｎｉ、Ｃｕ、Ｆｅ、Ｔｉ及びＭｎのいずれか１種類以上を含むものであればよい。Ｓｉ合金の作製方法としては、メカニカルアロイ法により機械的に合成する方法，またはＳｉ粒子と他の構成元素との混合物を加熱し、冷却する方法がある。

【００２７】

Ｓｉ合金の組成は、Ｓｉと他の構成元素との原子数比で５０：５０～９０：１０が望ましい。言い換えると、Ｓｉ合金中のＳｉの割合は，原子数比で５０～９０％であることが望ましい。当該原子数比は、６０：４０～８０：２０が更に望ましい。

【００２８】

（電池組立）

以下，リチウムイオン二次電池２０の製造工程について説明する。

【００２９】

作製した正極板１と負極板２とを１００℃で２４時間真空乾燥させ、正極板１と負極板２との間にセパレータ３を挟み込み、これらを捲回することにより、電極群Ｇを作製する。このとき，正極板１と負極板２とが適切に対向し、かつ、正極集電リード片５と負極集電リード片６とが互いに反対方向に位置するように捲回することが好ましい。

【００３０】

つぎに、正極集電リード片５の全てを正極集電リード部７に超音波接合し、負極集電リード片６の全てを負極集電リード部８に超音波接合する。その後，電極群Ｇの周囲に絶縁被覆を施し、正極集電リード部７及び負極集電リード部８が接続された電極群Ｇを、負極集電リード部８を底側に向けて電池缶４内に挿入する。

【００３１】

電極群Ｇの捲回中心部分に電極棒を通し、負極集電リード部８と電池缶４の内底部とを抵抗溶接した後、正極集電リード部７と電池蓋９とを抵抗溶接で接合する。そして，電池缶４内に非水電解液を注液した後、電池缶４にガスケット１２を介して電池蓋９をカシメ固定することにより、電池容量が１Ａｈ級のリチウムイオン二次電池２０を完成させる。

【実施例】

【００３２】
以下、実施例について説明する。
【００３３】
負極集電体として厚さ１０μｍの銅箔を用い、負極活物質、導電助材及びバインダの質量比は、９３：２：５とした負極合材を両面に塗布して負極を作製した。負極活物質は、天然黒鉛及びＳｉ合金の混合物である。天然黒鉛は、Ｘ線回折（ＸＲＤ）の測定をした結果、炭素六角網面層の層間距離ｄ（００２）は０．３３５ｎｍであり、結晶子サイズは、六角網面積層方向Ｌｃ（００２）が１２０ｎｍ以上、炭素六角網面方向Ｌａ（１１０）が１１０ｎｍ以上であった。Ｓｉ合金は、組成式$Si_{70}Ti_{10}Fe_{10}Al_{30}$で表されるものを、Ｓｉと他の金属との混合、メカニカルアロイ法により作製した。バインダとしてはポリアミドイミドを用い、導電助材としてはアセチレンブラックを用いた。負極活物質、導電助材及びバインダの質量比は、９３：２：５とした。また、溶媒としてはＮ－メチルピロリドン（ＮＭＰ）を用い、その量により粘度調整を行った。
【００３４】
負極集電体の表面に形成した塗工層を乾燥した後、ロールプレス装置により負極活物質合材層の密度が２．３ｇ／ｃｍ^{3}となるようにロールプレスした。負極活物質合材層の密度は、通常のロールプレスにより到達し得る最大値である。その後、ポリアミドイミドを硬化させるために２５０℃で乾燥した。
【００３５】
天然黒鉛及びＳｉ合金の混合比、及び負極活物質合材層の塗工量を変更し、種々の負極を作製した。一般に、塗工量が多くなるに従って、容量維持率が低下する一方、塗工量が少ない場合、容量維持率は高くなるが、負極容量が低下する。また、黒鉛の比率を高くするほど塗工量を増やすことが可能であるが、黒鉛の割合が大きくなりすぎると、塗工量はほぼ一定となるため好ましくない。一方、Ｓｉの比率を高くするほど、塗工量を減らさねばならず，電極密度が低下する。
【００３６】
表１は、実施例１～６及び比較例１～５の負極材料を構成する黒鉛及びＳｉ合金の割合並びに負極活物質合材の塗工量を示したものである。
【００３７】

【表１】

表 1

負極材料	黒鉛(質量%)	Si合金(質量%)	塗工量 y (mg/cm²)
実施例1	30	70	8
実施例2	50	50	13
実施例3	70	30	15
実施例4	90	10	17.5
実施例5	86	14	14
実施例6	80	20	12
比較例1	100	0	18
比較例2	88	12	4.5
比較例3	0	100	3.3
比較例4	0	100	5
比較例5	90	10	18

【００３８】
（負極容量及び容量維持率の測定）
実施例１～６及び比較例１～５の負極容量及びレート特性は、以下のように測定した。
【００３９】
作製した負極についてφ１６ｍｍのサイズに加工し、対極をＬｉとして負極容量を測定した。充放電条件は、０．２Ｃ相当の電流で電圧５ｍＶ、６時間の定電流定電圧充電とした。放電条件は、０．２Ｃ相当の放電電流で電圧１．５Ｖの定電流放電とした。このときの放電容量を負極容量（初期容量）とした。
【００４０】
負極容量を測定した後，１Ｃ放電容量を測定し、レート特性とした。ここて、充電条件は、０．２Ｃ相当の電流で電圧５ｍＶ、６時間の定電流定電圧充電とした。放電条件は、１Ｃ相当の放電電流で電圧１．５Ｖの定電流放電とした。このときの放電容量を０．２Ｃ容量（負極容量）で除し、容量維持率として算出した。
【００４１】
ここで、１Ｃは、１時間で電池容量の充電又は放電が終了する電流値であり、０．２Ｃは、５時間で電池容量の充電又は放電が終了する電流値である。実施例１～６及び比較例１～５の負極容量及び容量維持率の測定結果を表２に示す。
【００４２】

【表２】

表 2

	黒鉛質量/Si合金質量 x	塗工量 y (mg/cm²)	負極容量 (mAh)	容量維持率 (%)
実施例1	0.43	8	13.9	70
実施例2	1.00	13	19.6	70
実施例3	2.33	15	17.3	70
実施例4	9.00	17.5	14.6	70
実施例5	6.00	14	13.9	80
実施例6	4.00	12	13.4	80
比較例1	黒鉛のみ	18	12.6	70
比較例2	7.30	4.5	7.2	85
比較例3	Si合金のみ	3.3	5.3	70
比較例4	Si合金のみ	5	13.9	50
比較例5	9.00	18	15.5	55

【００４３】
（測定結果の検討）
実施例１～４は、黒鉛質量／Ｓｉ合金質量ｘを変化させるとともに、容量維持率が７０％となるように塗工量を調整したもの、実施例５及び６は、容量維持率が８０％となるように塗工量を調整したものである。実施例１～６は、比較例１と比して容量維持率を維持しながら、負極容量を大きくできる、すなわち１２．６ｍＡｈ以上とすることができた。
【００４４】
比較例１は、負極活物質を黒鉛のみ（Ｓｉ合金を用いない。）とした従来例である。塗工量は、容量維持率が７０％となるように調整したものであり、１８ｍｇ／ｃｍ^{2}とした例である。同様に、比較例３は、負極活物質をＳｉ合金のみ（黒鉛を用いない）とし、容量維持率が７０％となるように塗工量を３．３ｍｇ／ｃｍ^{2}に調整した例である。比較例４は、負極活物質をＳｉ合金のみとし、塗工量は、比較例３よりも多い５ｍｇ／ｃｍ^{2}とした例である。比較例５は、黒鉛／Ｓｉ合金質量（ｘ）の値が実施例４と等しく、塗工量を実施例４よりも多く、比較例１と同じ１８ｍｇ／ｃｍ^{2}とした例である。比較例２は、黒鉛／Ｓｉ合金質量（ｘ）の値は７．３とし、塗工量は、容量維持率が高くなるように４．５ｍｇ／ｃｍ^{2}とした例である。
【００４５】
以下、実施例と比較例とをグラフに表して比較し、本発明の望ましい範囲を明らかにする。
【００４６】
図２は、容量維持率が７０％の場合の混合比と負極容量の関係を示す図である。
【００４７】
比較例１は、実用化されている黒鉛負極（Ｓｉ合金と黒鉛との質量比が０）に対応する例である。実施例１～４のＳｉ合金／黒鉛質量（１／ｘ）が０．１～２．３の範囲で、黒鉛負極の容量維持率を７０％に維持しながら負極容量を向上させることができる。この領域外では、黒鉛負極の容量維持率を維持すると、負極容量が低下することとなり好ましくない。したがって、負極活物質の混合比は、黒鉛粒子は３０～９０質量％、Ｓｉ合金は１

０～７０質量％、黒鉛質量／Ｓｉ合金質量（ｘ）を０．４３～９．０とする必要がある。特に、Ｓｉ合金／黒鉛質量（１／ｘ）が０．５～１．７、黒鉛質量／Ｓｉ合金質量（ｘ）が０．６～２．０の範囲で高い負極容量を示し、好ましい。

【００４８】

図３に、黒鉛とＳｉ合金との質量比に対する塗工量を示す。横軸に黒鉛とＳｉ合金との質量比をとり、縦軸に塗工量をとっている。実施例を◆印で表し、比較例を■印で表している。

【００４９】

図３の実線の曲線を構成している実験データは、容量維持率が７０％である実施例１～４及び比較例１、一点鎖線の曲線を構成している実験データは、容量維持率が８０％である実施例５及び６のものである。これらの曲線は、塗工量の増大につれて容量維持率は低下するとともに、一定の容量維持率を達成するためには、黒鉛の比率が低い場合に塗工量を少なくする必要があることを意味する。

【００５０】

塗工量の増大につれて容量維持率は低下するため、高容量維持率を達成するためには塗工量が少ない方が望ましい。塗工量増加によるデメリットを回避するため、塗工量ｙは比較例１の塗工量（１８ｍｇ／ｃｍ^2）未満とする必要がある。一方、塗工量を減らすと容量が低下する。比較例１の場合の容量よりも高容量化するため、少なくとも塗工量ｙを８ｍｇ／ｃｍ^{2}以上とする必要がある。

【００５１】

特に、容量維持率７０％以上を達成するためには、実線の曲線の下側に塗布量を設定することが好ましく、黒鉛とＳｉ合金との質量比をｘとし、塗工量をｙとしたとき、この曲線の近似式より、

$y \leqq -4.29x^{-1} + 17.98$　　…式（１）

とすることが好ましい。

【００５２】

また、高容量維持率を達成する場合であっても、黒鉛の比率が高い場合には合材重量当たりの容量が低く、黒鉛の比率が低い場合には塗工量が少なく、結果的に負極容量が低下する。実施例１、５、６、４は、負極容量が１４ｍＡｈ近傍で、ほぼ同等の値である。高容量の達成のためには、塗工量がこの直線よりも多くなることが好ましい。当該斜辺の近似式より、高容量達成に望ましい塗工量ｙは、下記式（２）で表される。

【００５３】

$y \geqq 1.11x + 7.5$　　…式（２）

また、同様に、実施例１、５、６、４で形成される斜辺の下側の領域とすることで、高容量が維持されるとともに、高レート特性が達成可能である。上述の通り、当該斜辺の近似式より、高レート特性達成に望ましい塗工量ｙは、下記式（３）で表される。

【００５４】

$y < 1.11x + 7.5$　　…式（３）

本発明によれば、レート特性を維持しながら塗工量を最大限多くすることができるため、初期容量を向上させることができる。

【００５５】

また、上述のとおり、Ｓｉ合金を用いた負極の容量維持率を高くすることができるため、負極の容量維持率が正極の容量維持率以上となるような構成とすることにより、放電時に負極の電位が大きく上昇することなく（すなわち、過放電がなく）、負極の電位が銅の溶出する電位である３．３Ｖ以上とならないため、負極集電体を構成するＣｕの溶出を抑制することができる。これにより、リチウムイオン二次電池の安全性を向上することができる。

【符号の説明】

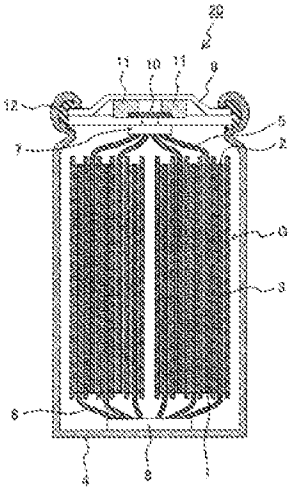
【００５６】

１：正極板、２：負極板、４：電池缶、９：電池蓋、２０：円筒型リチウムイオン二次

電池。

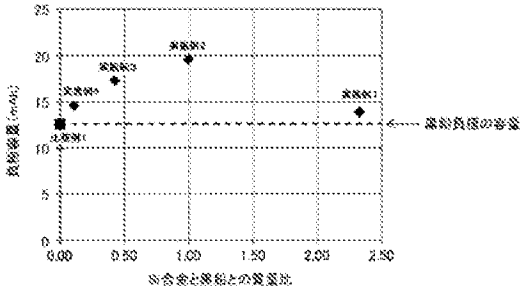
【図１】

図１



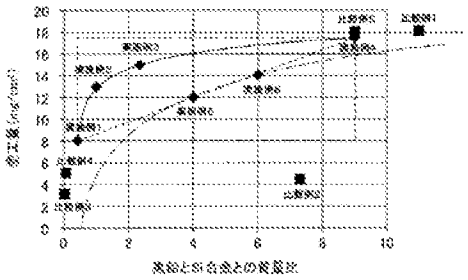
【図２】

図２



【図３】

図３



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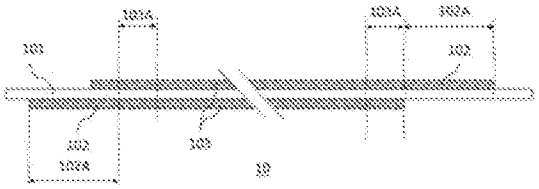
权利要求书2页 说明书10页 附图1页

(54)发明名称

负极和包含所述负极的电化学装置及电子装置

(57)摘要

本申请涉及负极及包含所述负极的电化学装置及电子装置。所述负极包括：负极集流体、第一负极活性材料层以及第二负极活性材料层。所述第一负极活性材料层单面设置在所述负极集流体的第一部分，且所述第二负极活性材料层双面设置在所述负极集流体的不同于所述第一部分的第二部分，其中所述第一负极活性材料层与所述第二负极活性材料层在所述负极集流体上的单位面积重量的比值为0.47至0.52，且所述第一负极活性材料层与所述第二负极活性材料层的压实密度的比值为0.9至1.1。通过采用上述负极能够从负极结构方向改善电化学装置的极化和析锂，从而提升电化学装置的循环性能和安全性能。



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1.一种负极，其包括：

负极集流体；

第一负极活性材料层，所述第一负极活性材料层单面设置在所述负极集流体的第一部分；以及

第二负极活性材料层，所述第二负极活性材料层双面设置在所述负极集流体的不同于所述第一部分的第二部分，

其中所述第一负极活性材料层与所述第二负极活性材料层在所述负极集流体上的单位面积重量的比值为0.47至0.52，且所述第一负极活性材料层与所述第二负极活性材料层的压实密度的比值为0.9至1.1。

2.根据权利要求1所述的负极，其中所述第一负极活性材料层和所述第二负极活性材料层各自独立地包含硅基材料及石墨，其中所述硅基材料选自由氧化硅、硅碳及其组合所组成的群组。

3.根据权利要求2所述的负极，其中所述第一负极活性材料层和所述第二负极活性材料层中所述硅基材料的重量以所述硅基材料及所述石墨的总重量计为大于或等于5%且小于100%。

4.根据权利要求2所述的负极，其中所述硅基材料的型态包括晶态、非晶态或其组合，其中所述第一负极活性材料层的颗粒度Dv50为8.0μm至20μm，且所述第二负极活性材料层的颗粒度Dv50为8.0μm至20μm。

5.根据权利要求2至4中任一权利要求所述的负极，其中所述硅基材料在拉曼光谱中，在500cm^{-1}±10cm^{-1}的波数上的峰高度与在1350cm^{-1}±10cm^{-1}的波数上的峰高度的比值大于0。

6.根据权利要求2至4中任一权利要求所述的负极，其中所述硅基材料进一步包含碳包覆层。

7.根据权利要求2至4中任一权利要求所述的负极，其中所述第一负极活性材料层和所述第二负极活性材料层各自独立地包含粘结剂及导电剂，其中所述粘结剂包括选自由聚丙烯酸酯、聚酰亚胺、聚酰胺、聚酰胺酰亚胺、聚偏氟乙烯、丁苯橡胶、海藻酸钠、聚乙烯醇、聚四氟乙烯、聚丙烯腈、羧甲基纤维素钠、羧甲基纤维素钾及其组合所组成的群组，且所述导电剂包括选自由导电炭黑、乙炔黑、科琴黑、石墨烯及其组成所组成的群组。

8.根据权利要求7所述的负极，其中，以所述第一负极活性材料层的总重量计，所述第一负极活性材料层中的所述硅基材料及所述石墨的总重量为94%～96%，所述粘结剂的重量为2.8%至4.0%，且所述导电剂的重量为0.4%至1.6%；以及

以所述第二负极活性材料层的总重量计，所述第二负极活性材料层中的所述硅基材料及所述石墨的总重量为94%～96%，所述粘结剂的重量为2.8%至4.0%，且所述导电剂的重量为0.4%至1.6%。

9.根据权利要求1所述的负极，其中所述第一负极活性材料层的厚度为40μm至60μm，且所述第二负极活性材料层的单层厚度为40μm至60μm。

10.一种电化学装置，其包括：

正极；

隔离膜；以及

根据权利要求1至9中任一项所述的负极。

11.一种电子装置,其包含权利要求10所述的电化学装置。

负极和包含所述负极的电化学装置及电子装置

技术领域

[0001] 本申请涉及储能技术领域，尤其涉及负极以及包括所述负极的电化学装置及电子装置。

背景技术

[0002] 随着移动电子技术的高速发展，人们使用诸如手机、平板、笔记本电脑、无人机等的移动电子装置的频率和体验要求越来越高。因此，为电子装置提供能源的电化学装置(例如，锂离子电池)需要表现出更高的能量密度、更大的倍率、更高的安全性以及在反复充放电过程后更小的容量衰减。

[0003] 锂离子电池在循环过程中由于负极的极化导致锂金属的析出，是损害锂离子电池的循环性能的其中一个主要原因。有鉴于此，需要降低负极在电池循环过程中的极化，而对负极结构作进一步的研究及优化是其中一个可行的解决方案。

发明内容

[0004] 本申请提供一种负极和包含所述负极的电化学装置及电子装置以试图在至少某种程度上解决至少一个存在于相关领域中的问题。

[0005] 根据本申请的一个方面，本申请提供了一种负极，所述负极包括：负极集流体、第一负极活性材料层以及第二负极活性材料层。所述第一负极活性材料层单面设置在所述负极集流体的第一部分，且所述第二负极活性材料层双面设置在所述负极集流体的不同于所述第一部分的第二部分，其中所述第一负极活性材料层与所述第二负极活性材料层在所述负极集流体上的单位面积重量的比值K为约0.47至0.52，且所述第一负极活性材料层与所述第二负极活性材料层的压实密度的比值R为约0.9至1.1。

[0006] 根据本申请的另一个方面，本申请提供了一种电化学装置，其包括：正极、隔离膜以及上述负极。

[0007] 根据本申请的另一个方面，本申请提供了一种电子装置，所述电子装置包含上述的电化学装置。

[0008] 本申请实施例的额外层面及优点将部分地在后续说明中描述、显示、或是经由本申请实施例的实施而阐释。

附图说明

[0009] 在下文中将简要地说明为了描述本申请实施例或现有技术所必要的附图以便于描述本申请的实施例。显而易见地，下文描述中的附图仅只是本申请中的部分实施例。对本领域技术人员而言，在不需要创造性劳动的前提下，依然可以根据这些附图中所例示的结构来获得其他实施例的附图。

[0010] 图1为本申请实施例的负极的结构示意图。

[0011] 图2为硅基材料与石墨的混合而成的负极活性材料冷压前后的示意图。

[0012] 图3为本申请实施例4与对比例2的循环容量曲线图。

具体实施方式

[0013] 本申请的实施例将会被详细的描示在下文中。在本申请说明书全文中，将相同或相似的组件以及具有相同或相似的功能的组件通过类似附图标记来表示。在此所描述的有关附图的实施例为说明性质的、图解性质的且用于提供对本申请的基本理解。本申请的实施例不应该被解释为对本申请的限制。

[0014] 如本文中所使用，术语“大致”、“大体上”、“实质”及“约”用以描述及说明小的变化。当与事件或情形结合使用时，所述术语可指代其中事件或情形精确发生的例子以及其中事件或情形极近似地发生的例子。举例来说，当结合数值使用时，术语可指代小于或等于所述数值的±10％的变化范围，例如小于或等于±5％、小于或等于±4％、小于或等于±3％、小于或等于±2％、小于或等于±1％、小于或等于±0.5％、小于或等于±0.1％、或小于或等于±0.05％。举例来说，如果两个数值之间的差值小于或等于所述值的平均值的±10％(例如小于或等于±5％、小于或等于±4％、小于或等于±3％、小于或等于±2％、小于或等于±1％、小于或等于±0.5％、小于或等于±0.1％、或小于或等于±0.05％)，那么可认为所述两个数值“大体上”相同。

[0015] 在本说明书中，除非经特别指定或限定之外，相对性的用词例如：“中央的”、“纵向的”、“侧向的”、“前方的”、“后方的”、“右方的”、“左方的”、“内部的”、“外部的”、“较低的”、“较高的”、“水平的”、“垂直的”、“高于”、“低于”、“上方的”、“下方的”、“顶部的”、“底部的”以及其衍生性的用词(例如“水平地”、“向下地”、“向上地”等等)应该解释成引用在讨论中所描述或在附图中所描示的方向。这些相对性的用词仅用于描述上的方便，且并不要求将本申请以特定的方向建构或操作。

[0016] 另外，有时在本文中以范围格式呈现量、比率和其它数值。应理解，此类范围格式是用于便利及简洁起见，且应灵活地理解，不仅包含明确地指定为范围限制的数值，而且包含涵盖于所述范围内的所有个别数值或子范围，如同明确地指定每一数值及子范围一般。

[0017] 在具体实施方式及权利要求书中，由术语“中的至少一者”、“中的至少一个”、“中的至少一种”或其他相似术语所连接的项目的列表可意味着所列项目的任何组合。例如，如果列出项目A及B，那么短语“A及B中的至少一者”意味着仅A；仅B；或A及B。在另一实例中，如果列出项目A、B及C，那么短语“A、B及C中的至少一者”意味着仅A；或仅B；仅C；A及B(排除C)；A及C(排除B)；B及C(排除A)；或A、B及C的全部。项目A可包含单个元件或多个元件。项目B可包含单个元件或多个元件。项目C可包含单个元件或多个元件。

[0018] 在现有技术中，为了追求最佳的能量密度，以及制备工艺上的稳定及简便，对卷绕式的电极组件会采用在极片的中间部分双面设置活性材料并在极片的端部单面设置活性材料的设计。参考图1，由于制备工艺上的限制，现有技术中的锂离子电池的锂金属往往会在负极活性材料的单面设置的区域102A以及双面设置的区域与其相邻的区域(占整个负极活性材料层涂布区域10％面积的区域)103A析出(下文中，术语“析锂”为锂金属的析出)。

[0019] 同时，替换具有更高克容量的负极活性材料也是提高能量密度的一个办法，其中硅具有高的理论克容量(4200mAh/g)，在锂离子电池中的应用有着广阔的前景。但硅基材料在充放电循环过程中，由于导电性差，锂离子嵌入和脱出时容易在负极表面聚集造成析锂。

同时，由于硅基材料的受热膨胀率高，当采用中间部分双面设置活性材料并在负极的端部单面设置活性材料的负极设计时，更容易导致单面设置的区域与双面设置的区域的交界处受热变形，进而加剧析锂。析锂代表锂离子电池中锂离子的损失，造成电池容量损失，并加速循环衰减，使得锂离子电池的循环性能降低。另外，析锂可能会造成正极的锂离子过量脱出以补充损失的锂离子，进而破坏正极结构。

[0020] 本申请通过调控单双面活性材料层的设置重量以及冷压过程中单双面活性材料层的压实密度比例，从负极结构方向改善极化和析锂，提升锂离子电池的循环性和安全性。

[0021] 图1为本申请实施例的负极的结构示意图。

[0022] 根据本申请的一个方面，本申请提供了一种负极10，其包括：负极集流体101、第一负极活性材料层102及第二负极活性材料层103，所述第一负极活性材料层102单面设置在所述负极集流体10的第一部分；以及第二负极活性材料层103，所述第二负极活性材料层103双面设置在所述负极集流体10的不同于所述第一部分的第二部分，其中所述第一负极活性材料层102与所述第二负极活性材料层103在所述负极集流体10上的单位面积重量的比值K为约0.47至约0.52，且所述第一负极活性材料层102与所述第二负极活性材料层103的压实密度的比值R为约0.9至约1.1。

[0023] 在另一些实施例中，所述第一负极活性材料层102与所述第二负极活性材料层103在所述负极集流体10上的单位面积重量的比值为约0.5，且所述第一负极活性材料层与所述第二负极活性材料层的压实密度的比值为约0.97至约1.0。

[0024] 在循环过程中，当负极活性材料层在负极集流体上的单位面积重量不一致，会造成具有不同单位面积重量的活性材料层分布的电流密度不均匀，负极电流密度不均匀时，会造成锂离子的滞留情况不一样，电流密度大则锂离子传输受限的情况下更容易在表面滞留，造成析锂。当第一负极活性材料层102与所述第二负极活性材料层103在所述负极集流体10上的单位面积重量越一致时，能够保持负极的电流密度分布，进而降低析锂的状况。

[0025] 在本文中，术语“压实密度”为单位面积集流体上的活性材料的重量除以冷压后活性材料层在集流体表面垂直方向上的总厚度。

[0026] 图2为硅基材料与石墨的混合而成的负极活性材料冷压前后的示意图。

[0027] 如图2所示，硅基材料与石墨的混合而成的负极活性材料在冷压前通过X射线衍法测定后110晶面衍射峰的强度C110较高，代表冷压前的负极活性材料的晶体结构排列呈110晶面。而在冷压后，随著压实密度越来越高则负极活性材料通过X射线衍法测定后004晶面衍射峰的强度C004也随著增加，代表随著压实密度的提高负极活性材料的晶体结构排列也会逐渐倾向于004晶面。当负极活性材料的晶体结构排列呈004晶面时，锂离子嵌入与脱出的阻力较大。因此，负极活性物质层的压实密度越高，就越容易析锂。

[0028] 当第一负极活性材料层102与所述第二负极活性材料层103的压实密度越一致时，其在负极活性材料的单面设置的区域102A以及双面设置的区域与其相邻的区域103A处的析锂状况则越平均。因此，不容易造成负极活性材料的单面设置的区域102A或是双面设置的区域与其相邻的区域103A任何单一处大量的析锂，进而降低析锂的状况，并提升电化学装置的循环性能。

[0029] 在一些实施例中，所述第一负极活性材料层与所述第二负极活性材料层的压实密度各自独立的为约1.3g/cm^{3}至约2.0g/cm^3。

[0030] 在一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层各自独立地包含硅基材料及石墨，其中所述硅基材料选自由氧化硅、硅碳及其组合所组成的群组。在一些实施例中，氧化硅为通式SiO_x所代表，其中$0.5 \leq x \leq 1.6$。

[0031] 在一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层中所述硅基材料的重量以所述硅基材料及所述石墨的总重量计为大于或等于约5%且小于约100%。在另一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层中所述硅基材料的重量为约10%至约40%。在另一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层中所述硅基材料的重量为约15%。

[0032] 由于所述第一负极活性材料层与所述第二负极活性材料层的负极活性材料包含所述硅基材料和所述石墨。其中，所述硅基材料的Dv99较小，一般小于约20μm，但是石墨的Dv99较大，一般可达到约30μm以上，极片压实的厚度至少要比单颗颗粒的粒径要大，不然颗粒会被压碎，导致循环衰减加速。

[0033] 在一些实施例中，所述第一负极活性材料层与所述第二负极活性材料层的单层厚度各自独立的为约40μm至约60μm。在一些实施例中，所述第二负极活性材料层的总厚度为约80μm至约120μm。

[0034] 在一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层的颗粒度Dv50为约8.0μm至约20μm。在另一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层的颗粒度Dv50大致为，例如，约8.0μm、约9.0μm、约10.0μm、约12.0μm、约14.0μm、约16.0μm、约18.0μm、约20.0μm或这些数值中任意两者组成的范围。

[0035] 在一些实施例中，所述硅基材料的型态包括晶态、非晶态或其组合。

[0036] 在一些实施例中，所述硅基材料的颗粒度Dv50为约4.0μm至约10μm。在另一些实施例中，所述硅基材料的颗粒度Dv50大致为，例如，约4.0μm、约5.0μm、约6.0μm、约7.0μm、约8.0μm、约9.0μm、约10.0μm或这些数值中任意两者组成的范围。

[0037] 在一些实施例中，所述硅基材料进一步包含碳包覆层。

[0038] 在一些实施例中，所述硅基材料在拉曼光谱(Jobin Yvon LabRAM HR光谱仪，波长：532nm，测试范围：$50cm^{-1}$~$2000cm^{-1}$)中，在约$500cm^{-1} \pm 10cm^{-1}$的波数上的峰高度与在约$1350cm^{-1} \pm 10cm^{-1}$的波数上的峰高度的比值大于0。其中，在约$500cm^{-1}$处的波数上表现出的是硅的拉曼特征峰，在约$1350cm^{-1}$处的波数上是硅表面包覆层碳的特征峰。

[0039] 在一些实施例中，所述第一负极活性材料层和所述第二负极活性材料层各自独立地包含粘结剂及导电剂，其中所述粘结剂包括选自由聚丙烯酸酯、聚酰亚胺、聚酰胺、聚酰胺酰亚胺、聚偏氟乙烯、丁苯橡胶、海藻酸钠、聚乙烯醇、聚四氟乙烯、聚丙烯腈、羧甲基纤维素钠、羧甲基纤维素钾及其组合所组成的群组，且所述导电剂包括选自由导电炭黑、乙炔黑、科琴黑、石墨烯及其组成所组成的群组。

[0040] 应理解，本领域技术人员可以根据实际需要选择添加本领域任何常规的粘结剂或导电剂，而不受期限制。

[0041] 在一些实施例中，以所述第一负极活性材料层的总重量计，所述第一负极活性材料层中的所述硅基材料及所述石墨的总重量为约94%至约96%，所述粘结剂的重量为约2.8%至约4.0%，且所述导电剂的重量为约0.4%至约1.6%。

[0042] 在一些实施例中，以所述第二负极活性材料层的总重量计，所述第二负极活性材

料层中的所述硅基材料及所述石墨的总重量为约94%至约96%，所述粘结剂的重量为约2.8%至约4.0%，且所述导电剂的重量为约0.4%至约1.6%。

[0043] 在一些实施例中，本申请负极的制备方法包括以下步骤：

[0044] 取一定量的硅基材料与石墨，将其与粘结剂、导电剂按固定重量比混合后，融入去离子水中搅拌均匀。搅拌后，通过筛选得到混合浆料。其中，混合浆料的粘度为约2500mPa.S至约4000mPa.S之间，固含量为约35%至约50%。

[0045] 将混合浆料分别涂布于铜箔集流体上，其中单面涂布的部分的单位面积重量为约65g/m^{2}至约130g/m^2，双面涂布的部分的单位面积重量为约130g/m^{2}至约260g/m^2，并进行烘干。烘干后，进行冷压处理，以得到第一负极活性材料层与第二负极活性材料层其中第二负极活性材料层的压实密度为约1.3g/cm^{3}至约2.0g/cm^3，第一负极活性材料层与第二负极活性材料层的压实密度比例R为约0.9至约1.1，，随后通过裁切程序后得到负极。

[0046] 应理解，本申请实施例中的负极的制备方法中的各步骤，在不违背本申请的精神下，可以根据具体需要选择或替换本领域的其他的常规处理方法，而不受其限制。

[0047] 根据本申请的另一个方面，本申请的一些实施例还提供了包括本申请负极的电化学装置。在一些实施例中，所述电化学装置为锂离子电池。所述锂离子电池包括：上述实施例中的负极、隔离膜以及正极，隔离膜设置于正极与负极之间。

[0048] 在一些实施例中，所述正极集流体可以为铝箔或镍箔，所述负极集流体可为铜箔或镍箔，然而，可以采用本领域常用的其他正极集流体及负极集流体，而不受其限制。

[0049] 在一些实施例中，正极包括能够吸收和释放锂(Li)的正极材料(下文中，有时称为“能够吸收/释放锂Li的正极材料”)。能够吸收/释放锂(Li)的正极材料的实例可以包括钴酸锂、镍钴锰酸锂、镍钴铝酸锂、锰酸锂、磷酸锰铁锂、磷酸钒锂、磷酸钒氧锂、磷酸铁锂、钛酸锂和富锂锰基材料中的一种或多种。

[0050] 在上述正极材料中，钴酸锂的化学式可以为$Li_yCo_aM1_bO_{2-c}$，其中，M1表示选自镍(Ni)、锰(Mn)、镁(Mg)、铝(Al)、硼(B)、钛(Ti)、钒(V)、铬(Cr)、铁(Fe)、铜(Cu)、锌(Zn)、钼(Mo)、锡(Sn)、钙(Ca)、锶(Sr)、钨(W)、钇(Y)、镧(La)、锆(Zr)和硅(Si)中的至少一种，y、a、b和c值分别在以下范围内：0.8≤y≤1.2、0.8≤a≤1、0≤b≤0.2、-0.1≤c≤0.2；

[0051] 在上述正极材料中，镍钴锰酸锂或镍钴铝酸锂的化学式可以为$Li_zNi_dM2_eO_{2-f}$，其中，M2表示选自钴(Co)、锰(Mn)、镁(Mg)、铝(Al)、硼(B)、钛(Ti)、钒(V)、铬(Cr)、铁(Fe)、铜(Cu)、锌(Zn)、钼(Mo)、锡(Sn)、钙(Ca)、锶(Sr)、钨(W)、锆(Zr)和硅(Si)中的至少一种，z、d、e和f值分别在以下范围内：0.8≤z≤1.2、0.3≤d≤0.98、0.02≤e≤0.7、-0.1≤f≤0.2；

[0052] 在上述正极材料中，锰酸锂的化学式为$Li_zMn_{2-g}M3_gO_{4-h}$，其中M3表示选自钴(Co)、镍(Ni)、镁(Mg)、铝(Al)、硼(B)、钛(Ti)、钒(V)、铬(Cr)、铁(Fe)、铜(Cu)、锌(Zn)、钼(Mo)、锡(Sn)、钙(Ca)、锶(Sr)和钨(W)中的至少一种，z、g和h值分别在以下范围内：0.8≤z≤1.2、0≤g<1.0和-0.2≤h≤0.2。

[0053] 在一些实施例中，所述正极能够进一步包含粘结剂及导电剂中的至少一种。应理解，本领域技术人员可以根据实际需要选择本领域常规的粘结剂及导电剂，而不受其限制。

[0054] 在一些实施例中，隔离膜包括，但不限于，选自聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯、聚酰亚胺和芳纶中的至少一种。举例来说，聚乙烯包括选自高密度聚乙烯、低密度聚乙烯和超高分子量聚乙烯中的至少一种组分。尤其是聚乙烯和聚丙烯，它们对防止短路具

有良好的作用，并可以通过关断效应改善电池的稳定性。

[0055] 本申请的锂离子电池还包括电解质，所述电解质可以是凝胶电解质、固态电解质和电解液中的一种或多种，电解液包括锂盐和非水溶剂。

[0056] 在一些实施例中，所述锂盐选自$LiPF_6$、$LiBF_4$、$LiAsF_6$、$LiClO_4$、$LiB(C_6H_5)_4$、$LiCH_3SO_3$、$LiCF_3SO_3$、$LiN(SO_2CF_3)_2$、$LiC(SO_2CF_3)_3$、$LiSiF_6$、LiBOB和二氟硼酸锂中的一种或多种。举例来说，锂盐选用$LiPF_6$，因为它可以给出高的离子导电率并改善循环特性。

[0057] 所述非水溶剂可为碳酸酯化合物、羧酸酯化合物、醚化合物、其它有机溶剂或它们的组合。

[0058] 上述碳酸酯化合物可为链状碳酸酯化合物、环状碳酸酯化合物、氟代碳酸酯化合物或其组合。

[0059] 上述其它有机溶剂的实例为二甲亚砜、1,2-二氧戊环、环丁砜、甲基环丁砜、1,3-二甲基-2-咪唑烷酮、N-甲基-2-吡咯烷酮、甲酰胺、二甲基甲酰胺、乙腈、磷酸三甲酯、磷酸三乙酯、磷酸三辛酯、和磷酸酯及其组合。

[0060] 在一些实施例中，非水溶剂选自由碳酸乙烯酯、碳酸丙烯酯、碳酸二乙酯、碳酸二甲酯、碳酸甲乙酯、碳酸亚丙酯、醋酸甲酯、丙酸乙酯、氟代碳酸乙烯酯及其组合所组成的群组。

[0061] 应理解，本申请实施例中的负极、正极、隔离膜以及锂离子电池的制备方法，在不违背本申请的精神下，可以根据具体需要选择本领域任何合适的常规方法，而不受其限制。在制造电化学装置的方法的一个实施方案中，所述锂离子电池的制备方法包括：将上述实施例中的负极、隔离膜及正极按顺序卷绕、折叠或堆叠成电极组件，将所述电极组件装入例如铝塑膜中，并注入电解液，随后进行真空封装、静置、化成、整形等工序，以获得锂离子电池。

[0062] 虽然上面以锂离子电池进行了举例说明，但是本领域技术人员在阅读本申请之后，能够想到由本申请的负极可以用于其他合适的电化学装置。这样的电化学装置包括发生电化学反应的任何装置，它的具体实例包括所有种类的一次电池、二次电池、燃料电池、太阳能电池或电容。特别地，该电化学装置是锂二次电池，包括锂金属二次电池、锂离子二次电池、锂聚合物二次电池或锂离子聚合物二次电池。

[0063] 本申请的一些实施例进一步提供了一种电子装置，所述电子装置包含本申请实施例中的电化学装置。

[0064] 本申请实施例的电子装置没有特别限定，其可以是用于现有技术中已知的任何电子装置。在一些实施例中，所述电子装置可以包括，但不限于，笔记本电脑、笔输入型计算机、移动电脑、电子书播放器、便携式电话、便携式传真机、便携式复印机、便携式打印机、头戴式立体声耳机、录像机、液晶电视、手提式清洁器、便携CD机、迷你光盘、收发机、电子记事本、计算器、存储卡、便携式录音机、收音机、备用电源、电机、汽车、摩托车、助力自行车、自行车、照明器具、玩具、游戏机、钟表、电动工具、闪光灯、照相机、家庭用大型蓄电池和锂离子电容器等。

[0065] 具体实施例

[0066] 下面列举了一些具体实施例和对比例并分别对其负极进行单位重量及压实密度测试并对其电化学装置(锂离子电池)进行循环性能测试及析锂测试以更好地对本申请的

技术方案进行说明。

[0067] 一、测试方法

[0068] 激光粒度分析：

[0069] 激光粒度测试是根据不同大小的颗粒能使激光产生不同强度散射的原理来测试粒度分布的。表征颗粒粒度特性的主要指标有Dn10、Dv10、Dv50、Dv90、Dv99等等，其中，Dv50被称为颗粒度，表示样品在体积基准的粒度分布中，从小粒度算起、体积累积达到总体积50%时的粒度。本申请实施例及对比例采用Mastersizer 3000激光粒度分布测试仪分析样品的颗粒的粒度：将负极活性材料的样品分散在100mL的分散剂(去离子水)中，使遮光度达到8～12%、随后在超声强度为40KHz及180w下对样品进行超声处理5分钟。待超声处理后，将对样品进行激光粒度分布分析，得到粒度分布数据。

[0070] 单位重量及压实密度测试：

[0071] 从待测负极上的第一负极活性材料层与第二负极活性材料层沿负极集流体表面分别取得面积为1540.25mm^{2}的小圆片的活性材料样品。在去除负极集流体后，记录其负极活性材料的重量。每组取12处不同位置的活性材料样品，并计算第一负极活性材料层与第二负极活性材料层的单位面积重量。

[0072] 量测负极上的第一负极活性材料层与第二负极活性材料层在集流体表面垂直方向上的总厚度(去除集流体厚度)。每组取12处不同位置的活性材料样品，并计算第一负极活性材料层与第二负极活性材料层的压实密度。压实密度＝负极活性材料的重量/在集流体表面垂直方向上的总厚度。

[0073] 循环性能测试：

[0074] 将以下实施例及对比例的锂离子电池置于25℃±2℃的恒温箱中静置2小时，以0.5C恒流充电至4.45V，然后以4.45V恒压充电至0.02C并静置15分钟；再以0.5C恒流放电至3.0V，此为一次充放电循环过程，记录锂离子电池首次循环的放电容量；而后按上述方法重复进行充放电循环过程，并记录每次充放电循环过程的放电容量，随后将其与首次循环的放电容量比较得到循环容量曲线。

[0075] 每组取4块锂离子电池，计算锂离子电池的容量保持率的平均值。锂离子电池的循环保持率＝第400次循环的放电容量(mAh)/首次循环后的放电容量(mAh)×100%。

[0076] 析锂测试：

[0077] 将以下实施例及对比例的锂离子电池置于25℃±2℃的恒温箱中静置2小时，以0.5C恒流放电至3.00V。静置5分钟后，以0.7C恒流充电至4.45V，然后以4.45V恒压充电至0.02C。此为一次析锂测试循环，重复10次上述析锂测试循环后，将锂离子电池以0.5C恒流放电至3.00V，后拆解锂离子电池并计算析锂面积(呈灰色)占负极活性材料层的面积的比值S。根据满充负极析锂面积(呈灰色)与负极活性材料层的面积的比值S来判断析锂的程度：小于3%为轻微析锂、3%至5%为析锂、大于5%为严重析锂。

[0078] 二、制备方法

[0079] 正极的制备

[0080] 将钴酸锂($LiCoO_2$)、导电炭黑、聚偏二氟乙烯(PVDF)按重量比96.7:1.7:1.6的比例溶于N-甲基吡咯烷酮(NMP)溶液中，形成正极浆料。采用铝箔作为正极集流体，将正极浆料涂覆于正极集流体上，经过干燥、冷压、裁切程序后得到正极。

[0081] 电解液的制备

[0082] 在含水量小于10ppm的环境下，将六氟磷酸锂、氟代碳酸乙烯酯(FEC)与非水有机溶剂(碳酸乙烯酯(EC)：碳酸二甲酯(DMC)：碳酸二乙酯(DEC)＝1：1：1，重量比)配制成氟代碳酸乙烯酯的重量浓度为10wt％且六氟磷酸锂浓度为1mol/L的电解液。

[0083] 锂离子电池的制备

[0084] 采用以聚乙烯(PE)多孔聚合薄膜作为隔离膜。将上述正极、隔离膜与以下实施例与对比例的负极的依顺序堆叠，使隔离膜处于正极与负极中间起到隔离的作用，然后卷绕成电极组件。随后将该电极组件装入铝塑膜包装袋中，并在80℃下脱去水分后，获得干电极组件。随后将上述电解液注入干电极组件中，经过真空封装、静置、化成、整形等工序，即完成以下各实施例和对比例的锂离子电池的制备。

[0085] 实施例1

[0086] 将400克的SiO_x(0.5≤x≤1.6)、2400克的人造石墨和35克的导电碳黑加入到搅拌器中，在公转速度为20圈/分钟下搅拌120分钟。随后，将95克的聚丙烯酸加入到搅拌中的混合物内，在公转速度为20圈/分钟及自转转速为1200圈/分钟下搅拌60分钟，再加入去离子水搅拌120分钟，得到混合浆料。将混合浆料用170目双层筛网过滤，即得到负极浆料。

[0087] 采用铜箔作为负极集流体，将所述负极浆料涂布于负极集流体上，其中单面涂布的部分的单位面积重量为76.6g/m^2，双面涂布的部分的单位面积重量为153.2g/m^2，两者的涂布重量比K为0.5并进行烘干。烘干后，进行冷压处理，以得到第一负极活性材料层与第二负极活性材料层，其中第二负极活性材料层的压实密度为1.78g/cm^3，第一负极活性材料层与第二负极活性材料层的压实密度比例R为0.9，随后通过裁切程序后得到负极。

[0088] 实施例2

[0089] 与实施例1的制备方式相同，不同的地方是实施例2中第一负极活性材料层与第二负极活性材料层的压实密度比例R为0.95。

[0090] 实施例3

[0091] 与实施例1的制备方式相同，不同的地方是实施例3中第一负极活性材料层与第二负极活性材料层的压实密度比例R为0.97。

[0092] 实施例4

[0093] 与实施例1的制备方式相同，不同的地方是实施例4中第一负极活性材料层与第二负极活性材料层的压实密度比例R为1.0。

[0094] 实施例5

[0095] 与实施例1的制备方式相同，不同的地方是实施例5中第一负极活性材料层与第二负极活性材料层的压实密度比例R为1.1。

[0096] 实施例6

[0097] 与实施例1的制备方式相同，不同的地方是实施例6中单面涂布的部分的单位面积重量为76.6g/m^2，两者单位面积上的涂布重量比K为0.47。

[0098] 实施例7

[0099] 与实施例1的制备方式相同，不同的地方是实施例7中单面涂布的部分的单位面积重量为76.6g/m^2，两者单位面积上的涂布重量比K为0.52。

[0100] 实施例8

[0101] 与实施例1的制备方式相同，不同的地方是实施例8中采用的硅基材料为400克的硅碳(SiC)。

[0102] 对比例1

[0103] 与实施例1的制备方式相同，不同的地方是对比例1中第一负极活性材料层与第二负极活性材料层的压实密度比例R为0.85。

[0104] 对比例2

[0105] 与实施例1的制备方式相同，不同的地方是对比例2中第一负极活性材料层与第二负极活性材料层的压实密度比例R为1.5。

[0106] 对比例3

[0107] 与实施例1的制备方式相同，不同的地方是对比例3中单面涂布的部分的单位面积重量为76.6g/m^2，两者单位面积上的涂布重量比K为0.4。

[0108] 对比例4

[0109] 与实施例1的制备方式相同，不同的地方是对比例4中单面涂布的部分的单位面积重量为76.6g/m^2，两者单位面积上的涂布重量比K为0.55。

[0110] 对比例5

[0111] 与对比例1的制备方式相同，不同的地方是对比例5中采用的硅基材料为400克的硅碳(SiC)。

[0112] 对比例6

[0113] 与实施例1的制备方式相同，不同的地方是对比例6中采用的硅基材料为400克的硅碳(SiC)，且第一负极活性材料层与第二负极活性材料层的压实密度比例R为1.2。

[0114] 对以上实施例及对比例的负极，并对其进行单位重量及压实密度测试。随后对锂离子电池进行循环性能测试以及存储膨胀率测试，并记录其测试结果。

[0115] 实施例1-8及对比例1-6的负极的统计数值及通过单位重量及压实密度测试、循环性能测试及析锂测试的结果如下表1所示。

[0116] 表1

[0117]

实施例/对比例	硅基材料	循环负极K值	循环负极R值	循环保持率(-)	400圈循环后K值	400圈循环后R值	400圈循环后第一负极活性材料层区域(102A)S值	400圈循环后第二负极活性材料层与第一负极活性材料层的相邻区域(103A)S值	析锂测试循环S值
实施例1	氧化硅	0.5	0.9	90.3%	0.5	0.88	0	2.8%	2.6%
实施例2	氧化硅	0.5	0.95	91.1%	0.5	0.94	0	1.6%	2.0%
实施例3	氧化硅	0.5	0.97	91.7%	0.5	0.96	0	0	0
实施例4	氧化硅	0.5	1.0	92.1%	0.5	1.0	0	0	0
实施例5	氧化硅	0.5	1.1	91.9%	0.5	1.12	2.4%	0	2.5%
实施例6	氧化硅	0.47	1.0	89.7%	0.47	0.95	2.7%	0	2.8%
实施例7	氧化硅	0.52	1.0	90.6%	0.52	1.08	0	1.8%	2.0%
实施例8	硅碳	0.5	1.0	89%	0.5	1.0	0	0	0
对比例1	氧化硅	0.5	0.85	83.4%	0.5	0.78	2.0%	3.3%	30%
对比例2	氧化硅	0.5	1.5	80.3%	0.5	1.6	6%	4.8%	22%
对比例3	氧化硅	0.4	1.0	77.5%	0.4	0.85	8%	2.3%	36%
对比例4	氧化硅	0.55	1.0	82.5%	0.55	1.1	2.6%	8.9%	26%
对比例5	硅碳	0.5	0.85	73.1%	0.5	0.72	2.7%	4.3%	28%
对比例6	硅碳	0.5	1.2	79%	0.5	1.4	3.4%	3.1%	24%

[0118] 如表1所示，本申请实施例相较于其对应对比例能够有效的降低负极上的析锂现

象，同时提升锂离子电池的循环容量保持率。

[0119] 通过比较实施例1-5和8与对比例1、2、5和6可知，第一负极活性材料层与第二负极活性材料层的压实密度比值R越接近1，则越能够降低负极的析锂情况。其中，当第一负极活性材料层与第二负极活性材料层的单位面积重量比值K为0.5时，由于极片涂布重量均匀，第一负极活性材料层与第二负极活性材料层之间的电流密度相同，此时R值＜1时表明第一负极活性材料层区域的压实密度较低，锂离子更容易在第一负极活性材料层区域嵌入和脱出，所以第一负极活性材料层区域不存在析锂。当R＞1时表明第一负极活性材料层区域的压实密度较大，锂离子脱嵌阻力更大，更容易在第一负极活性材料层区域析锂。

[0120] 图3为本申请实施例4与对比例2的循环容量曲线图。

[0121] 如图3所示，实施例4中的新鲜的负极的第一负极活性材料层与第二负极活性材料层的压实密度比值R为1。经过400圈循环后，其由于其压实密度一致，不容易产生膨胀变形其R值并没有太多的变化。因此，实施例4的锂离子电池能够在循环过程中一直保持极高的容量保持率。相对的，对比例2的负极的压实密度比值R为1.5，在经过400圈循环后，原先不一致的压实密度会导致负极上第一负极活性材料层与第二负极活性材料层的硅基材料含量不同，进而导致其膨胀率不一致，加剧压实密度的变化。因此，对比例2的锂离子电池的容量保持率会急速的下降。

[0122] 通过比较实施例4、6和7与对比例3和4可知，第一负极活性材料层与第二负极活性材料层的单位面积重量比值K越接近0.5则越能够降低负极的析锂情况。当K＜0.5时，表明第一负极活性材料层区域的负极活性材料较少，导致循环过程中第一负极活性材料层区域的电流密度大，更容易析锂；当K＞0.5时，表明第一负极活性材料层区域的负极活性材料较多，导致循环过程中第一负极活性材料层区域的电流密度小，不易析锂。

[0123] 通过上述实施例及对比例的比较，可以清楚的理解本申请的负极通过控制第一负极活性材料层与第二负极活性材料层的单位面积重量比值K与压实密度比值R，能够有效的降低析锂的程度，从而提高其锂离子电池的循环性能。

[0124] 整个说明书中对“一些实施例”、“部分实施例”、“一个实施例”、“另一举例”、“举例”、“具体举例”或“部分举例”的引用，其所代表的意思是在本申请中的至少一个实施例或举例包含了该实施例或举例中所描述的特定特征、结构、材料或特性。因此，在整个说明书中的各处所出现的描述，例如：“在一些实施例中”、“在实施例中”、“在一个实施例中”、“在另一个举例中”，“在一个举例中”、“在特定举例中”或“举例”，其不必然是引用本申请中的相同的实施例或示例。此外，本文中的特定特征、结构、材料或特性可以以任何合适的方式在一个或多个实施例或举例中结合。

[0125] 尽管已经演示和描述了说明性实施例，本领域技术人员应该理解上述实施例不能被解释为对本申请的限制，并且可以在不脱离本申请的精神、原理及范围的情况下对实施例进行改变，替代和修改。

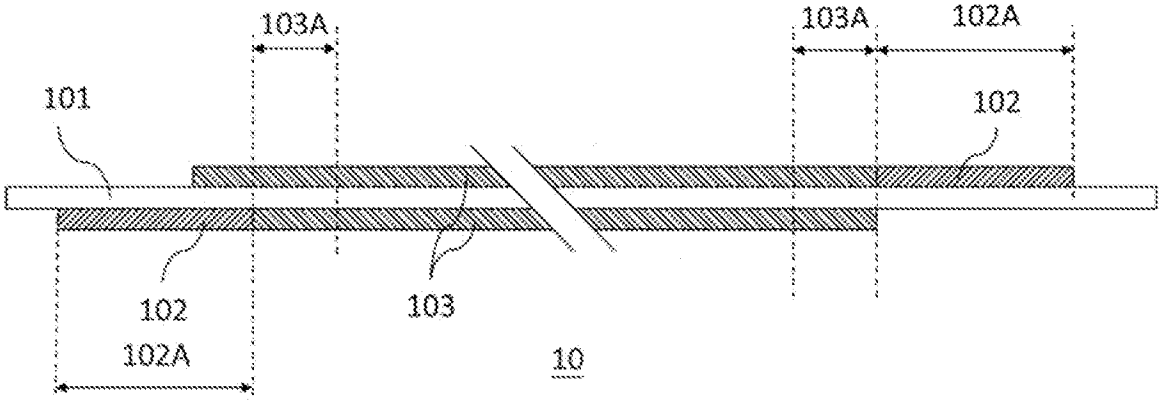

103A
103A
102A
101
102
102
103
102A
10

图1

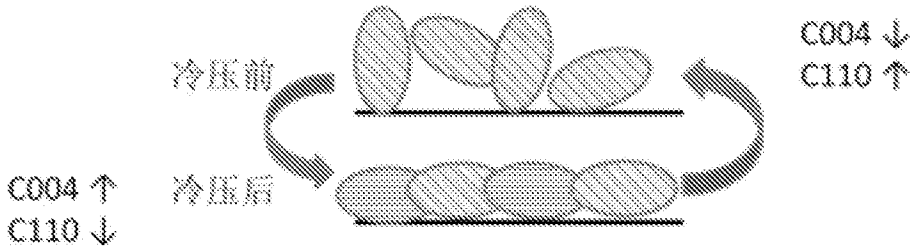

C004 ↓
C110 ↑
冷压前
冷压后
C004 ↑
C110 ↓

图2

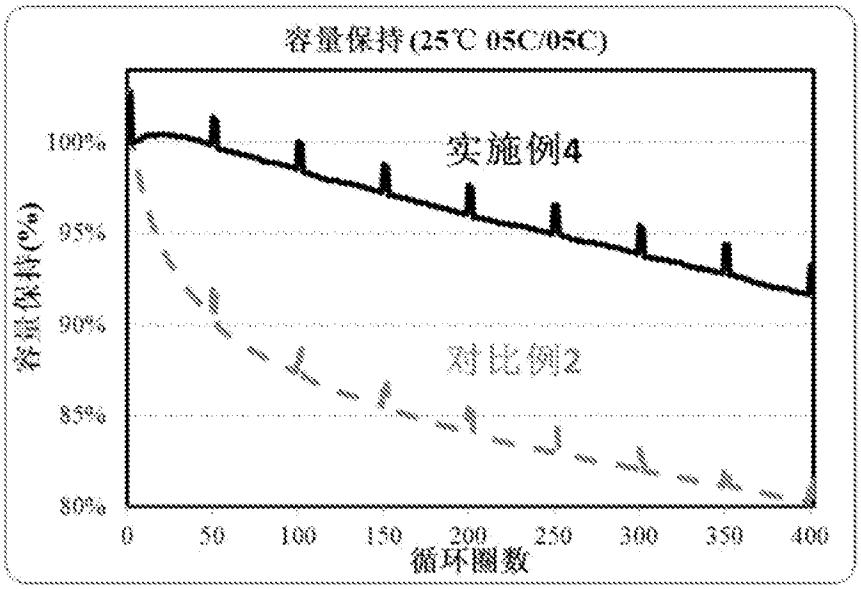

容量保持(25℃ 05C/05C)
实施例4
对比例2
容量保持(%)
100%
95%
90%
85%
80%
0
50
100
150
200
250
300
350
400
循环圈数

图3

Lithium secondary battery

Abstract

PROBLEM TO BE SOLVED: To provide a lithium secondary battery suitable especially for driving a motor of an electric vehicle capable of keeping good charge/discharge characteristics even in high output cycle operation. SOLUTION: A lithium secondary battery is obtained by housing an inner electrode body 1 prepared by winding or stacking a positive electrode plate 2 and a negative electrode plate 3 through a separator 4 made of a porous polymer in a battery case 17. A resistance value of each of a plurality of positive electrode tabs 5A to be connected to the positive electrode plate 2 is specified to a range of ±20% of an average resistance value of the positive electrode tabs 5A, and a resistance value of each of a plurality of negative electrode tabs 5B to be connected to the negative electrode plate 3 is specified to a range of ±20% of an average resistance value of the negative electrode tabs 5B.

Classifications

- Y02E60/10 Energy storage using batteries

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Claims (10)

Hide Dependent

translated from Japanese

[Claims] 1. A lithium secondary battery using an internal electrode body in which a positive electrode plate and a negative electrode plate are wound or laminated via a separator made of a porous polymer, wherein at least a plurality of lithium secondary batteries connected to the positive electrode plate are provided. Each resistance value of the positive electrode tab is ± 20% of the average resistance value of the positive electrode tab.
And a resistance value of at least a plurality of negative electrode tabs connected to the negative electrode plate is within ± 20% of an average resistance value of the negative electrode tab. battery. 2. A lithium secondary battery using an internal electrode body in which a positive electrode plate and a negative electrode plate are wound or laminated via a separator made of a porous polymer, and connected to the positive electrode plate and the negative electrode plate, respectively. A lithium secondary battery characterized in that an O material is used for a positive electrode tab and a negative electrode tab, and / or a current extraction terminal that collectively connects the positive electrode tab and the negative electrode tab for each electrode. 3. The method according to claim 1, wherein a plurality of the positive electrode tabs and the negative electrode tabs are assembled at one location for each electrode and connected to one current extraction terminal by crimping or welding. Item 3. The lithium secondary battery according to Item 1 or 2. 4. A method in which the positive electrode tab and the negative electrode tab are connected to a current extraction terminal by crimping, welding, or screwing after a plurality of sheets are integrated for each electrode by crimping, welding, or eyelets in advance. The lithium secondary battery according to claim 1, wherein: 5. The lithium secondary battery according to claim 3, wherein only one current extraction terminal is provided for each pole. 6. The lithium secondary battery according to claim 1, wherein the thickness of one of the positive electrode tab and the negative electrode tab is 5 μm or more and 100 μm or less. 7. The lithium secondary battery according to claim 6, wherein the total thickness of the tabs collectively connected to the one current extraction terminal is 200 μm or more. 8. The lithium secondary battery according to claim 6, wherein at least two tabs are collectively connected to the one current extraction terminal. 9. The lithium secondary battery according to claim 1, wherein the battery capacity is 5 Ah or more. 10. An electric vehicle or a hybrid electric vehicle.
The lithium secondary battery according to any one of claims 9 to 8.

Description

translated from Japanese

DETAILED DESCRIPTION OF THE INVENTION

[0001]

TECHNICAL FIELD The present invention has a high productivity.
Particularly in electric vehicle motors, the resistance of the current collecting tab and the connection at both ends of the tab are made uniform so that good charge / discharge characteristics are maintained even in high-power cycle operation. The present invention relates to a lithium secondary battery suitably used for driving

[0002]

2. Description of the Related Art In recent years, with the growing demand for environmental protection, there has been a strong demand for emission regulations such as carbon dioxide. In the automotive industry, electric vehicles (EVs) have been replaced by gasoline vehicles and other vehicles using fossil fuels.) And hybrid electric vehicles (HEV).
The lithium secondary battery as a motor drive battery, which is the key to the practical application of EVs and HEVs, not only has a large battery capacity, but also has a large battery output that has a large effect on the acceleration performance and climbing performance of vehicles, is required.

In general, an internal electrode body of a lithium secondary battery is wound or wound on a positive electrode plate and a negative electrode plate via a separator made of a porous polymer film so that the positive electrode plate and the negative electrode plate do not come into direct contact with each other. It is configured by lamination. For example, as shown in FIG. 1, a wound internal electrode body 1 is produced by winding a positive electrode plate 2 and a negative electrode plate 3 with a separator 4 interposed therebetween, and the positive electrode plate 2 and the negative electrode plate 3 (hereinafter, referred to as " Electrode plates 2 and 3 "
That.) For each of the positive electrode tab 5A and the negative electrode tab 5B.
(Hereinafter, referred to as "tabs 5A and 5B").

[0004] Then, the electrode plates 2 and
The other end connected to 3 is attached to a current extraction terminal 13 such as an external terminal 11 or an internal terminal member 12 that conducts to the external terminal 11. That is, the tab 5A
5B plays a role as a lead wire that conducts current from the electrode plates 2 and 3 and conducts with the current extraction terminal 13. Note that the external terminal is an electrode terminal for extracting a current to the outside of the battery, the internal terminal member is a member for temporarily collecting the current inside the battery, and the current extracting terminal is a generic term for these. Therefore, it is also possible to configure the current extraction terminal by integrating the external terminal and the internal terminal member.

Here, FIG. 2 shows a plan view of the electrode plates 2 and 3 when the internal electrode body 1 is developed. Electrode plates 2 and 3
The positive electrode plate 2 is formed by applying a metal foil such as aluminum for the positive electrode plate 2 and the like for the negative electrode plate 3 as a current collecting substrate 15 and applying an electrode active material 16 to each of them. Since the tabs 5A and 5B are disposed on one side of such a current collecting board 15, it is preferable to use a thin strip-shaped one. It is preferable to arrange them at substantially equal intervals so that electricity is supplied. Note that, in general, the material of the tab 5 is the same as the material of the current collecting board 15 to which the tab 5 is attached.

[0006]

However, in a lithium secondary battery for EV or HEV, a current of 100 A or more may flow per battery. Even when such a large current flows, it is necessary to minimize the internal resistance of the entire battery so that the output loss of the battery is reduced

Therefore, it is needless to say that it is preferable to reduce the resistance of the internal electrode body. However, focusing on the connection path between the internal electrode body (electrode plate) and the current extraction terminal, it is preferable that the resistance of the substrate, the tab, and the member of the current extraction terminal itself be small. However, with respect to the current collecting substrate, there is a certain limit in reducing the resistance value due to the limitation of the material and the restrictions on the shape and energy density of the battery.

On the other hand, the tab and the current extraction terminal can be freely set in shape as long as their shapes fit in the gap between the battery case accommodating the internal electrode body and the internal electrode body. There is a tolerance in the setting. Also,
Since the tab and the current collecting board are integrated by welding, the resistance of these connection parts does not change greatly except for extreme welding failure, but the connection between the tab and the current extraction terminal is not Since various methods can be considered, there is room for reducing the contact resistance.

For example, a method of bundling thin ribbon tabs by stacking them in a certain direction is preferred because it is easy and preferable in the battery manufacturing process, and the internal structure of the battery is not complicated. However, in this case, when the number of tabs increases, the number of contacts between the tabs increases, which causes a problem that the contact resistance on the contact surface of each tab increases and the variation of the contact resistance also increases. Therefore, in order to reduce the variation in the contact resistance while reducing the contact resistance, it is considered necessary to study the fixing method of the tab and the material used in detail.

Nevertheless, conventionally, regarding the material of the tab and the current extraction terminal itself, and the connection method between the tab and the current extraction terminal, the resistance of the tab and the current extraction terminal itself and the connection resistance of the tab and the current extraction terminal have been reduced. In view of the internal resistance of
Since it did not occupy a large proportion, it was not regarded as important. Therefore, the influence of the variation (distribution) of the resistance caused by the connection between the tab and the current extraction terminal on the output characteristics and the charge / discharge cycle operation characteristics has been clear so far. It was not.

[0011]

Means for Solving the Problems The present invention has been made in view of the above-mentioned problems of the prior art. That is, according to the present invention, a positive electrode plate and a negative electrode plate are formed of a separator made of a porous polymer. A lithium secondary battery using an internal electrode body wound or laminated through, wherein each of the resistance values of at least a plurality of positive electrode tabs connected to the positive electrode plate is ± 20 of the average resistance value of the positive electrode tab. %, And the resistance value of at least a plurality of negative electrode tabs connected to the negative electrode plate is within ± 20% of the average resistance value of the negative electrode tab. Next battery is provided. The "resistance value of the tab" here includes the contact resistance between the tab and the current extraction terminal, that is, one end of the tab connected to the positive electrode plate or the negative electrode plate, and the other end of the tab connected to the other end of the tab. The resistance between the current extraction terminal and
It is not the resistance value of the tab itself as a member.

Further, according to the present invention, there is provided a lithium secondary battery using an internal electrode body in which a positive electrode plate and a negative electrode plate are wound or laminated via a separator made of a porous polymer, wherein the positive electrode plate is provided. O material is used for a positive electrode tab and a negative electrode tab respectively connected to the negative electrode plate and / or a current extraction terminal for collectively connecting the positive electrode tab and the negative electrode tab for each pole. Lithium secondary battery is provided.

In such a lithium secondary battery of the present invention, a plurality of positive electrode tabs and a plurality of negative electrode tabs are assembled at one location for each electrode and connected to one current extraction terminal by crimping or welding. It is preferred. It is also preferable that a plurality of positive electrode tabs and negative electrode tabs are integrated for each electrode by crimping, welding, or eyelets beforehand, and then connected to the current extraction terminal by crimping, welding, or screwing. Here, a structure in which only one current extraction terminal is provided for each pole, that is, all the positive electrode tabs are collectively

connected to one current extraction terminal, and the same applies to the negative electrode tab, is considered as a manufacturing method of a battery. This is also preferable because variation in the resistance of the tab (including the contact resistance with the current extraction terminal, the same applies hereinafter) is suppressed.

The thickness of one tab is preferably 5 μm or more and 100 μm or less, and the total thickness of the tabs connected to one current extraction terminal is 250 μm or more, or the tabs collectively connected to one current extraction terminal. When the number of connected tabs is at least ten or more, the effect of reducing the variation in the resistance of the tabs, that is, the effect of making the resistance uniform, is greatly exhibited. Such tab uniform resistance has a remarkable effect in the form of improvement in charge / discharge characteristics and the like in a lithium secondary battery having a battery capacity of 5 Ah or more. Utilizing the thus obtained excellent charge / discharge characteristics, the lithium secondary battery of the present invention is suitably adopted as a lithium secondary battery for an electric vehicle or a hybrid electric vehicle.

[0015]

BEST MODE FOR CARRYING OUT THE INVENTION The lithium secondary battery of the present invention
Since the resistance from the positive and negative plates to the electrode extraction terminals is uniform, the current collection from the positive and negative plates and the battery reaction within the positive and negative plates are uniform. It is possible to discharge a large current stably.
Since local deterioration of the battery material is suppressed, the battery has excellent durability even in cycle operation. Hereinafter, embodiments of the present invention will be described, but it goes without saying that the present invention is not limited to the following embodiments.

In the internal electrode body of the lithium secondary battery (hereinafter referred to as "battery") in the present invention, the positive electrode plate and the negative electrode plate are directly connected to each other via a separator made of a porous polymer film. It is wound or laminated so as not to come into contact with.
Specifically, the wound internal electrode body 1 is formed by winding a positive electrode plate 2 and a negative electrode plate 3 via a separator 4 as shown in FIG. Are provided with tabs 5A and 5B.

On the other hand, as shown in FIG. 3, the laminated internal electrode body 7 alternately laminates a positive electrode plate 8 and a negative electrode plate 9 with a separator 10 interposed therebetween to form positive and negative electrode plates 8.
It is called "electrode plates 8 and 9".) For each positive electrode tab 6A
And the negative electrode tab 6B are connected. When such a tab is used as a reference for the battery element, the internal electrode bodies 1 and 7 may be regarded as a structure in which a plurality of element batteries including the opposed positive electrode plates 2 and 8 and negative electrode plates 3 and 9 are connected in parallel. Can be.

Each of the positive electrode plates 2 and 8 and the negative electrode plates 3 and 9 is formed in a thin plate shape by applying each electrode active material to a current collecting substrate. Examples of the form of the current collecting substrate include foil and mesh. In the present invention, an aluminum foil is used as the current collecting substrate for the positive electrode plates 2 and 8, and a copper foil is used as the current collecting substrate for the negative electrode plates 3 and 9. Are preferably used.

In any of the batteries having any of the above structures, generally, as a positive electrode active material, lithium cobalt oxide (LiCoO $_2$) or lithium nickel oxide (Li
NiO $_2$) or lithium manganate (LiMn $_2$ O
$_4$) and the like are used. In addition, in order to improve the conductivity of these positive electrode active materials, a carbon powder such as acetylene black or graphite powder is frequently mixed with the electrode active material. on the other hand,
As the negative electrode active material, an amorphous carbonaceous material such as soft carbon or hard carbon, or a carbonaceous powder such as natural graphite or artificial graphite is used.

As the separators 4 and 10, those having a three-layer structure in which a lithium ion permeable polyethylene film having micropores is sandwiched between porous lithium ion permeable polypropylene films are preferably used. When the temperature of the internal electrode body rises, the polyethylene film softens at about 130 ° C. and the micropores are crushed, which also serves as a safety mechanism for suppressing the movement of lithium ions, that is, the battery reaction. Then, the polyethylene film is sandwiched by a polypropylene film having a higher softening temperature, whereby the separator 4
It is possible to prevent contact and welding between the electrode plate 10 and the electrode plates (2, 3) and (8, 9).

Next, a method of connecting the tab to the internal electrode body (electrode plate) and the current extraction terminal will be described by taking the case of the wound internal electrode body 1 as an example. As mentioned above, FIG.
FIG. 2 is a plan view of the electrode plates 2 and 3 when the wound internal electrode body 1 shown in FIG. 1 is developed. Here, when the battery capacity is constant, the width D of the electrode plates 2 and 3 is , The length L in the winding direction can be shortened.

However, when the width D of the electrode plates 2 and 3 is long, the distance between the electrode active material 16 near the side opposite to the side where the tabs 5A and 5B are attached and the tabs 5A and 5B is long. Therefore, there arises a disadvantage that the internal resistance increases. Therefore, the width of the electrode plates 2 and 3 is usually 10c.
It is preferable that the width of the electrode plates 2 3 is within such a range.
It is preferable that the number of 5B disposed on the electrode plates 2 and 3 in the length L in the winding direction is about 6 to 10 per 1 m.

The arrangement of the tabs 5A and 5B on the electrode plates 2 and 3 does not require a complicated structure inside the battery, as shown in FIG. For ease of operation, when the electrode plates 2 and 3 are wound,
It is preferable that the tabs 5A and 5B are arranged substantially linearly in the radial direction of the internal electrode body 1.

The connection method between the electrode plates 2 and 3 and the tabs 5A and 5B may be resistance welding or ultrasonic welding. However, except for extreme welding failure, the connection between the tabs 5A and 5B and the electrode plates 2,3 is not limited. Contact resistance does not differ greatly. However, it goes without saying that it is preferable to make the contact resistance between the tabs 5A and 5B and the electrode plates 2 and 3 substantially constant.

The tabs 5 arranged at substantially equal intervals in this way
Each of A and 5B contributes to the transmission of electrons involved in the battery reaction in substantially the same electrode area in the electrode plates 2 and 3.
However, if there is a variation in resistance in the current collection path from the current extraction terminal to the electrode plates 2 and 3,
Variations also occur in the current extraction. That is, the current may concentrate on the tab connected so that the resistance becomes small. In this case, not only the battery reaction does not become uniform, but also the portion where the battery reaction is most actively performed (the low-resistance tab is There is also a concern that the material may deteriorate rapidly at the connected part).

In order to avoid such a problem, in the present invention, each of the resistance values of at least the plurality of positive electrode tabs 5A connected to the positive electrode plate 2 is in a range of ± 20% of the average resistance value of the positive electrode tab 5A. The same applies to the negative electrode tab 5B. Note that, as is

clear from the above problem, the resistance value of the tab includes the contact resistance between the tab and the current extraction terminal, that is, a portion of one end of the tab connected to the positive electrode plate or the negative electrode plate. And the resistance between the current extraction terminal connected to the other end of the tab and not the resistance value of the tab itself as a member.

For this reason, it is preferable that all the tabs 5 are gathered in one place and connected to the current extracting terminal by crimping or welding. However, it is also possible to provide two or more current extraction terminals for each pole. In this case, the current distribution terminals do not satisfy the resistance distribution condition, but all the tabs for each pole must be used. It is necessary to satisfy the conditions described above. That is, it is necessary to make the connection state of the tab at each current extraction terminal substantially constant.

Specifically, as shown in FIG. 4, a rivet 22 is used as the current output terminal 13 attached to the battery cap 23, and the tabs 5A (5B) can be collectively connected to the rivet 22 by crimping. It is. Even in this case, the tab 5A (5
The resistance value of 5) can be included in the resistance distribution range. In addition, tab 5A (5B) by welding instead of crimping
May be connected to the rivet 22, or the tab 5A (5B)
After crimping to the rivet 22, the connection portion may be further welded and integrated.

As shown in FIG. 5, a plurality of, and preferably all, tabs 5A (5B) are previously integrated by crimping using a metal plate 26 such as a copper plate or an aluminum plate. A connection method of fitting into the barrel bolt 24 and tightening with a nut 25 and screwing is also suitably used. The tabs 5A (5B) can be integrated by a method such as welding or eyelet besides crimping, and the current extraction terminals 13 of the integrated tabs 5A (5B) can be used.
For attachment to the device, a method such as welding or crimping may be used.

As described above, since the metal foil is preferably used as the current collecting substrate for the electrode plates 2 and 3,
The tab 5 is also preferably in the form of a thin strip, and preferably has a thickness of 5 μm or more and 100 μm or less.
In the present invention, the positive electrode tab 5A is preferably made of aluminum, and the negative electrode tab 5B is preferably made of copper or nickel.

In consideration of the above-mentioned problems, it is most preferable that the condition regarding the variation in resistance is satisfied in both of the electrode plates 2 and 3. The battery characteristics are improved as compared with the technology

The tabs 5A and 5B are connected to the current extraction terminals 1
3 are connected collectively to the tabs 5A and 5B and the electrode plates 2,3 and 3 are connected by the number of the tabs 5A and 5B. This causes a difference in the resistance value of each tab, which is not preferable. For this reason, the tab to be used should be adjusted to the one that requires the longest length, or if tabs with different lengths are used, the thickness and width are changed to adjust the resistance value and make it equal is preferred

Now, in the connection of the tab to the current extraction terminal described above, it is considered that the material of the tab and / or the current extraction terminal also has a large effect on the productivity and the state of resistance variation. In view of this, in the present invention, a tab and / or a current extraction terminal made of an O material is preferably used.

The O (0) material is also called an annealing material or a material A, and is not subjected to cold working or hardening after soft annealing (including solution treatment). It is a material that has been subjected to light cold working to a degree that is not so distinctive, and is distinguished from cold worked H material.

When the tabs are collectively connected to the current extraction terminals, the tabs are often stored in the battery case by being bent or the like. Here, when the tabs are made of an O material, Since the applied force easily bends and the repulsion is small, there is an advantage that the positioning and fixing work of the cap to which the current extraction terminal is attached can be easily performed in the battery manufacturing process. In addition, when the O material is used for the tab, especially when the tabs are bundled by crimping,
There is an advantage that a good contact state between the tabs can be maintained.

Regarding the current extraction terminal, for example, FIG.
When the O material is used for the rivet 22 shown in (1), the portion to be crimped has a large malleability, the rivet 22 is easily damaged by the crimping, the production yield is improved, and the contact with the tab is good. . And there is an advantage that contributes to reduction in variation in contact resistance between the tab and the current extraction terminal. Therefore, it is preferable to use an O material for both the tab and the current extraction terminal

In the case where the above-described method of connecting the tabs is adopted, or when an O material is used for the tabs and / or the current extraction terminals, the total thickness of the tabs collectively connected to one current extraction terminal is set to 200 μm. This is preferable, and when the number of tabs to be collectively connected to one current extraction terminal is at least 10 or more, the effect of suppressing the variation in the resistance of the tabs is large, which is preferable.

Although the above description has been made with a focus on the wound internal electrode body 1, it goes without saying that the same applies to the electrode plates 8 and 9 forming the laminated internal electrode body 7.
By arranging a plurality of tabs per one of the electrode plates 8 and 9,
Alternatively, one positive electrode tab 6A and one negative electrode tab 6B can be connected to one electrode plate 8, 9, respectively, and can be connected to a current extraction terminal.

By employing the above-described battery structure, the current can be taken out from the internal electrode body of one battery evenly through each tab.
The charge / discharge efficiency is improved, large current discharge is facilitated, and the durability is improved. Such an effect is particularly remarkable in a large-capacity battery having a battery capacity of 5 Ah or more, which requires a large number of tabs, and the battery of the present invention is used for EV or HEV.
Suitable for use as a battery. Hereinafter, the present invention will be described with reference to Examples, but it goes without saying that the present invention is not limited to the following Examples.

[0043]

Example (Measurement of Resistance of Tab) In manufacturing a battery, first, in order to examine a variation in resistance due to a difference in a method of connecting a tab to a current extraction terminal, a tab 5A (5B) as shown in FIG. is a rivet 22 which is a current extraction terminal.
Using a connection method of crimping, a positive electrode rivet made of aluminum foil was bundled and bonded to 30 pieces of aluminum positive electrode rivets, while a negative electrode tab made of 30 pieces of copper foil was bundled and pressed to a copper negative electrode rivet. . The positive electrode rivet and the negative electrode rivet in which the tabs were crimped were combined into one set. At this time, the crimping pressure was set to 1 ton / cm ^{2} as Example 1, and the crimping pressure was set to ^{2} ton / cm ^{2} as Example 2. I do.

Next, as shown in FIG. 6, by measuring the voltage when a current of 1 A flows between each of the tabs 5A (5B) and the rivet 22, the resistance value of the tab 5A (5B) is measured. Was measured. Then, the average value of the obtained resistance values was calculated, and the resistance value distribution of each of the tabs 5A (5B) was determined by normalizing the average value to 100%.

On the other hand, as Comparative Example 1,

2, the pressing pressure was set to 500 kg / cm ^{2}.
The tab was pressed against a rivet, and the resistance value of the tab was measured. Further, as Comparative Example 2, as shown in FIG.
As shown in FIG. 5, the tabs 5A (5B) are not integrated beforehand as shown in FIG. 5, but each tab 5A (5B) is screwed.
The resistance value of each of the tabs 5A (5B) was measured.

FIG. 8 shows how the resistance of the positive electrode tab 5A varies in Examples 1 and 2 and Comparative Examples 1 and 2. In Examples 1 and 2, the variation in the resistance of the positive electrode tab 5A was within ± 20% of the average value, but in Comparative Examples 1 and 2, the variation in the resistance was ± 20% of the average value.
It can be seen that it is wider than the range of 20%. Although not shown, the variation of the resistance of the negative electrode tab 5B also showed the same distribution as that of FIG. 8, and was within ± 20% of the average value in Examples 1, 2 and Comparative Example 1. Example 2 did not fall within this range. In Comparative Example 1, the reason for the large variation in resistance at the positive electrode tab 5A and the small variation in resistance at the negative electrode tab 5B is due to the properties of the material and the oxide film formed on the surface thereof, as described later. It is conceivable that.

The result is explained as follows.
That is, first, when the bolt 24 and the nut 25 of Comparative Example 2 are used, as shown in FIG.
(5B) is provided with a hole for insertion into the thread 27 of the bolt 24, and the diameter of this hole is
7, the area where the side surface of the hole of the tab 5A (5B) contacts the thread 27 is very small. Therefore, the current of the tab 5A (5B) is changed as shown by the arrow 50 to the adjacent tab 5A.
It flows to the bolt 24 through (5B) or flows to the bolt 24 via the adjacent tab 5A (5B) and nut 25, and hardly flows in the direction shown by the arrow 60.

On the other hand, the same applies to the case where the rivet 22 is used as in the case of the first and second embodiments and the comparative example 1. In this case, as shown in FIG. 10, the tab 5A (5
Since the area where the side surface of 8) comes into contact with the rivet 22 is very small, the current of the tab 5A (5B) flows to the rivet 22 in the direction indicated by the arrow 50, that is, through the adjacent tab 5A (5B), in the direction indicated by 60, it becomes difficult to flow.

That is, Examples 1 and 2, Comparative Example 1,
In either case, the current flows through the tab 5A (5B).
It will flow through the contact interface between them. Therefore, among the tabs 5A (5B) that are bundled, the number of contact interfaces with the bolt 24 or the rivet 22 increases as the position is closer to the center, and the resistance value increases.

Therefore, in order to reduce the variation in the resistance of the tab, it is necessary to reduce the resistance of the contact interface generated on the tab. Here, it is known that an alumina insulating coating is easily formed on the surface of a tab made of aluminum foil.As the number of ribbon-shaped tabs is increased, the influence of the insulating coating on the resistance distribution of the tabs increases. Become. Therefore, in order to reduce the variation in the resistance of the tab, it is necessary to break the insulating coating to secure the contact with the metal material portion of the tab.

The same applies to a tab made of copper foil. However, since the oxide film formed on the surface of the copper foil is a semiconductor, the influence of the contact interface is smaller than when an aluminum foil is used. However, since the metal conductivity is naturally superior to the semiconductor with respect to the electron conductivity, it is preferable to secure the contact between the metals by destroying the oxide film on the surface of the copper foil.

Therefore, for the connection between the tab and the current extraction terminal, a method such as crimping that can secure contact between metals is preferable. In the first and second embodiments, the crimping with an appropriate pressure is performed to obtain the tab surface. It is considered that as a result of the oxide film being destroyed and the contact between the metal materials being secured, the variation in the resistance of the tab was suppressed. However, even when crimping is used, as shown in the results of Comparative Example 1, when the crimping pressure is small, the oxide film is not uniformly broken, and as a result, the connection state of the tab is uneven. It is considered that the effect of crimping cannot be obtained due to the occurrence of crimping. In Comparative Example 2, it is considered that the tightening pressure for screwing does not easily reach the pressure required to break the oxide film on the tab, and as a result, it is presumed that the variation in the resistance of the tab increased. .

It should be noted that the variation in the resistance of the tab is calculated as an average value ±
To fit within 20%, in the case of using an aluminum foil as a tab crimping pressure should be at 1 ton / cm ^{2} or more 50ton / cm ^{2} or less, whereas, in the case of using a copper foil, 500 kg / cm ^{2} or more and 1t
n / cm ^{2} or less.

As described above, one of the reasons for the difference in the required pressure range between the aluminum foil and the copper foil in order to keep the resistance value variation within a predetermined range is that the aluminum foil is more preferable. It is conceivable that the oxide film is formed more easily than the copper foil and the difference in the electrical properties of the oxide film described above. The upper limit of the pressure applied to the tab is the pressure when the tab is damaged at the end of the rivet.

(Production of Battery) A lithium secondary battery was produced by the following method. First, $LiMn_2O_4$ powder was used as a positive electrode active material, acetylene black for imparting conductivity was added thereto, and a binder and a solvent were further mixed to prepare a paste. Apply on both sides of aluminum foil, winding length 3600
A positive electrode plate having an electrode surface shape of mm × 200 mm in width was produced. On the other hand, a highly graphitized carbon powder is used as a negative electrode active material, a binder and a solvent are mixed with the negative electrode active material to form a paste, and the paste is applied to both surfaces of a 10-μm-thick copper foil, and the length in the winding direction is 4,000
A negative electrode plate having an electrode surface shape of mm × 200 mm was produced.

Next, as shown in FIG. 11, the produced positive electrode plate 2 and negative electrode plate 3 were wound while being insulated using a 210 mm wide polypropylene separator 4, and at the same time, as in Example 1 above. The same 30 aluminum positive electrode tabs 5A and the same copper negative electrode tabs 5B as those used were arranged substantially linearly in the radial direction of the internal electrode body 1.
In addition, the electrode plates 2 and 3 are arranged so that they are arranged at substantially equal intervals when the electrode plates 2 and 3 are developed, and one electrode is formed at one end of the internal electrode body 1. It was attached by ultrasonic welding.

The prepared internal electrode body 1 is inserted into a battery case 17 made of aluminum, and the tabs 5 A and 5 B for each of the positive and negative electrodes are set to 1 ton / cm by using the same method as in the first embodiment.
At a pressure of ^{2}, each of the rivets 22A and 22B for the positive and negative electrodes, which are current extraction terminals, is crimped, a battery cap is attached to the negative rivet 22B, the negative side of the battery case 17 is sealed, and the open battery case is opened. From the positive electrode side of 17,

1 mol of electrolyte $LiPF_6$ in a mixed solvent of EC (ethylene carbonate) and DEC (diethyl carbonate)

% Electrolyte solution, and then
The battery case 17 was sealed by attaching a battery cap to the positive electrode rivet 22A. Note that the battery case 17 may be sealed from the positive electrode side. Thus, the battery manufactured by using the method for connecting the tab and the current extraction terminal of the first embodiment is referred to as a battery of the first embodiment.

Subsequently, in the same manner as in the battery of Example 1 except for the method of connecting the tab and the current extracting terminal, the method of connecting the tab and the current extracting terminal according to Example 2 and Comparative Examples 1 and 2 was used. Each method was used to fabricate a battery.
The batteries manufactured in this manner were respectively used as the battery of Example 2,
The battery of Comparative Example 1 and the battery of Comparative Example 2 were used.

The battery capacity of each of the prepared batteries was 2.
Although it was 5 Ah, its charge / discharge characteristics were evaluated by a cycle operation test. Here, charging is performed at a constant current of 25 A.
The discharge was performed by 4.1 V constant voltage charging, and the discharge was performed by constant current discharge at a discharge rate of 1 C (25 A) to a discharge end voltage of 2.5 V, and the charging and discharging were repeated.
Then, the discharge capacity of each time, the initial discharge capacity is 100%
It was standardized as

FIG. 12 shows how the discharge capacity changes in the cycle operation test. The batteries of Examples 1 and 2 in which the variation in the resistance of the tab was small showed a small decrease in the capacity, and there was no large difference between the two. On the other hand, in the battery of Comparative Example 2 in which the variation in resistance was large in both the positive and negative electrode tabs, a large decrease in capacity was recognized, and in Comparative Example 1 in which the variation in resistance of only the positive electrode tab was large and the variation in resistance of the negative electrode tab was small, Properties intermediate between Examples 1 and 2 and Comparative Example 2 were shown. It is considered that such a result is caused by non-uniformity of the battery reaction in the internal electrode body due to the variation in the resistance of the tab, and partial deterioration of the positive and negative electrode plates.

[0058]

As described above, in the lithium secondary battery of the present invention, since the variation in the resistance of the plurality of tabs is kept within a certain range, the current collection from the electrode plate is made uniform, and The uniformity of the battery reaction in the internal electrode body is achieved, and an excellent effect that a large current can be stably discharged is achieved. Thereby, local deterioration of the battery material is suppressed, and an excellent effect of having excellent durability even in a cycle operation can be obtained.

[Brief description of the drawings]

FIG. 1 is a perspective view showing the structure of a wound internal electrode body.

FIG. 2 is a plan view showing a state in which positive and negative electrode plates in a wound internal electrode body are developed.

FIG. 3 is a perspective view showing one embodiment of a structure of a laminated internal electrode body.

FIG. 4 is a cross-sectional view showing one embodiment of a method for connecting a tab and a current extraction terminal in the lithium secondary battery of the present invention.

FIG. 5 is an explanatory view showing another embodiment of a method for connecting a tab and a current extraction terminal in the lithium secondary battery of the present invention.

FIG. 6 is an explanatory view showing a method for measuring the resistance of a tab in the lithium secondary battery of the present invention.

FIG. 7 is an explanatory diagram showing a connection method between a tab and a current extraction terminal in the lithium secondary battery of Comparative Example 2.

FIG. 8 is an explanatory diagram showing variations in tab resistance in the example and the comparative example.

FIG. 9 is an explanatory diagram illustrating a flow of current from a tab to a current extraction terminal including a bolt and a nut.

FIG. 10 is an explanatory diagram showing a flow of current from a tab to a current extraction terminal formed of a rivet.

FIG. 11 is an explanatory view showing a process of connecting a tab to a current extraction terminal in manufacturing a lithium secondary battery of the present invention.

FIG. 12 is an explanatory diagram showing the results of a cycle operation test in Examples and Comparative Examples.

[Description of Signs] 1 ... Internal electrode body, 2 ... Positive electrode plate, 3 ... Negative electrode plate, 4 ... Separator, 5A / 6A ... Positive electrode tab, 5B / 6B ... Negative electrode tab,
7 internal electrode body, 8 positive electrode plate, 9 negative electrode plate, 10 separator, 11 external terminal, 12 internal terminal member, 13
Current extraction terminal, 15: current collecting board (metal foil, etc.), 16: electrode active material, 17: battery case, 22: rivet, 22A
... Positive electrode rivet, 22B ... Negative electrode rivet, 23 ... Battery cap, 24 ... Bolt, 25 ... Nut, 26 ... Metal plate,
27: screw thread, 50: current flow, 60: current flow.

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Publication number	Priority date	Publication date	Assignee	Title
KR100846071B1	2006-07-18	2008-07-14	주식회사 엘지화학	Electrode Assembly Having Notch Lead-Tap Joint and Electrochemical Cell Containing the Same
JP2012104226A *	2010-11-05	2012-05-31	Mitsubishi Heavy Ind Ltd	Battery and battery manufacturing method

WO2014024531A1 *	2012-08-09	2014-02-13	[redacted]	Method for producing battery and battery
KR101473391B1 *	2010-12-06	2014-12-16	주식회사 엘지화학	Electrode assembly and secondary battery using the same
EP3157077A1 *	2015-10-12	2017-04-19	Robert Bosch Gmbh	Battery
Family To Family Citations				
KR100624933B1	2004-11-29	2006-09-18	삼성에스디아이 주식회사	Lithium secondary battery

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

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US8911907B2	2012-02-21	Stack type battery
JP4155440B2	2008-10-01	Secondary battery and assembled battery using the same
US8815426B2	2014-08-26	Prismatic sealed secondary cell and method of manufacturing the same
CN101944638B	2013-05-15	Battery module, method of fabricating the same, and vehicle having battery module
JP5165482B2	2013-03-21	Winding type secondary battery
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KR20060059716A	2006-06-02	Lithium secondary battery
JP4805111B2	2009-07-29	Battery pack and electric vehicle
KR102208830B1	2021-01-29	Lithium secondary battery
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JP7251436B2	2023-04-04	Secondary batteries, electronic devices and power tools
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JP4752154B2	2011-08-17	Method for manufacturing lithium secondary battery
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JP3511476B2	2004-03-29	Lithium secondary battery
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JP2003331840A	2003-08-21	Lithium secondary battery
JP3511866B2	2004-03-29	Cylindrical lithium-ion battery

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
JP01352099A	1998-03-18	1999-01-21	Lithium secondary battery

Applications Claiming Priority (5)

Application	Filing date	Title
JP6801798	1998-03-18	
JP10-68017	1998-03-18	
JP10-171105	1998-06-18	
JP17110598	1998-06-18	
JP01352099A	1999-01-21	Lithium secondary battery

Legal Events

Date	Code	Title	Description
2003-12-25	A01	Written decision to grant a patent or to grant a registration (utility model)	**Free format text**: JAPANESE INTERMEDIATE CODE: A01 **Effective date**: 20031224
2004-01-15	A61	First payment of annual fees (during grant procedure)	**Free format text**: JAPANESE INTERMEDIATE CODE: A61 **Effective date**: 20031225
2007-11-27	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20090116 **Year of fee payment**: 5
2008-11-20	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20090116 **Year of fee payment**: 5
2008-11-26	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20100116 **Year of fee payment**: 6
2009-11-24	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20110116 **Year of fee payment**: 7
2010-11-30	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20120116 **Year of fee payment**: 8
2011-11-29	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20130116 **Year of fee payment**: 9
2012-11-27	FPAY	Renewal fee payment (event date is renewal date of database)	**Free format text**: PAYMENT UNTIL: 20140116 **Year of fee payment**: 10
2016-01-16	LAPS	Cancellation because of no payment of annual fees	

Concepts

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Name	image	Sections	Count	Query match
lithium		title,claims,abstract,description	35	0.000
lithium		title,claims,abstract,description	35	0.000
polymer		claims,abstract,description	7	0.000
extraction		claims,description	62	0.000
crimping		claims,description	25	0.000
material		claims,description	23	0.000
welding		claims,description	17	0.000

winding	abstract,description	7	0.000

Show all concepts from the description section

Data provided by IFI CLAIMS Patent Services

Tab sealant heat-resistant insulating structure for nonaqueous electrolyte secondary battery and nonaqueous electrolyte secondary battery

Abstract

PROBLEM TO BE SOLVED: To provide a laminate pack type nonaqueous secondary battery in which even when a tab lead and a heat-sealed portion of a sheathing material are heated and melted and thus a sealant layer of the sheathing material partially flows out, a heat-resistant insulating layer interposed between the sheathing material and the tab lead prevents short-circuiting, thereby securing the adhesion between the tab lead and the sheathing material, and the insulation between the tab lead and a barrier layer comprising the metal foil of the sheathing material.SOLUTION: In a nonaqueous electrolyte secondary battery structure in which a sealant layer of a sheathing material 16 is sealed at the inner surface side while enclosing a battery member, the front and back surfaces or the peripheries of a positive electrode tab lead 31 extending outwards from a positive electrode 21 and a negative electrode tab lead 32 extending outwards from a negative electrode 23 are coated to form a heat-resistant insulating layer a, and the heat-resistant insulating layer is brought into close contact with each other by heat sealing (heat seal) to form a tab sealant heat-resistive insulating structure b. The heat-resistive insulating layer includes fluorine-based resin, curing agent, and adhesion imparting agent. A nonaqueous electrolyte secondary battery has the tab sealant heat-resistive insulating structure.SELECTED DRAWING: Figure 1

Classifications

- Y02E60/10 Energy storage using batteries

JP2017059402A

Japan

Download PDF Find Prior Art Similar

Other languages: Japanese

Inventor: [redacted] Mina Sato, [redacted]

Current Assignee : Toppan Inc

Worldwide applications

2015 JP

Application JP2015182966A events

2015-09-16 Application filed by Toppan Printing Co Ltd

2015-09-16 Priority to JP2015182966A

2017-03-23 Publication of JP2017059402A

Status Pending

Info: Cited by (5), Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (6)

Hide Dependent

translated from Japanese

A nonaqueous electrolyte secondary battery exterior material formed by laminating at least a base material layer, a barrier layer, and a sealant layer, and a positive electrode tab lead and a negative electrode tab lead that are connected to and stretched with the positive electrode and the negative electrode, respectively, with the sealant layer on the inner surface side, in a non-aqueous electrolyte secondary battery structure in which a separator and an electrolytic solution are encapsulated by the non-aqueous electrolyte secondary battery exterior material, heat resistance is formed by covering the front and back surfaces or the periphery of the sealant layer, the positive electrode tab lead, and the negative electrode tab lead. A non-water characterized in that it forms a tab sealant heat resistant insulating structure that is adhered to the heat insulating layer by heat fusion, and the heat-resistant insulating layer contains a fluororesin, a curing agent, and an adhesion-imparting agent. Tab sealant heat-resistant insulation structure for electrolyte secondary battery.

The tab sealant heat-resistant insulating structure of a non-aqueous electrolyte secondary battery according to claim 1, wherein the heat-resistant insulating layer is formed larger than a heat-sealed region with the sealant layer. The tab sealant heat-resistant insulating structure for a non-aqueous electrolyte secondary battery according to claim 1, wherein the fluororesin contained in the heat-resistant insulating layer contains a functional group having an element other than fluorine. 2. The tab sealant heat resistance of a non-aqueous electrolyte secondary battery according to claim 1, wherein the fluorine-based resin constituting the heat-resistant insulating layer includes a functional group having an element other than fluorine that reacts with a curing agent, insulating structure. 2. The tab sealant heat-resistant insulating structure for a non-aqueous electrolyte secondary battery according to claim 1, wherein the heat-resistant insulating layer has a thickness of 5 μm to 30 μm. A non-aqueous electrolyte secondary battery comprising the tab sealant heat-resistant insulating structure according to claim 1

Description

translated from Japanese

The present invention relates to a tab sealant heat-resistant insulating structure used for a tab lead of a non-aqueous electrolyte secondary battery and a non-aqueous electrolyte secondary battery having the tab sealant heat-resistant insulating structure.

A lithium ion battery, which is a representative non-aqueous electrolyte secondary battery that has been attracting attention in recent years due to its high energy density, is shifting from a can type to a laminate pack type in order to reduce the size of mobile phones. Laminate packs store and paste battery contents such as electrodes and electrolyte inside the outer packaging made of a laminate with a heat-resistant substrate layer / aluminum foil layer / heat-sealable film layer (sealant layer). A heat-sealing film layer (hereinafter referred to as a sealant layer) at the combined peripheral portion is sealed by heat sealing. A metal tab lead extends from the electrode to the outside of the laminate pack, and the lithium ion battery is charged and discharged through the tab lead.

Conventionally, since the tab lead is sandwiched between exterior materials and fixed by heat sealing, a slight burr generated when cutting the tab lead may damage the sealant layer of the exterior material. In addition, since the sealant layer melts and flows out from the pressurizing part in the pressurization and heating state in the heat sealing process, when the tab lead is thick, the sealant layer in the heat seal part in contact with the tab lead may be thin. In addition, since a metal foil layer is used outside the exterior material for the purpose of moisture barrier, there is a problem that the metal foil layer and the tab lead are short-circuited when the sealant layer is damaged or thinned as described above. It was.

For example, FIG. 5 shows a schematic cross-sectional view of an example of a conventional nonaqueous electrolyte secondary battery 14. In the heat seal process of the conventional nonaqueous electrolyte secondary battery manufacturing process, a sealant layer (not shown) formed inside the exterior material 1 is softened and melted by heat and pressure in the region of the heat seal portion 6. The sealant layer of the facing exterior material 1 is heat-sealed. However, when there is a tab lead between the sealant layers of the facing exterior material, the thickness of the sealant layer is reduced by the resin material of the sealant layer flowing out around the heat-sealed area. In some cases, the insulating property of the sealant layer of the exterior material 1 is lowered, and there is a possibility that a short circuit may occur between the metal foil layer outside the sealant layer and the positive electrode tab lead 31 or the negative electrode tab lead. In the case where the metal foil layer is exposed after the sealant layer flows out, the metal foil layer may be contacted and short-circuited.

Therefore, for example, as disclosed in Patent Document 1, a method of winding a sealant film around a tab lead in advance has been devised. However, this tab lead sealant film is also the same polyolefin as the sealant layer of the exterior material, so the heat resistance is low, and in the heat sealing process, the sealant layer flows out at the heat seal part and becomes thin, so there is a risk of short circuiting. there were.

Japanese Patent No. 4449143

In order to solve the above-described problems, the present invention provides a non-aqueous electrolyte secondary battery such as a laminate pack type lithium ion battery. Even if the sealant layer of the exterior material partially flows out of the heat seal part by heating and melting, they do not short-circuit, the adhesiveness between the tab lead and the exterior material, and the barrier layer made of the metal foil of the tab lead and the exterior material A tab sealant heat-resistant insulation structure capable of ensuring the insulation properties of the non-aqueous electrolyte secondary battery having the same.

As means for solving the above-mentioned problems, the invention according to claim 1 is characterized in that a nonaqueous electrolyte secondary battery exterior material formed by laminating at least a base material layer, a barrier layer, and a sealant layer, and the sealant layer on the inner surface side. In the non-aqueous electrolyte secondary battery structure in which the positive electrode tab lead and the negative electrode tab lead, which are connected to and stretched with the positive electrode and the negative electrode, respectively, the separator, and the electrolyte solution are encapsulated by the non-aqueous electrolyte secondary battery exterior material, A tab sealant heat-resistant insulating structure is formed by adhering the positive electrode tab lead and the heat-resistant insulating layer formed by coating the front and back surfaces of the negative electrode tab lead or the periphery thereof, and the heat-resistant insulating layer is a fluorine-based material. A tab sealant heat-resistant insulating structure for a nonaqueous electrolyte secondary battery, comprising a resin, a curing agent, and an adhesion-imparting agent.

According to a second aspect of the present invention, in the nonaqueous electrolyte secondary battery according to the first aspect, the heat-resistant insulating layer is formed larger than a heat-sealed region with the sealant layer. Tab sealant heat-resistant insulation structure.

The invention according to claim 3 is the nonaqueous electrolyte secondary according to claim 1, wherein the fluororesin contained in the heat-resistant insulating layer contains a functional group having an element other than fluorine. It is a tab sealant heat-resistant insulation structure of a battery.

The invention according to claim 4 is characterized in that the fluorine-based resin constituting the heat-resistant insulating layer contains a functional group having an element other than fluorine that reacts with a curing agent. It is a tab sealant heat-resistant insulation structure of a nonaqueous electrolyte secondary battery.

The invention according to claim 5 is the tab sealant heat resistant insulation structure for a non-aqueous electrolyte secondary battery according to claim 1, wherein the heat resistant insulation layer has a thickness of 3 μm to 30 μm, is there.

A sixth aspect of the present invention is a nonaqueous electrolyte secondary battery having the tab sealant heat-resistant insulating structure according to the first to fifth aspects.

The non-aqueous electrolyte secondary battery provided with the tab sealant heat-resistant insulation structure of the present invention on the tab lead ensures insulation between the tab lead and the barrier layer made of the metal foil of the exterior material, and retains insulation even after heat sealing. It can. Moreover, since the adhesiveness imparting agent is added to the heat resistant insulating structure of the tab sealant, the adhesiveness with the tab lead is excellent. As an additional effect, the heat-resistant resin layer can be easily formed by various coating methods because the base fluororesin is soluble in an organic solvent, and the manufacturing cost can be kept low.

It is an external appearance perspective view which shows an example of the nonaqueous electrolyte secondary battery of this invention. It is a schematic sectional drawing in the cutting line AA 'of FIG. It is a schematic sectional drawing of the tab sealant heat resistant insulation structure and battery member of this invention. (The tab leads from the two electrodes extend in the same direction, but the position is shifted left and right, so only one tab lead is shown in the cross-sectional view.) It is a schematic block diagram of a tab lead and a battery member. It is a schematic sectional drawing of the nonaqueous electrolyte secondary battery of the prior art example in the same location as the schematic sectional drawing of the nonaqueous electrolyte secondary battery of this invention shown in FIG.

An embodiment of a tab sealant heat-resistant insulating structure for a non-aqueous electrolyte secondary battery of the present invention will be described with reference to FIGS.

FIG. 1 is an external perspective view showing an example of an embodiment of a nonaqueous electrolyte secondary battery of the present invention. In the heat seal part 5 in which the sealant layer surfaces of the outer packaging material 1 of the nonaqueous electrolyte secondary battery of the present invention face each other and heat seal, the sealant layer overlaps the positive electrode tab lead 31 and the negative electrode tab lead 32 at the heat resistant insulating layer. a is formed to form a tab sealant heat-resistant insulating structure (not shown).

FIG. 2 shows an example of a schematic cross-sectional view of the nonaqueous electrolyte secondary battery of the present invention. As shown in FIG. 2, the tab sealant heat-resistant insulating structure b, which is a feature of the present invention, has heat resistance on at least the front and back surfaces of the positive electrode tab lead 31 and the negative electrode tab lead (not shown in the cross-sectional view because they overlap with the positive electrode tab lead). This is a structure in which the heat insulating material 1 is bonded to the portion where the conductive insulating layer a is formed by the exterior material 1 on both sides. The packaging material 1 includes a heat-resistant base material layer / barrier layer (for example, a metal foil layer such as aluminum, copper, and stainless steel) / a heat-fusible film layer (hereinafter referred to as a sealant layer). The sealant layer of the exterior material 1 is opposed to the inside, and the heat-resistant insulating layer a is formed at least on the front and back surfaces of the positive electrode tab lead 31 and the negative electrode tab lead (not shown). The size of the region of the heat resistant insulating layer a formed on the positive electrode tab lead 31 and the negative electrode tab lead (not shown) is the same as that of the heat seal portion 5 (the end portion of the exterior material 1 and the end portion of the heat resistant insulating layer a are A state in which the heat-resistant insulating layer a protrudes from the end portion of the exterior material 1).

FIG. 3 is a schematic sectional view of the tab sealant heat-resistant insulating structure and battery member of the present invention. The tab leads from the two electrodes extend in the same direction and are shifted to the left and right, but are overlapped in the cross-sectional views, so that only one tab lead (positive electrode tab lead 31) is clearly shown.
A heat-resistant insulating layer a is formed on a part of the tab lead group composed of the positive electrode tab lead 31 and the negative electrode tab lead (not

shown) extended outward from the internal electrode group 2 composed of the positive electrode 21, the negative electrode 23 and the separator 22. It is the schematic sectional drawing which showed an example of the state currently performed.

The tab sealant heat-resistant insulating structure b of the nonaqueous electrolyte secondary battery of the present invention has a base material, a barrier layer (metal foil layer), and an outer packaging material 1 of the nonaqueous electrolyte secondary battery 10 formed by laminating a sealant layer. The front and back surfaces of the positive electrode tab lead 31 and the negative electrode tab lead 32 that are connected to and extended from the sealant layer and the positive electrode 21 and the negative electrode 23 that are enclosed by the outer packaging material 1 of the nonaqueous electrolyte secondary battery 10 with the sealant layer as the inner surface side, or A heat-resistant insulating layer a formed by covering the periphery and a tab sealant heat-resistant insulating structure b formed by heat sealing (heat sealing) are formed, and the heat-resistant insulating layer a is a fluororesin, cured It is the tab sealant heat-resistant insulating structure b of the nonaqueous electrolyte secondary battery 10 including the agent and the adhesion-imparting agent.

The heat-resistant insulating layer a is mainly composed of a fluorine resin, and a curing agent for the fluorine resin,
Adhesion enhancer is added to enhance the adhesion of fluororesin, so that high adhesion to the heat sealant (sealant) of the exterior material is obtained, and at the same time it is exposed to high temperature during heat sealing, Can be retained, so that the original film thickness and structure can be maintained. Even if the sealant layer of the exterior material is melted by pressure and heating during heat sealing and flows around it, it is heat resistant. The layer does not melt and does not flow around. As a result, it is possible to maintain the electrical insulation of the nonaqueous electrolyte secondary battery.

The tab sealant heat-resistant insulating structure b may be formed larger than a heat-sealed (heat-sealed) region with the sealant layer.

FIG. 4 is a schematic configuration diagram of the tab lead and the battery member. The battery member 7 includes an internal electrode group 2 including a positive electrode 21, a negative electrode 23, and a separator 22 disposed therebetween. The tab lead is an extraction electrode for connecting the electrodes (the positive electrode 21 and the negative electrode 23) to an external circuit. The tab lead group 3 including the positive electrode tab lead 31 extending from the positive electrode 21 and the negative electrode tab lead 32 extending from the negative electrode 23 is provided. It is composed.

<Manufacturing method>
Next, the manufacturing method of the nonaqueous electrolyte secondary battery of this invention is demonstrated using FIG.
The method for producing a non-aqueous electrolyte secondary battery of the present invention includes a positive electrode / negative electrode production process for producing the positive electrode 21 or the negative electrode 23 by forming the positive electrode active material 41 or the negative electrode active material 42 on one side of the current collector, The positive electrode active material 41 is formed on one surface of the current collector, and the negative electrode active material 42 is formed on the other surface, thereby manufacturing the internal electrode group 2 electrode and the internal electrode manufacturing step. A battery member manufacturing process for manufacturing the battery member 7 by laminating a plurality of electrodes with the surface on which the positive electrode active material 41 is formed and the surface on which the negative electrode active material 42 is formed facing each other via the separator 22 The surface on which the outermost negative electrode active material 42 of the battery member 7 manufactured in the member manufacturing process is formed is opposed to the positive electrode 21 through the separator 22, and the surface on which the outermost positive electrode active material 41 is formed is Via separator 22 And a stacking step of stacking facing the negative electrode 23, and a heat sealing step of stacking the exterior material 1 from the front and back surfaces of the battery member 7 together with the electrolyte, and heat-sealing the peripheral portion of the battery member 7. In the water electrolyte secondary battery manufacturing method, the positive electrode / negative electrode manufacturing process includes at least heat-sealed portions of the positive electrode tab 21 and the negative electrode tab lead 32 extending from the positive electrode 21, the negative electrode 23, the positive electrode 21 and the negative electrode 23 (heat seal portion S). The method for producing a non-aqueous electrolyte secondary battery includes a step of forming a tab sealant heat-resistant insulating structure b.

Alternatively, in the positive electrode / negative electrode manufacturing process, a member in which the heat-resistant insulating layer a is formed at least on the heat-sealed portion (heat seal portion S) of the tab lead extending from the positive electrode 21, the negative electrode 23, the internal electrode group 2 and the like in advance is used. You can do it.

Next, each component will be described in detail.

[Exterior material]
Since the outer packaging material 1 is a container that encloses the electrode member 7, the tab leads 31 and 32, and the electrolytic solution, the outer packaging material 1 is made of a laminated film that can form the concave portion 11 by cold forming, in the laminated film, a protective layer for preventing pinholes and electrolytic corrosion of the barrier layer is formed on one side of the barrier layer for preventing moisture permeation, and the exterior material 1 is formed on the other side of the barrier layer. A sealant layer for heat-sealing is provided via an adhesive layer.

As the barrier layer, various metal foils such as aluminum and stainless steel can be used, and aluminum foil is particularly preferable from the viewpoint of workability such as moisture resistance and spreadability and cost. A general soft aluminum foil can be used as the aluminum foil. Among these, an aluminum foil containing iron is preferable from the viewpoint of excellent pinhole resistance and spreadability at the time of molding.
The content of iron in the aluminum foil containing iron (100% by mass) is 0.1% by mass or more and 9.0.
% By mass or less is preferable, and 0.5% by mass or more and 2.0% by mass or less is more preferable. If the iron content is 0.1% by mass or more, the exterior material 1 is excellent in pinhole resistance and spreadability. If the iron content is 9.0% by mass or less, the exterior material 1 is excellent in flexibility.

The thickness of the barrier layer is preferably 9 μm or more and 200 μm or less, and more preferably 15 μm or more and 100 μm or less from the viewpoint of barrier properties, pinhole resistance, and workability.

A corrosion prevention treatment layer can be provided on one side or both sides of the barrier layer. The corrosion prevention treatment layer plays a role of suppressing corrosion of the metal foil layer due to the electrolytic solution or hydrofluoric acid generated by the reaction between the electrolytic solution and water. As the corrosion prevention treatment layer, a coating film formed by a coating type or immersion type acid resistant corrosion prevention treatment agent is preferable. Such a coating film is excellent in the effect of preventing corrosion of the barrier layer against acid.

As the coating film constituting the corrosion prevention treatment layer, for example, a coating film formed by cerium oxide and phosphoric acid and various thermosetting resins, chromate, phosphate, Examples thereof include a coating film formed by chromate treatment with a corrosion preventing treatment agent comprising fluoride and various thermosetting resins. The corrosion prevention treatment layer may be a coating film in which the corrosion resistance of the metal foil layer is formed by a boehmite treatment or the like.

The corrosion prevention treatment layer may be a single layer or a multilayer. In addition, an additive such as a silane coupling agent may be added to the corrosion prevention treatment layer.

The thickness of the corrosion prevention treatment layer is preferably 10 nm or more and 5 μm or less, and more preferably 20 nm or more and 500 nm or less from the viewpoint of the corrosion prevention function and the function as an anchor.

The protective layer is formed of a resin, and is formed by a method in which the film is attached with an adhesive, the film is attached by heat fusion, or directly applied without using an adhesive or the like.

As the resin material for forming the protective layer, polyvinyl chloride, imide resin, polyester resin, fluorine resin, acrylic resin, urethane resin, polyamide resin, etc. can be used, among which polyester resin or fluorine based resins are preferred. This is because the polyester-based resin or the fluorine-based resin has high electrolytic solution resistance and can maintain insulation even under high humidity.

Examples of the fluorine-based resin forming the protective layer include, for example, tetrafluoroethylene resin, tetrafluoroethylene / perfluoroalkoxyethylene copolymer resin, tetrafluoroethylene / hexafluoropropylene copolymer resin, tetrafluoroethylene / Hexafluoropropylene / vinylidene fluoride copolymer resin, ethylene tetrafluoride / ethylene copolymer, ethylene tetrafluoride / vinyl copolymer resin, ethylene trifluoride / ethylene resin, ethylene tetrafluoride / perfluorodioxysol Polymerized resins, perfluoroalkenyl vinyl ether resins, vinylidene fluoride resins, vinyl fluoride resins and the like can be mentioned. Among them, tetrafluoride type fluororesins having a stable structure and excellent in insulation under high humidity are preferable. As the fluorine-based resin, one type or two or more types may be mixed.

Moreover, as a fluorine-type resin, in order to improve solvent solubility, it is desirable to give functional groups other than a fluorine. By improving the solvent solubility of the fluorine-based resin, it becomes possible to handle the same as a general coating liquid, and the manufacturing process such as coating and coating becomes easy.

Examples of functional groups other than fluorine include alkyl groups, alkoxy groups, halogen groups, halogenated alkyl groups, hydroxyl groups, phenol groups, carboxyl groups, aldehyde groups, ketone groups, amino groups, nitro groups, sulfo groups, and diazo groups. Cyano group, ether group, silanol group, vinyl group, vinyl ester group, vinyl ether group and the like. Among them, a hydroxyl group having high solubility in many solvents is preferable. As a method for imparting a functional group other than fluorine, various methods such as copolymerization, graft polymerization, and modification can be used. As the functional group other than fluorine, one type may be used, or two or more types may be provided.

Examples of the fluororesin having a functional group other than fluorine as described above include, for example, hydroxyl-modified tetrafluoroethylene / vinyl copolymer resin, carboxyl-modified tetrafluoroethylene / hexafluoropropylene copolymer resin, and the like. Can be mentioned.

As the polyester-based resin forming the protective layer, generally known polyester-based resins such as polyethylene terephthalate, polytrimethylene terephthalate, polybutylene terepinthalate, polyethylene naphthalate, polybutylene naphthalate can be used alone or in combination. The polyester resin is preferably a solvent-soluble amorphous polyester.

Moreover, it is preferable to harden the said fluorine-type resin or polyester-type resin with isocyanate. By curing with isocyanate, it is possible to improve the heat resistance of the coating film and to ensure insulation under high humidity due to the dense cross-linked structure.

The thickness of the protective layer is preferably 3 μm or more and 30 μm or less, and more preferably 5 μm or more and 20 μm or less. If the thickness of the protective layer is equal to or greater than the lower limit, insulation can be ensured, and even if it is thicker than the upper limit, the performance does not change and the space for enclosing the battery contents is reduced and the volume density is reduced.

The adhesive layer is a layer that bonds the barrier layer and the sealant layer. The exterior material 1 is roughly divided into two, a thermal laminate configuration and a dry laminate configuration, depending on the adhesive component forming the adhesive layer.

In the case of a thermal laminate configuration, for example, an acid-modified polyolefin resin obtained by graft-modifying a polyolefin resin with an acid such as maleic anhydride is preferable. The acid-modified polyolefin-based resin has a non-polar sealant layer formed of a polyolefin-based resin film and the like, and a polar barrier layer or corrosion because a polar group is introduced into a part of the non-polar polyolefin-based resin. It is possible to firmly adhere to both of the prevention treatment layers. In addition, by using an acid-modified polyolefin-based resin, resistance to contents such as an electrolytic solution is improved, and even if hydrofluoric acid is generated inside the battery, it is easy to prevent a decrease in adhesion due to adhesive deterioration. The acid-modified polyolefin resin may be one type or two or more types.

Examples of the polyolefin resin used for the acid-modified polyolefin resin include low density, medium density or high density polyethylene; ethylene-α olefin copolymer; homo, block or random polypropylene; propylene-α olefin copolymer. Can be mentioned. In addition, a copolymer obtained by copolymerizing a polar molecule such as acrylic acid or methacrylic acid with the aforementioned one, a polymer such as a crosslinked polyolefin, and the like can also be used. Examples of the acid that modifies the polyolefin resin include carboxylic acid and acid anhydride, and maleic anhydride is particularly preferable.

In the case of a thermal laminate configuration, the adhesive layer can be formed by extruding the adhesive component with an extrusion device.

In the case of a dry laminate configuration, as an adhesive component, for example, a two-component curable type in which a bifunctional or higher aromatic or aliphatic isocyanate compound is allowed to act as a curing agent on a main component such as polyester polyol, polyether polyol, and acrylic polyol. And polyurethane adhesives. However, since the polyurethane-based adhesive has a highly hydrolyzable bond such as an ester group or a urethane group, a thermal laminate configuration is preferable for applications that require higher reliability.

The adhesive layer having a dry laminate structure can be formed by applying an adhesive component on the barrier layer and then drying. If a polyurethane adhesive is used, after coating, for example, by aging for 4 days or more at 40 ° C., the reaction between the hydroxyl group of the main agent and the isocyanate group of the curing agent proceeds and strong adhesion is possible. It becomes.

The thickness of the adhesive layer is preferably 2 μm or more and 50 μm or less, and more preferably 3 μm or more and 20 μm or less from the viewpoints of adhesiveness, followability, workability, and the like.

The sealant layer is a layer that imparts sealing properties by heat sealing in the exterior material 1. Examples of the sealant layer include a polyolefin resin or a resin film made of an acid-modified polyolefin resin obtained by graft-modifying an acid such as maleic anhydride to a polyolefin resin.
Examples of the polyolefin-based resin include low density, medium density, and high density polyethylene; ethylene-α olefin copolymer; homo, block, or random polypropylene; propylene-α olefin copolymer. These polyolefin resin may be used individually by 1 type, and may use 2 or more types together.
Examples of the acid that modifies the polyolefin resin used in the acid-modified polyolefin resin include carboxylic acid, epoxy compound, acid anhydride, and the like, and maleic anhydride is preferable.

The sealant layer may be a single layer film or a multilayer film, and may be selected according to the required function. For example, in terms of imparting moisture resistance, a multilayer film in which a resin such as an ethylene-cyclic olefin copolymer or polymethylpentene is interposed can be used.
The sealant layer may contain various additives such as a flame retardant, slip agent, anti-blocking agent, antioxidant, light stabilizer, and tackifier.

The thickness of the sealant layer is preferably 10 μm to 100 μm, and more preferably 20 μm to 60 μm.

[electrode]
The electrode member 7 includes a positive electrode 21, a separator 22, and a negative electrode 23. The positive electrode 21 is formed by providing a positive electrode active material 41 layer made of an oxide powder, a conductivity-imparting agent, and a binder on a current collector made of a metal foil such as aluminum, nickel, or titanium. As the oxide powder, for example, $LiCoO_2$, $LiNiO_2$, $LiMn_2O_2$ or the like is used. As the conductivity imparting agent, for example, carbon black, acetylene black, graphite, carbon nanotube, conductive oxide powder, or the like is used. As the binder, for example, polyvinylidene fluoride (PVDF), fluoro rubber, carboxymethyl cellulose (CMC), styrene butadiene rubber, or the like is used. As the separator 22, for example, a porous film made of polyolefin, aramid, polyimide, or the like, or a nonwoven fabric made of polyester, nylon, acetate, or the like is used. The negative electrode 23 is formed by providing a negative electrode active material 42 layer made of graphite or a lithium transition metal composite oxide and a binder on a current collector made of copper or stainless steel. For example, natural graphite or artificial graphite is used as the graphite. As the lithium transition metal composite oxide, for example, a lithium-titanium composite oxide, a lithium-silicon alloy, a lithium-tin alloy, or the like is used.

[Tab Lead]
The tab lead includes a positive electrode tab lead 31 and a negative electrode tab lead 32, and extends outward from the positive electrode 21 and the negative electrode 23, respectively, or is joined to the positive electrode 21 and the negative electrode 23.
Since the tab lead takes out current, the other tip which is not joined to the positive electrode 21 and the negative electrode 23 is arranged outside the battery. The tab lead is made of, for example, aluminum, nickel, titanium, stainless steel, copper, or an alloy thereof. Alternatively, it is also formed by leaving a part where the active material is not applied to a part of the current collector of the electrode such as the positive electrode 21 and the negative electrode 23 and processing this part. The tab lead is provided with a tab sealant heat-resistant insulating structure a. When heat-sealing the outer packaging material 1 with the tab lead sandwiched, the burrs when cutting the tab lead damage the sealant layer of the outer packaging material 1, or when the tab lead is thick, the sealant layer flows and becomes thin due to heat. There is a possibility that the barrier layer made of the metal foil of the exterior material 1 may be short-circuited. In order to prevent this, a tab sealant heat-resistant insulating structure a is provided at least in a portion where the tab lead heat-seals with the exterior material 1 (heat seal portion S).

[Tab sealant heat-resistant insulation structure]
The tab sealant heat-resistant insulating structure a is provided in a portion where the tab lead heat-seals with the exterior material 1 (heat seal portion S). The tab sealant heat-resistant insulating structure a contains a fluororesin, a curing agent, and an adhesion-imparting agent. A coating film having heat resistance and insulation can be obtained by curing the fluororesin with a curing agent. In the present invention, the heat resistance can withstand at least the sealant temperature (heat melting temperature) of the sealant processing with the sealant layer (not shown) of the exterior material 1. In the present invention, at a temperature of 200 ° C. The coating film does not flow out even after being exposed for 10 seconds, and the insulation resistance value when the voltage of 25 V is applied can be maintained at 500Ω (3 minutes) or more. As the fluororesin, for example, a fluororesin that forms the protective layer described in the above paragraph 0034 can be used, but the fluororesin is not limited thereto. This fluorine-based resin is desirably provided with a functional group other than fluorine in order to improve solvent solubility and cause a curing reaction with a curing agent. Functional groups other than fluorine are imparted using various methods such as copolymerization, graft polymerization, and modification. One type of fluorine-based resin may be used, or two or more types may be mixed.

A general resin curing agent can be used as the curing agent. Examples thereof include, but are not limited to, diisocyanate, dicarboxylic acid, epoxy, hydrazine, diamine, metal complex compound, and carbodiimide. As the curing agent, it is desirable to select a curing agent that reacts with the functional group of the fluorine-based resin. As a hardening (curing agent, 1 type may be sufficient and 2 or more types may be mixed.

The addition amount of the curing agent is determined by the functional group amount that reacts with the functional group of the fluororesin contained in the curing agent. The functional group amount of the curing agent is preferably 0.5 to 5 times, more preferably 1 to 3 times the functional group amount of the fluororesin. If the functional group amount of the curing agent is less than the lower limit, insulation cannot be obtained, and if it exceeds the upper limit, curing takes time and productivity is lowered.

The adhesion-imparting agent is added to increase the adhesion between the heat-resistant insulating layer a and the tab lead. By adding an adhesion-imparting agent, the adhesion can be obtained without providing an adhesive layer such as a modified polyolefin layer between the tab lead and the heat-resistant insulating layer a. Examples of the adhesion-imparting agent include those that interact or react with the metal surface. For example, polycarboxylic acid resin, epoxy resin, phenol resin, polyvinyl acetal resin, melamine resin and the like can be mentioned. As the adhesion-imparting agent, one kind may be used, or two or more kinds may be mixed.

The addition amount of the adhesion-imparting agent is preferably 0.1% by mass or more and 30.0% by mass or less, and 1.0% by mass or more and 10.0% by mass or less in 100% by mass of the material constituting the heat-resistant insulating layer a. More preferred. If the addition amount of the adhesion imparting agent is less than the lower limit value, the adhesion imparting effect cannot be obtained, and if it is greater than the upper limit value, the tensile stress of the heat-resistant insulating layer a decreases.

As the heat-resistant insulating layer a, since an adhesion-imparting agent is added, the heat-resistant insulating layer a can be formed by directly printing or applying the coating liquid of the heat-resistant insulating layer a on the electrode tab lead. After coating, it may be formed by other methods such as pasting or winding on the electrode tab lead, or pasting or winding a heat-resistant insulating film formed in a film shape on the electrode tab lead.

The tab sealant heat-resistant insulating structure b may or may not have another layer between the tab leads. For example, an adhesive resin layer may be provided between the heat-resistant insulating layer a and the tab lead. Examples of the adhesive resin layer include modified polyolefins. Further, there may or may not be another layer on the other surface between the tab lead of the heat-resistant insulating layer a. An adhesive resin layer such as a modified polyolefin may be provided on the other surface between the heat-resistant insulating layer a and the tab lead.

As the heat resistant insulating layer a, a film thickness of 3 μm or more and 30 μm or less is desirable. When the film thickness is equal to or greater than the lower limit, the insulation between the exterior material 1 and the tab lead is particularly good. However, the insulation between the exterior material 1 and the tab lead does not change even when the film thickness is greater than the upper limit, is just wasted.

When the heat-resistant insulating layer a is provided on the entire surface of the tab lead, conductivity cannot be obtained. Therefore, the heat-resistant insulating layer a should be provided only on the portion (heat seal portion S) that is heat-sealed with the tab lead exterior material 1, desirable. The heat-resistant insulating layer a may protrude from the heat seal portion S along the tab lead.

Although the Example of this invention is shown below, it is not limited to this.

<Example 1>
A tab lead made of an aluminum sheet 1N30-O material having a width of 4 mm, a length of 30 mm, and a thickness of 100 μm was subjected to a non-chromium surface treatment by an immersion method. A coating liquid in which 20% by mass of a fluorine-based resin, 51% by mass of a diisocyanate curing agent, 2% by mass of a polycarboxylic acid resin, and 27% by mass of toluene are mixed in a heat-sealed portion of the surface-treated tab lead is dried and then coated. The coating was applied to a thickness of 3 μm, dried at 140 ° C. for 1 minute, and aged at 40 ° C. for 4 days to form a heat-resistant insulating layer.
An exterior material made of a fluororesin layer, aluminum foil, acid-modified polypropylene, and polypropylene is cut into a size of 50 mm × 90 mm, folded in half at the

long side, and a positive tab lead and a negative tab lead are provided on one side of the side having a width of 45 mm. It was sandwiched and heat sealed. Heat sealing was performed at 200 ° C. for 10 seconds. The other two sides without tab leads were heat sealed at 200 ° C. for 5 seconds. First, heat-seal the opposite side, then fill 2ml of $LiPF_6$ (lithium hexafluorophosphate) in a mixed solution of diethyl carbonate and ethylene carbonate, and finally heat-seal the tab lead. Went. Thereby, a non-aqueous electrolyte secondary battery pack for evaluation having a tab sealant heat-resistant insulating structure in the heat seal portion and not enclosing a battery element such as a current collector was produced.

<Example 2>
A battery pack was produced in the same manner as in Example 1 except that the thickness of the heat-resistant insulating layer was 5 μm.

<Example 3>
A battery pack was produced in the same manner as in Example 1 except that the thickness of the heat-resistant insulating layer was 20 μm.

<Example 4>
A battery pack was produced in the same manner as in Example 1 except that the thickness of the heat-resistant insulating layer was 30 μm.

<Example 5>
A battery pack was produced in the same manner as in Example 2 except that the epoxy resin was used as the polycarboxylic acid resin of the heat resistant insulating layer.

<Example 6>
A battery pack was produced in the same manner as in Example 2 except that the polycarboxylic acid resin of the heat-resistant insulating layer was changed to a phenol resin.

<Example 7>
A battery pack was produced in the same manner as in Example 2 except that the polycarboxylic acid resin of the heat-resistant insulating layer was changed to polyvinyl acetal resin.

<Example 8>
A battery pack was produced in the same manner as in Example 2 except that the melamine resin was used as the polycarboxylic acid resin of the heat resistant insulating layer.

<Comparative Example 1>
A battery pack was produced in the same manner as in Example 1 except that a sealant film made of 50 μm acid-modified polyolefin was wrapped around the heat-sealed portion of the tab lead instead of providing the heat-resistant insulating layer.

<Comparative example 2>
A battery pack was produced in the same manner as in Example 2 except that no curing agent was added to the heat resistant insulating layer.

<Comparative Example 3>
A battery pack was produced in the same manner as in Example 2 except that no adhesion promoter was added to the heat-resistant insulating layer.

[Evaluation method]
The tab lead insulation and the adhesion between the tab lead and the exterior material were evaluated. Details are shown below.

(Insulation)
Insulation evaluation equipment (manufactured by Kikusui Electronics Co., Ltd.) was used to measure the insulation between the exterior material heat seal portion and the tab lead. If the insulation resistance value reached the measurement limit of the device, it was A. If the insulation resistance value did not reach the measurement limit but it was not shorted, it was B, and if it was shorted, it was C.

(Tab lead adhesion)
Measurement was performed with a tensile tester (manufactured by Shimadzu Corporation) under conditions of a peeling angle of 180 degrees and a peeling speed of 90 mm / min. If the peel strength between the tab lead and the layer on the tab lead is 2.5 N / 5 mm or more, it is A, and if it is less than 2.5 N / 5 mm, it is B.

As a result, as shown in Table 1, Examples 1 to 8 having a tab sealant heat-resistant insulating structure maintained insulation even after heat sealing by providing a heat-resistant insulating layer on the tab lead. Examples 2 to 8 in which the film thickness of the tab sealant heat-resistant insulating structure was 5 μm or more were particularly excellent in insulation. Examples 1 to 8 were also excellent in adhesion between the exterior material and the tab lead. On the other hand, in Comparative Example 1 using a polyolefin-based sealant film, the sealant film was thinned by flowing with heat of heat sealing, and insulation was not obtained. In Comparative Example 2 in which a heat-resistant insulating layer was provided but no curing agent was added, insulation was not obtained, and in Comparative Example 3 in which no adhesion-imparting agent was added, adhesion with a tab lead was not obtained. became.
As described above, a tab lead having a tab sealant heat-resistant insulating structure having a heat-resistant insulating layer composed of a fluororesin, a curing agent, and an adhesion-imparting agent maintains the insulating property even when heat-sealed. It was also possible to secure the adhesion with.

DESCRIPTION OF SYMBOLS 1 Exterior material 11 Recessed part 2 Internal electrode group 21 Positive electrode 22 Separator 23 Negative electrode 3 Tab lead group 31 Positive electrode tab lead 32 Negative electrode tab lead 41 Positive electrode active material 42 Negative electrode active material 5, 6 Heat seal part 7 Battery member 10, 14 Nonaqueous electrolyte secondary battery a Heat-resistant insulation layer b Tab sealant heat-resistant insulation structure

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CN111525194A *	2020-04-28	2020-08-11	[redacted]	Electrochemical device and electronic device including the same
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Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
JP2015182966A	2015-09-16	2015-09-16	Tab sealant heat-resistant insulating structure for nonaqueous electrolyte secondary battery and nonaqueous electrolyte secondary battery

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Application	Filing date	Title

JP2015182958A	2015-09-16	Tab sealant heat-resistant insulating structure for nonaqueous electrolyte secondary battery and nonaqueous electrolyte secondary battery

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/699,555	**09/18/2023 04:17:43 PM ET**	**U 020968-8**

Title of Invention

ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	3466	FILED BY	Olivia Stanford Cato
PATENT CENTER #	62816815	FILING DATE	03/21/2022
CUSTOMER #	140	FIRST NAMED INVENTOR	Xiaojing Liu
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Janet Cord

Documents

TOTAL DOCUMENTS: 28

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
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NPL1_EESR.pdf	6	Other reference-Patent/Application/Search Documents	745 KB
NPL2_CA-OA1.pdf	3	Other reference-Patent/Application/Search Documents	552 KB
NPL3_PAT201909051JP1-OA1.pdf	3	Other reference-Patent/Application/Search Documents	640 KB

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Digest

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5_JP2014225326A_translation. pdf	71D415F1EFC91EFF9304E2C8DFD38EA78BDDD092D5363471 FDF67B340B45F8C2F279C20228DBE69AFC7FAEF7DB3280FF4 4AAF2981326813DB575BB8BA36A20EE
6-JP2000106167A.pdf	29D533D85B8EC72D4701F7E0D7E0C748DDCB48913002CDBE 92FC9CE4B4D32A55B68D5BD10A49FDB2DF407B640E846C1B 41F6A8756B00B1875D12E5986DB2E3F2
6-	2EF4B0204F6DA0EFF527CFEFD2CBAABEB4CCAA7130CCC1B

JP2000106167A_translation.pdf	CE48FEC656899B76ECA6460549BAC38E1E9C013B3E3102CCC6D15583BF6D13D1AB18CF54144E3C16B
7_JP2019046592A.pdf	DCA3EC92A67BC1BCC5263CA5BC420FB285813A4C7D71C09FE4FF31927C9804D8AE9C1156AF880772D7AA2941E3E5D5552A9A97D8973ED293D71C838E134A57A7
7_JP2019046592A_translation.pdf	759E8CB0C1C6C246FC82117673F3F364F94E663E2901BDBFC3CCF98BEB8B96AE684CA236A9F5E688B6910A3E8A4BD92D65771441DA55F424A43D5DE666F0604A
8_CN111029527A.pdf	9D3DE1236030017D4E019C576C9D3AAC277B2A8272C03A394233D2DD015985D987CB1F4BF9CF75FCA9540AC48ABEA57824017BD290083D73628730D8F299ED51
8_CN111029527A_translation.pdf	EE56DE0B537C50544EA21CEA6BF427A1A067E73D66CA3DB91D0A1C6893B7E0E5AA6152181F59E85679DCB7904B4587B4A0EFAA020BF1748CB22BF4146C477C6B
9_JP2017059402A.pdf	6C3E5E9BED19BA73760EF2510E880EB236DCE45F1EAE3AB76E10D29A1DA40C77CA44E9128AF3A56564BA00A3E4782AF039C9CA0254790A44554810A0A4626D10
9_JP2017059402A_translation.pdf	B3EFECA3D102902E70FBC4A4E874A35E2D6F0A407E5777436AE39BAF6BA30E6E41CB0051030ED1169308F0397BA87D34B4685423CCD580B3A1A59599CF95F399

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the

International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	17699555
Filing Date	2022-03-21
First Named Inventor	Xiaojing Liu
Art Unit	
Examiner Name	
Attorney Docket Number	U 020968-8

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20190207212	A1	2019-07-04	Caicai LI	claims 1-20, figs 1-7
	2	20190044124	A1	2019-02-07	K. Kawate	
	3	20180026298	A1	2018-01-25	K. Hasegawa et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2000077055	JP	A	2000-03-14	NGK Insulators Ltd		☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17699555
	Filing Date	2022-03-21
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

	2	2016018654	JP	A	2016-02-01	Hitachi Ltd		☒
	3	2006032052	JP	A	2006-02-02	Sony Corp		☒
	4	2012084412	JP	A	2012-04-26	Panasonic Corp		☒
	5	2014225326	JP	A	2014-12-04	Panasonic Corp		☒
	6	2000106167	JP	A	2000-04-11	Mitsubishi Electric Corp		☒
	7	2019046592	JP	A	2019-03-22	GS Yuasa Corp		☒
	8	111029527	CN	A	2020-04-17	Ningde Amperex Technology Ltd		☒
	9	2017059402	JP	A	2017-03-23	Toppan Inc		☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Extended European Search Report for EP Application No. 20933746.8, dated July 4, 2023	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17699555
	Filing Date	2022-03-21
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

	2	First Office Action of CA application No. 3,164,572, dated July 25, 2023	☐
	3	First Office Action of JP application No. 2022543155, dated Sept. 5, 2023	☒
	4	First Office Action of IN application No. 202227044389, dated December 12, 2022	☒
	5	Supplementary Search Report for CN Application No. 202010349336.4, dated March 30, 2023	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	17699555
	Filing Date	2022-03-21
	First Named Inventor	Xiaojing Liu
	Art Unit	
	Examiner Name	
	Attorney Docket Number	U 020968-8

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Shiming Wu/	Date (YYYY-MM-DD)	2023-09-18
Name/Print	Shiming Wu	Registration Number	56885

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

INTELLECTUAL PROPERTY INDIA
एकस्व/PATENTS|अभिकल्प/DESIGNS|
व्यापार चिह्न/TRADE MARKS|भौगोलिक
उपदर्शन/GEOGRAPHICAL INDICATIONS

भारत सरकार
GOVERNMENT OF INDIA

एकस्व कार्यालय /THE PATENT OFFICE
बौद्धिक सम्पदा भवन/ I.P.O. BUILDING
एंटोप हिल/Antop Hill,
एस एम रोड/ S.M.Road,
मुंबई/ Mumbai- 400037
दूरभाष /Tel. No.: (022)24159194, 24141026
फैक्स/ Fax: 022-24130387
ई मेल/ Email: mumbai-patent@nic.in
वेबसाइट /Website:http://ipindia.nic.in

अ.संख्या/Ref.No /आवेदन संख्या/Application No/ 202227044389 दिनांक/Date of Dispatch/Email: 01/12/2022

सेवा मे,/To
PRIYANK GUPTA,
Stratjuris Law Partners, Office 301, Westport, Pan card club road, Baner, Pune-411045, Maharashtra, India
Email : ip@stratjuris.com

विषय: एकस्व अधिनियम, 1970 की धारा 12 व 13 तथा एकस्व नियम, 2003 के अधीन परीक्षण रिपोर्ट
Subject: Examination report under sections 12 & 13 of the Patents Act, 1970 and the Patents Rules, 2003.

1. उपर्युक्त आवेदन के संदर्भ मे परीक्षण रिपोर्ट (अर्थात, एकस्व नियम, 2003 (यथा संशोधित) के नियम 24-ख(3) में विनिर्दिष्ट आपत्तियों का प्रथम कथन) इसके साथ संलग्न है। यह रिपोर्ट परीक्षण हेतु अनुरोध दिनांक 03/08/2022 के उत्तर मे जारी की गयी है। परीक्षण रिपोर्ट का उत्तर दाखिल करने की अंतिम तिथि (अर्थात, इस रिपोर्ट में लगाई गयी सभी आवश्यकताओं के अनुपालन की अवधि) आवेदक को आपत्तियों का प्रथम कथन जारी होने की तिथि से छः माह है।
Please find enclosed herewith an Examination Report (i.e. a first statement of objections as specified in Rule 24-B(3) of The Patents Rules, 2003 (as amended)) in respect of above-mentioned application. This report is issued with reference to a request for examination dated 03/08/2022.The last date for filing a response to the Examination Report (i.e. a period to comply with all the requirements raised in this examination report) is six months from the date on which the first statement of objections is issued to the Applicant.

2. यदि रिपोर्ट के अंतर्गत लगाई गयी आवश्यकताओं का अनुपालन एकस्व नियम, 2003 (यथा संशोधित) के नियम 24 ख(5) में विनिर्दिष्ट अवधि के भीतर अंदर अनुपालन नहीं किया गया तो एकस्व अधिनियम 1970 की धारा 21(1) के अधीन वर्तमान आवेदन को परित्यक्त माना जाएगा।
The instant application shall be deemed to have been abandoned under Section 21(1) of The Patents Act, 1970, unless all the requirements raised in this report are complied with in the period as specified in Rule 24-B (5) of The Patents Rules, 2003 (as amended).

3. आपका ध्यान एकस्व नियम, 2003 के नियम 24 ख(6) के प्रावधानों की ओर भी आमंत्रित किया जाता है।
Your attention is also invited to the provisions of Rule 24-B (6) of the Patents Rules 2003.

4. आपको सलाह दी जाती है कि शीघ्र निपटान हेतु अपना उत्तर शीघ्र प्रस्तुत करें।
You are advised to file the reply at the earliest for early disposal.

Sandeep Kumar
नियंत्रक पेटेंट/ Controller of Patents

संलग्न/Enclosed: उपरोक्त अनुसार/As above

टिप्पणी: यह इलेक्ट्रोनिक रूप से उत्पन्न रिपोर्ट है।
NOTE: This is an electronically generated report.

सभी पत्राचार नियंत्रक एकस्व को उपरोल्लिखित पते पर भेजा जाये।
All communications should be sent to the Controller of Patents at the above mentioned address.

THE PATENT OFFICE

परीक्षण रिपोर्ट /Examination Report

आवेदन संख्या /Application Number	202227044389
दाखिल करने की तिथि /Date of Filing	03/08/2022
पूर्विकता दिनांक /Date of Priority	--
पीसीटी अंतर्राष्ट्रीय आवेदन की संख्या व दिनांक / PCT International Application No. & Date	CN2020087515 -- 28/04/2020
आवेदक /Applicant	NINGDE AMPEREX TECHNOLOGY LIMITED
परीक्षण हेतु अनुरोध की संख्या व दिनांक /Request for Examination No. & Date	R20222028340 03/08/2022
प्रकाशन की तिथि /Date of Publication	16/09/2022

इस परीक्षण रिपोर्ट के चार भाग हैं, अर्थात रिपोर्ट का सारांश, विस्तृत तकनीकी रिपोर्ट, औपचारिक आवश्यकताएँ तथा रिकॉर्ड में दस्तावेज़ /
This examination report consists of four parts, namely summary of the report, detailed technical report, formal requirements and documents on record.

भाग -1: रिपोर्ट का सारांश
PART-I: SUMMARY OF THE REPORT

क्र. सं. /Sl. No.	अधिनियम के तहत आवश्यकताओं पर विस्तृत टिप्पणियां /Requirements under the Act		दावों की संख्या /Claim Numbers	टिप्पणी /Remarks
1.	धारा 2(1)(ज) के तहत आविष्कार /Invention u/s 2(1)(j)	नवीनता /Novelty	दावे /Claims:	हाँ /Yes
			दावे /Claims: 1-10	नहीं /No
		आविष्कारी कदम / Inventive step	दावे /Claims:	हाँ /Yes
			दावे /Claims: 1-10	नहीं /No
		औद्योगिक उपयोगिता /Industrial Applicability	दावे /Claims: 1-10	हाँ /Yes
			दावे /Claims:	नहीं /No
2.	धारा 3 के अधीन पेटेंट-अयोग्यता (यदि हाँ, खंड 3(क-प) /Non-patentability u/s 3 (if yes, specify section3(a-p))		दावे /Claims: 1-2	हाँ /Yes 3(k)
			दावे /Claims:	नहीं /No
3.	[धारा 10(5) व 10(4) (ग)] के अधीन दावे /Claims [u/s 10(5) & 10(4) (c)]	स्पष्टता/ संक्षिप्तता /Clarity / Conciseness	दावे /Claims:	हाँ /Yes
			दावे /Claims: 1-10	नहीं /No
		क्षेत्र /Scope	दावे /Claims:	हाँ /Yes
			दावे /Claims: 1-10	नहीं /No
4.	अन्य आवश्यकता (एं) /Other requirement(s): 1. All the submitted documents and forms have been presumed as originally signed by the authorized signatory under the provisions of the Patents Act, 1970. If not, submit the originally signed copy of the same failing to which the document may not be considered filed.			

भाग –II विस्तृत तकनीकी रिपोर्ट
PART-II: DETAILED TECHNICAL REPORT

क. उद्धरित दस्तावेजों की सूची /A.List of documents cited:

(क) पेटेंट साहित्य / (a). Patent Literature :

क्र. सं. / Sl.no	दस्तावेज़ों का विवरण /Details of documents	प्रकाशन तिथि(दिन/माह/वर्ष) / Publication date	उद्धरित दस्तावेज़ का प्रासंगिक विवरण (पृष्ठ व अनुच्छेद संख्या) / Relevant description (page and paragraph no.) of cited document	उद्धरित दस्तावेज़ के प्रासंगिक दावे / Relevant claims of cited document	अभिकथित आविष्कार के दावे /Claims of alleged invention
1	D1: CN1949580A	18/04/2007	the whole document		all claims
2	D2: CN110459730A	15/11/2019	the whole document		all claims

(a) गैर-पेटेंट साहित्य /(b).Non-patent literature

कोई दस्तावेज़ उद्धृत नहीं है /No Document Cited

ख. अधिनियम के तहत आवश्यकताओं पर विस्तृत टिप्पणियां /B. Detailed observations on the requirements under the Act:

(1).नवीनता / NOVELTY:

(I) ऊपर उद्धरित दस्तावेज़ के संदर्भ (1-10) में लिये गए प्रकटन के पूर्वानुमान को ध्यान में रखते हुए, निम्नलिखित कारणों से दावा(वों) (1-10) में नवीनता की कमी है /
Claim(s) (1-10) lack(s) novelty, being anticipated in view of disclosure in the document cited above under reference for the following reasons:

D1: CN1949580A

Document D1 published on 18/04/2007 discloses a high power Li ion battery, comprising anode, cathode, diaphragm and nonaqueous electrolyte, where anode and cathode coatings containing active materials are continuous coatings, one side of each of the anode and cathode in the coiling direction has a current collector margin where anode and cathode ears are arranged. And it is characterized in that: anode ear section area S1, anode ear distance d1 and anode coating width w1 meet: 1*10-5

Hence, in view of cited documents D1, the subject matter claimed in claims 1-10 of the alleged invention is not new, lacks novelty. Therefore claims 1-10 do not meet the requirement of section 2 (1) (j) of The Indian Patents Act.

(2).आविष्कारी कदम / INVENTIVE STEP:

(I) ऊपर उद्धरित दस्तावेज़(जों) के संदर्भ में स्पष्ट अध्यापन(नों) को ध्यान में रखते हुए, निम्नलिखित कारणों से दावा(वों) (1-10) में आविष्कारी कदम की कमी है
Claim(s) (1-10) lack(s) inventive step, being obvious in view of teaching (s) of cited document(s) above under reference for the following reasons:

D2: CN110459730A

Document D2 published on 15/11/2019 discloses a kind of lithium ion battery, comprising the following steps: 1. make positive plate and negative electrode tab respectively; 2. chemical conversion: it is fixed after positive plate and negative electrode tab are alternately superimposed, it after heated baking, in water-less environment, is immersed in electrolyte, is melted into the electric current of 0.01C-0.2C, obtains battery semi-finished product; 3. compression molding and encapsulation: the battery semi-finished product after chemical conversion being

heated to 60-100 DEG C, is put into prefabricated mould, applies the pressure of 0.2-15MPa, be allowed to form ; It places into shell, obtains lithium ion battery after encapsulated.The present invention provides a kind of lithium ion battery and preparation method thereof, without processes such as coating, cutting, film-makings, can once form pole piece, production method is simple and efficient. (See the whole document).

The subject matter of claims can be achieved by combining the prior art documents D1-D2. Hence, claims lack inventive steps in view of documents D1-D2 U/S 2(1) (ja) of The Patents Act, 1970.

(3).पेटेंट अयोग्यता /NON PATENTABILITY:

(I) निम्नलिखित कारणों से धारा 3 के खंड (3(k))के प्रावधान के तहत दावा(वे) (1-2) आविष्कार के रूप में पेटेंट योग्य नहीं हैं /
Claim(s) (1-2) are statutorily non-patentable under the provision of clause (3(k)) of Section 3 for the following reasons:

1. Without prejudice to any other objections, Claims 1-2 is nothing but a mathematical method. Hence subject matter of said claims falls within scope of clause (k) of section (3) of the Patents Act, 1970 (as amended). Therefore invention claimed in said claims is not patentable.

(4).प्रकटन की दक्षता /SUFFICIENCY OF DISCLOSURE:

(5).क्षेत्र /SCOPE:

(I) दावा(वे) 1-10 आविष्कार के उस क्षेत्र जिस के लिए संरक्षण का दावा किया गया है उसे निम्नलिखित कारणों से परिभाषित नहीं करता(वे) है.
Claim(s) 1-10 does/do not define the scope of invention for which the protection is claimed for the following reasons:

1. The term "any one of claims" in claims tends to widen the scope of the subject matter claimed from the preceding claims.

(6).स्पष्टता एवं संक्षिप्तता /CLARITY AND CONCISENESS:

(I) दावा(वे) 1-10 के संबंध में स्पष्ट रूप से परिभाषित नहीं हैं.
Claim(s) 1-10 are not clearly worded in respect of:

1. Technical features of the claims should be referenced with numerals in parentheses as per u/s 10(5).

(7).अन्य आवश्यकताएँ /OTHERS REQUIREMENTS:

(I)

1. In case the applicant decides to amend the claims subsequent to this report, the same shall be drafted afresh to include the technical advancement over the prior art cited in FER as required u/s 2(1)(j) of the Patents Act. Please indicate in the response Communication the support for such amendments claims in the original specification, as required u/s 10(4) of the Act. Care shall be taken that requirement section 59 (1) of the Act is also met. Please provide an additional copy of marked up amendments (highlighting the amendments) wherever applicable.

2. In case the applicant decides to contest this report, the reasons therefore along with the technical significance thereof may please be indicated in the response communication.

भाग – III: औपचारिक आवश्यकताएँ /PART-III: FORMAL REQUIREMENTS

आपत्तियां /Objections	टिप्पणी /Remarks
Statement & Under Taking (Form 3 Details)	1. The period within which the applicant shall file the statement and undertaking under sub-section (1) of section 8 is six months from the date of filing the application. Annexure to form 3 has not been filed in accordance to rule 12 (1A) of The Patent Act.
Power of Attorney (Whether GPA, SPA, Stamped, requisite fee etc.)	1. Attested copy of GPA should also be submitted in original after filing them electronically as per the provisions of rule 6(1-A) of the Patents Rules, 2016 (as amended).
Format of Specification (rule 13)	1. Blank page and irrelevant portion should be scored out from the complete specification. 2. The complete specification should be prepared following the margin requirement prescribed in rule 9. Further, any fee needs to be paid for extra pages resulting therein should be paid.
Other Deficiencies	1. Date and sign of the applicant/authorized agent is not mentioned in verious forms and other documents (it appears that applicant has pasted the sign). 2. Application no. should be mention in form-5.

भाग-IV: रिकॉर्ड में दस्तावेज़ /PART-IV: DOCUMENTS ON RECORD

निम्नलिखित दस्तावेज़ों के आधार पर यह परीक्षण रिपोर्ट तैयार की गयी है
The examination report has been prepared based on the following documents:

कार्यसूची तिथि / Docket Date	कार्यसूची संख्या /Docket Number	प्रविष्टि संख्या विवरण /Entry Number Description
03 Aug 2022	46146	12-Request For Early Publication - Form 9
03 Aug 2022	46146	1-New Application For Patent With Provisional /Complete Specification
03 Aug 2022	46146	28(i)-Request For Examination After 18 months Publication - Form 18
04 Aug 2022	46320	18(i)-Amendment Of Application Before Grant - Form 13

नियंत्रक का नाम /Name of the Controller: Sandeep Kumar

नियंत्रक स्थान /Controller Location: Delhi

टिप्पणी: परीक्षण रिपोर्ट का उत्तर दाखिल करने की अंतिम तिथि / Note: Last date for filing response to the Examination Report: 01/06/2023

US 20190207212A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0207212 A1**

LI (43) **Pub. Date: Jul. 4, 2019**

(54) **WOUND-TYPE CELL AND ELECTROCHEMICAL DEVICE**

(71) Applicant: **NINGDE AMPEREX TECHNOLOGY LIMITED**, Ningde (CN)

(72) Inventor: **Caicai LI**, Ningde (CN)

(21) Appl. No.: **16/234,210**

(22) Filed: **Dec. 27, 2018**

(30) **Foreign Application Priority Data**

Dec. 28, 2017 (CN) 201711459269.6

Publication Classification

(51) **Int. Cl.**

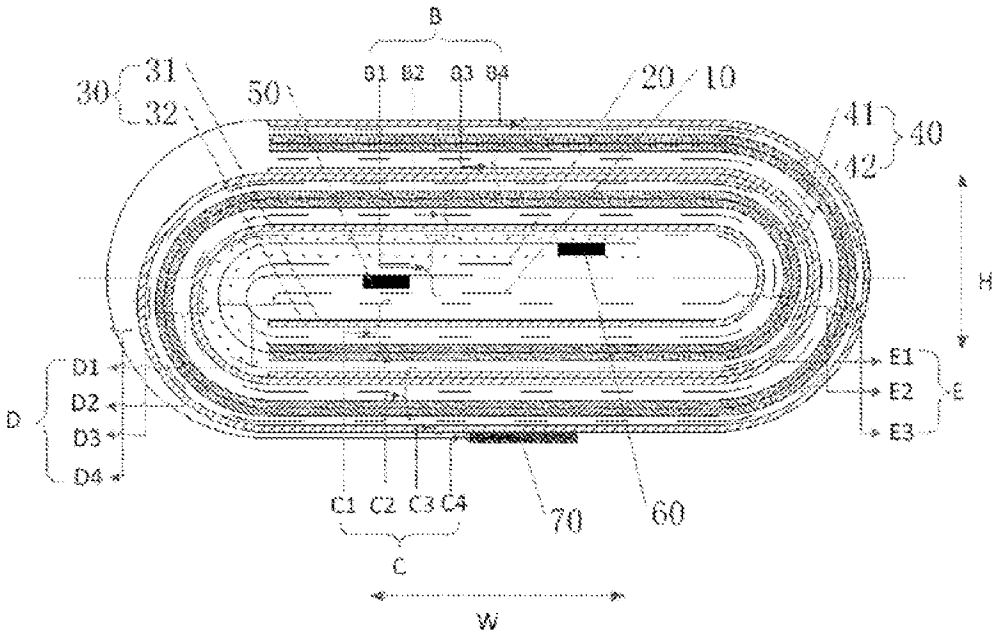
H01M 4/36	(2006.01)
H01M 10/04	(2006.01)
H01M 4/66	(2006.01)

(52) **U.S. Cl.**

CPC ***H01M 4/366*** (2013.01); ***H01M 4/667*** (2013.01); ***H01M 10/0431*** (2013.01)

(57) **ABSTRACT**

A wound-type cell and an electrochemical device are provided. The wound-type cell includes a negative electrode. The negative electrode includes a negative electrode current collector and a negative electrode active material layer. The negative electrode is composed of a double-sided coated area of the negative electrode active material layer, where surfaces of both sides of the negative electrode current collector are coated with the negative electrode active material layer, and an uncoated area where surfaces of the negative electrode current collector are not coated with the negative electrode active material layer.



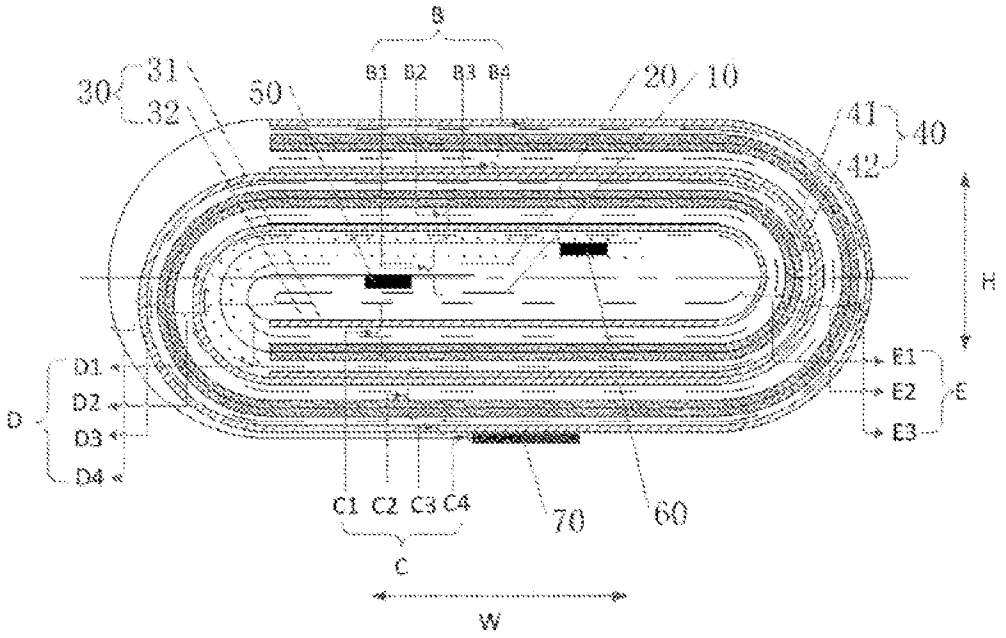

B
B1 B2 B3 B4
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32
50
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41
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D2
D3
D4
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60
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Fig. 1

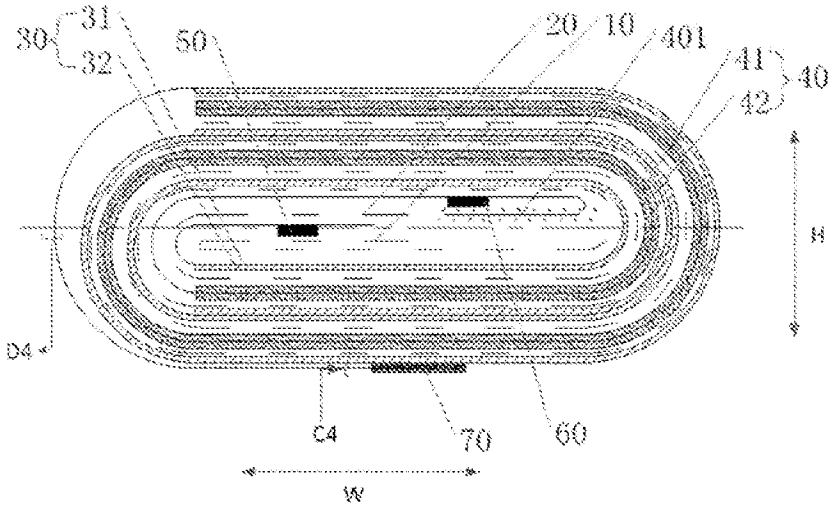

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Fig. 2

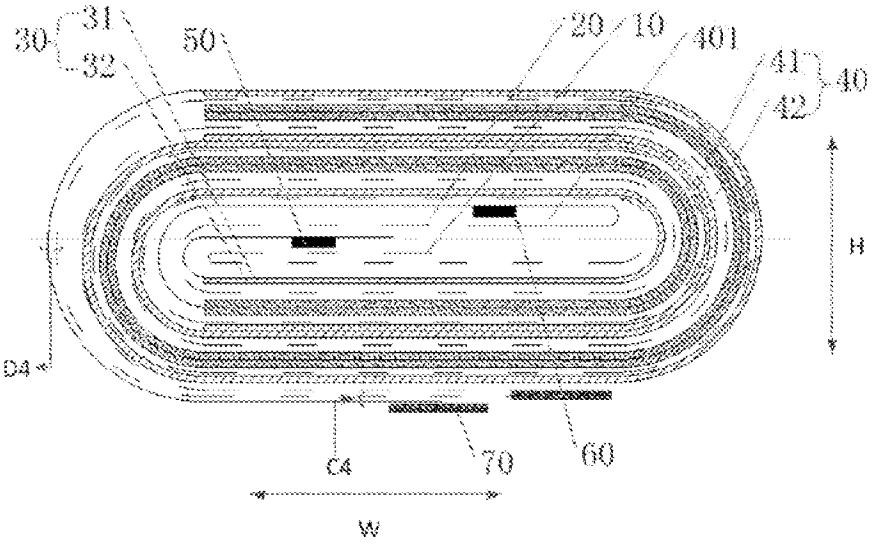

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Fig. 3

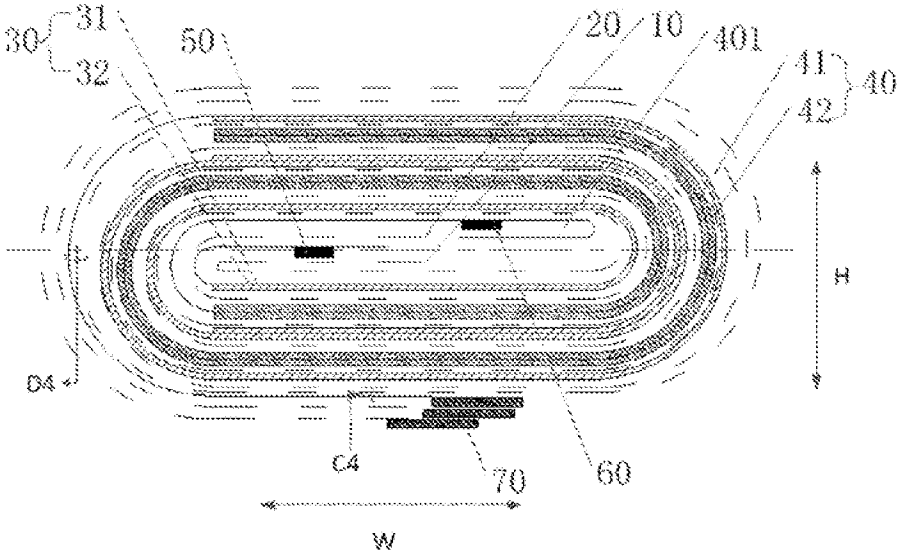

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Fig. 4

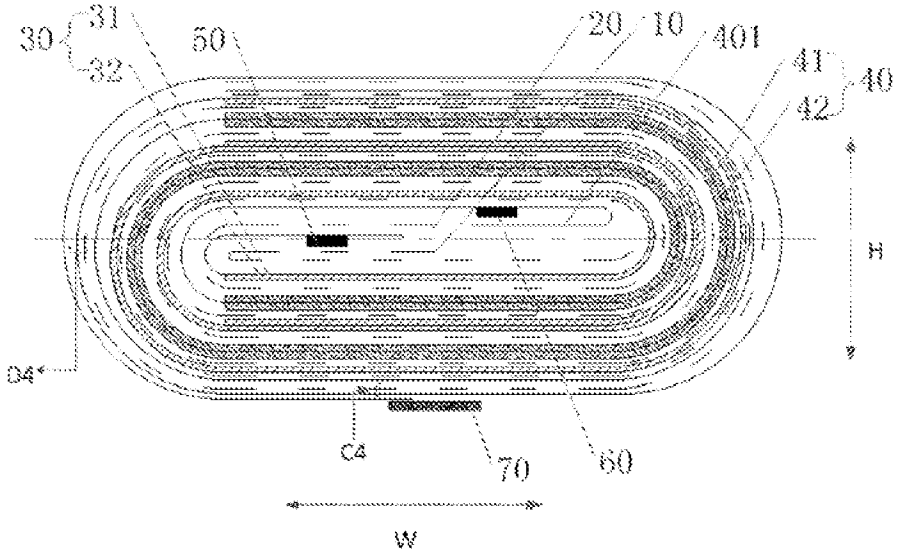

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Fig. 5

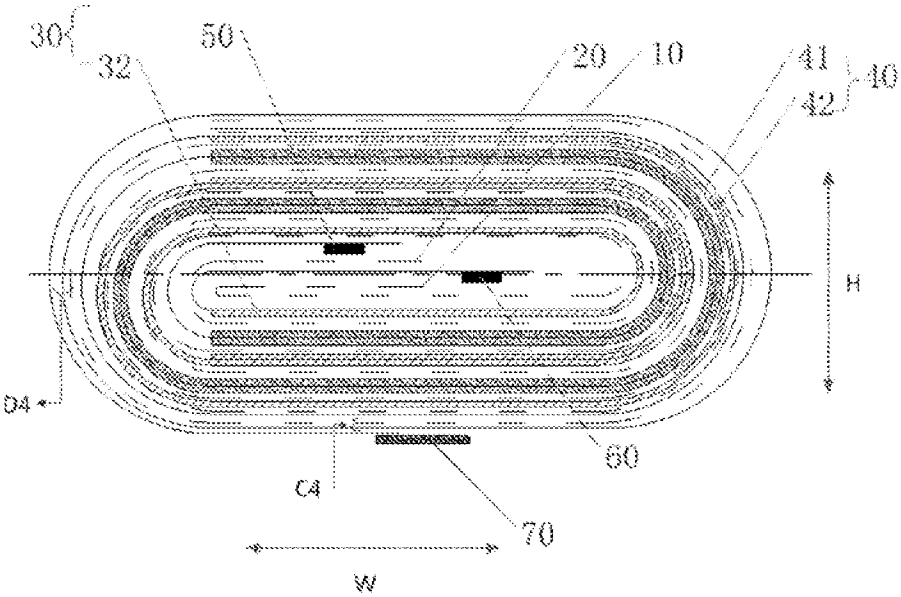

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Fig. 6

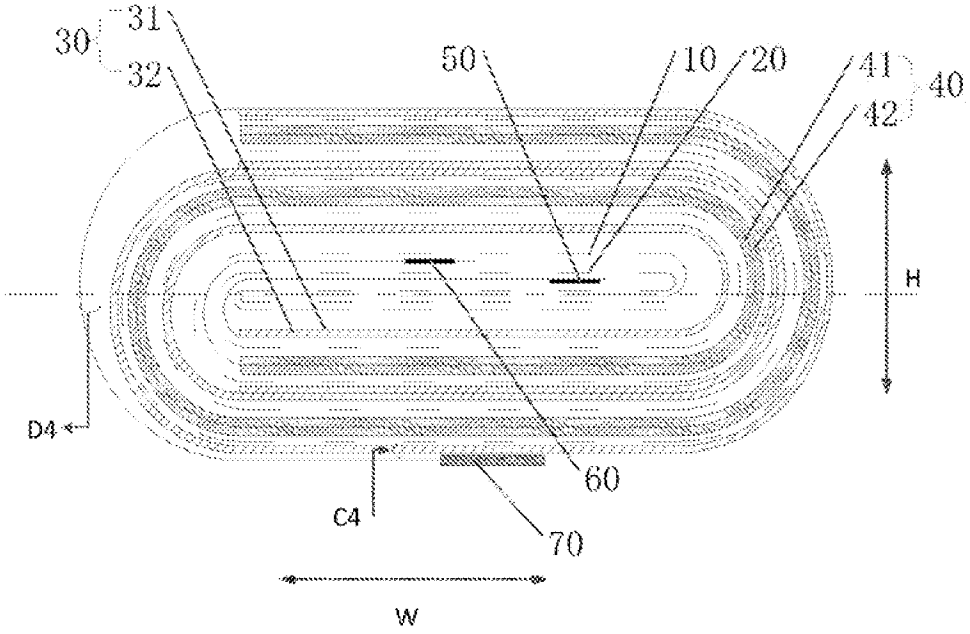


Fig. 7

WOUND-TYPE CELL AND ELECTROCHEMICAL DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The application claims priority to and benefits of Chinese Patent Application Serial No. 201711459269.6, filed with the State Intellectual Property Office of P. R. china on Dec. 28, 2017, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to a technical field of batteries, more particularly to a wound-type cell and an electrochemical device using the same.

BACKGROUND

[0003] With the commercialization of wound-type cells of batteries, the market is more and more demanding on the cells' energy density. A method for improving the energy density of the wound-type cell of the battery is to reduce thicknesses of a current collector, an electrode tab and a separator, and increase the capacity and compaction density of positive electrode material and negative electrode material.

[0004] A conventional wound-type cell is a flat cell formed by stacking and winding a negative electrode, a separator, and a positive electrode. A section of the negative electrode is an uncoated area and coupled with an electrode tab, and a section of the positive electrode is an uncoated area and coupled with the electrode tab. In the related art, the negative electrode has a single-sided coated area of a negative electrode active material layer roughly in one circle inside the flat cell. That is, only an outside surface of the negative electrode current collector of the negative electrode is coated with the negative electrode active material layer, while an inner surface of the negative electrode current collector is not coated with the negative electrode active material layer. During the charging process, due to the structure of the negative electrode active material layer itself, for example, ion intercalation of lithium ions or the like can cause the negative electrode to expand on one side, so that the negative electrode is bent from one side coated with the negative electrode active material layer towards the other side without being coated with the negative electrode active material layer.

[0005] The unidirectional bending deformation of the negative electrode will cause the deformation and deterioration of the cell, and as the compaction density of the negative electrode increases, the deformation of the cell becomes more obvious, and the cyclic expansion of the cell during the charging is also significantly deteriorated.

SUMMARY

[0006] Aiming at the technical problem existing in the related art, an object of the present disclosure is to provide an improved wound-type cell and an electrochemical device, in which a negative electrode is free of a single-sided coated area of a negative electrode active material layer, and thus it is possible to overcome the technical problem of deformation of the negative electrode of the cell in the related art.

[0007] The present disclosure provides a wound-type cell. The wound-type cell includes a negative electrode, in which the negative electrode includes a negative electrode current collector and a negative electrode active material layer. The negative electrode is composed of a negative electrode double-sided coated area, where surfaces of both sides of the negative electrode current collector are coated with the negative electrode active material layer, and a negative electrode uncoated area where surfaces of the negative electrode current collector are not coated with the negative electrode active material layer.

[0008] The present disclosure further provides an electrochemical device that has the wound-type cell according to the present disclosure.

[0009] Since surfaces of both sides of the negative electrode current collector of the wound-type cell of the present disclosure are coated with the negative electrode active material layer, and thereby, the negative electrode double-sided coated area is formed, it is possible to overcome the technical problem of deformation of the negative electrode caused by the negative electrode single-sided coated area existing inside the cell of the related art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic view of a wound-type cell according to a first embodiment of the present disclosure.

[0011] FIG. **2** is a schematic view of a wound-type cell according to a second embodiment of the present disclosure.

[0012] FIG. **3** is a schematic view of a wound-type cell according to a third embodiment of the present disclosure.

[0013] FIG. **4** is a schematic view of a wound-type cell according to a fourth embodiment of the present disclosure.

[0014] FIG. **5** is a schematic view of a wound-type cell according to a fifth embodiment of the present disclosure.

[0015] FIG. **6** is a schematic view of a wound-type cell according to a sixth embodiment of the present disclosure.

[0016] FIG. **7** is a schematic view of a wound-type cell according to a seventh embodiment of the present disclosure.

REFERENCE NUMERALS

[0017] **10**—first separator, **20**—second separator, **30**—positive electrode, **31**—positive electrode current collector, **32**—positive electrode active material layer, **40**—negative electrode, **41**—negative electrode current collector, **42**—negative electrode active material layer, **50**—first electrode tab, **60**—second electrode tab, **70**—glue, B—upper portion, B1—upper portion of first wound layer, B2—upper portion of second wound layer, B3—upper portion of third wound layer, B4—upper portion of fourth wound layer, D—left bent portion, D1—left bent portion of first wound layer, D2—left bent portion of second wound layer, D3—left bent portion of third wound layer, D4—left bent portion of fourth wound layer, C—lower portion, C1—lower portion of first wound layer, C2—lower portion of second wound layer, C3—lower portion of third wound layer, C4—lower portion of fourth wound layer, E—right bent portion, E1—right bent portion of first wound layer, E2—right bent portion of second wound layer, E3—right bent portion of third wound layer, W—width direction, H—thickness direction.

DETAILED DESCRIPTION

[0018] A wound-type cell of the present disclosure will be described in detail below with reference to the drawings. It

should be noted that although the wound-type cell has two separators in the following embodiments for convenience of illustration of technical solutions of the present disclosure, the present disclosure is not limited thereto, and only one separator or more than two separators may be employed.

First Embodiment

[0019] Referring to FIG. **1**, a wound-type cell of the present disclosure is a flat cell formed in such a way that a first separator **10**, a positive electrode **30**, a second separator **20**, and a negative electrode **40** are sequentially stacked from the inside to the outside and wound. The positive electrode **30** has a positive electrode current collector **31** and a positive electrode active material layer **32** coated on a surface of the positive electrode current collector **31**; the negative electrode **40** has a negative electrode current collector **41** and a negative electrode active material layer **42** coated on a surface of the negative electrode current collector **41**. A section of the positive electrode **30** is an uncoated area and coupled with a first electrode tab **50**, and a section of the negative electrode **40** is an uncoated area and coupled with a second electrode tab **60**.

[0020] In the present disclosure, "the uncoated area" refers to an area of the electrode without being coated with any active material layer, i.e., an area of the electrode only having the current collector. "The flat cell" refers to a cell with an oblong section. "The section" of the positive electrode refers to a part of the positive electrode where the positive electrode starts to be wound and which is located inside the cell and uncoated with the positive electrode active material layer; "the section" of the negative electrode refers to a part of the negative electrode where the negative electrode starts to be wound and which is located inside the cell and uncoated with the negative electrode active material layer. The section of the negative electrode is taken as an example, and a part surrounded by dotted lines in FIG. **1** indicates the section of the negative electrode.

[0021] The flat cell includes an upper portion B and a lower portion C extending along a width direction W, as well as a left bent portion D and a right bent portion E located between the upper portion B and the lower portion C. A center line of the flat cell in the width direction W is a vertical center line of the cell, and a center line of the flat cell in a thickness direction H is a horizontal center line of the cell.

[0022] A winding method and process of the wound-type cell of the present embodiment will be described below. It should be understood that the following description is related to a preferred winding method and process, but the winding method and process of the wound-type cell of the present disclosure is not limited thereto.

[0023] The first separator **10**, the positive electrode **30**, the second separator **20** and the negative electrode **40** are sequentially arranged from the inside to the outside, and are wound in a counterclockwise direction from the inside to the outside to form the wound-type cell of the present disclosure. Starting ends of respective sections of the first separator **10** and the second separator **20** are aligned and extend beyond a starting end of the section of the positive electrode **30**; a starting end of the section of the negative electrode **40** extends beyond the starting ends of the sections of the first separator **10** and the second separator **20**. Meanwhile, the first electrode tab **50** and the second electrode tab **60** are located at two sides of the above starting ends of the first separator **10** and the second separator **20** in the width direction W correspondingly. Thus, the first electrode tab **50** and the second electrode tab **60** do not overlap in the thickness direction H of the cell, thereby avoiding an increase in the thickness of the cell. It should be noted that at the beginning of the winding, since the sections of the positive electrode **30** and the negative electrode **40** are uncoated areas, the first separator **10**, the positive electrode current collector **31**, the second separator **20** and the negative electrode current collector **41** are initially involved in winding.

[0024] At the beginning of the winding process, an upper portion B1 of a first wound layer and a left bent portion D1 of the first wound layer are formed first, in which the first wound layer as the innermost layer of the cell is formed of the first separator **10**, the positive electrode current collector **31** of the positive electrode **30**, the second separator **20**, and the negative electrode current collector **41** of the negative electrode **40**.

[0025] Then, at a tail end of the left bent portion D1 of the first wound layer, where an outside surface of the positive electrode current collector **31** is coated with the positive electrode active material layer **32**, while inside and outside surfaces of the negative electrode current collector **41** are both coated with the negative electrode active material layer **42**, the winding is continued in the counterclockwise direction for one circle, so that a lower portion C1 of the first wound layer, a right bent portion E1 of the first wound layer, an upper portion B2 of a second wound layer, and a left bent portion D2 of the second wound layer are sequentially formed by winding.

[0026] Starting from a tail end of the left bent portion D2 of the second wound layer, where an inside surface of the positive electrode current collector **31** is also coated with the positive electrode active material layer **32**, the winding is continued in the counterclockwise direction, so that a lower portion C2 of the second wound layer, a right bent portion E2 of the second wound layer, and an upper portion B3 of a third wound layer are sequentially formed by winding.

[0027] At a tail end of the upper portion B3 of the third wound layer, the negative electrode **40** stops winding, and the second separator **20** also stops winding, the outside surface of the positive electrode current collector **31** is not coated with the positive electrode active material layer **32**, and the positive electrode **30** and the first separator **10** continue to wind up counterclockwise, so that a left bent portion D3 of the third wound layer, a lower portion C3 of the third wound layer, a right bent portion E3 of the third wound layer, and an upper portion B4 of a fourth wound layer are formed. The positive electrode active material layer **32** at the inner side of the positive electrode current collector **31** and the first separator **10** terminate at a tail end of the upper portion B4 of the fourth wound layer.

[0028] The positive electrode current collector **31** continues to wind up along the counterclockwise direction to form a left bent portion D4 and a lower portion C4 of the fourth wound layer, and a tail end of the lower portion C4 of the fourth wound layer is bonded to the lower portion C3 of the third wound layer by glue. Hence, the wound-type cell illustrated in FIG. **1** is formed.

[0029] It can be seen that surfaces at two sides of the negative electrode current collector **41** of the negative electrode **40** of the wound-type cell are both coated with the negative electrode active material layer **42**, and a negative

electrode double-sided coated area of the negative electrode **40** is formed, that is, no negative electrode single-sided coated area of the negative electrode **40** is present in the entire wound layer. Therefore, the wound-type cell of this embodiment overcomes the following defects in the related art: since the negative electrode **40** has a negative electrode single-sided coated area, that is, one side of the negative electrode current collector **41** is coated with the negative electrode active material layer **42** while the other side thereof is bare, the stress on two sides is different, which easily causes the wrinkling and demolding of the negative electrode current collector **41** and the deformation of the negative electrode **40** due to the one-side expansion of the negative electrode **40** during the charging.

[0030] Additionally, it can be seen from FIG. **1** that the innermost portion of the wound-type cell of the present embodiment includes two layers of separators, and compared with four layers of separators adopted in the related art, the wound-type cell of the present disclosure has a higher energy density.

[0031] Furthermore, the quantity of layer of the negative electrode double-sided coated area in the upper portion B is identical to the quantity of layer of the negative electrode double-sided coated area in the lower portion C, i.e. the number is two. Moreover, an assumed plane extends along the width direction W and is orthogonal to the thickness direction B, the projections of all the negative electrode double-sided coated areas on the assumed plane overlap each other. Preferably, the negative electrodes **40** of the upper portion B and the lower portion C of the wound-type cell are symmetrical with respect to the horizontal center line of the cell. In this way, the defect in the related art that the cell is bent and deformed from one side where the number of the negative electrodes is large to the other side where the number of the negative electrodes is small during the charging process is overcome. Meanwhile, due to the symmetrical structure of the wound-type cell relative to the horizontal center line of the cell, a part of the expansion force on two sides of the cell is mutually counteracted and weakened, so that partial expansion can also be suppressed, thereby facilitating the improvement of energy density after the cell cycle. In addition, in this embodiment, in order to ensure the above effect, the quantity of layer of the positive electrode double-sided coated area in the upper portion B and the quantity of layer of the positive electrode double-sided coated area in the lower portion C are further made the same, and the projections of the positive electrode double-sided coated area on the above assumed plane overlap each other; the quantity of layer of the positive electrode single-sided coated area in the upper portion B and the quantity of layer of the positive electrode single-sided coated area in the lower portion C are further made the same, and the projections of all the positive electrode single-sided coated areas on the above assumed plane overlap each other.

[0032] Although the negative electrodes on two sides of the vertical center line of the cell are asymmetrical in this embodiment, since the lithium ion cell generally has a small thickness and tends to be ultra-thin, eliminating or reducing the deformation of the cell in the horizontal plane has greater effect on the development of ultra-thin cells. Since the cell is thin, during the charging, the number of lithium ions intercalated in the cell at both ends in the width direction W is small, and the resulting expansion is small, which may be disregarded.

[0033] The positive electrode active material layer **32** may specifically be at least one of lithium cobaltate, lithium iron phosphate, and lithium manganate. The negative electrode active material layer **42** may specifically be at least one of graphite, hard carbon, and silicon.

Second Embodiment

[0034] Referring to FIG. **2**, based on the first embodiment, the section of the negative electrode current collector **41** of the negative electrode **40** has a fold-back part **401** formed by being folded back inwards (e.g. a portion enclosed by dotted block in FIG. **2**), and the arrangement of the fold-back part **401** can facilitate clamping of a winding apparatus. Meanwhile, the fold-back part **401** can ensure that sufficient space exists during the cutting of the negative electrode **40**, and no glue for electrode tabs will be cut. Specifically, the fold-back part **401** can be formed in such a way that the fold-back part **401** is bent at the section of negative electrode current collector **41** for 180 degree clockwise. Preferably, the fold-back part **401** does not overlap the first electrode tab **50** in the thickness direction H, thereby avoiding an increase in the thickness of the cell. Likewise, the section of the positive electrode current collector **31** of the positive electrode **30** also has a fold-back part formed by being folded back inwards (not illustrated in drawings). Other features of this embodiment are identical to the first embodiment.

Third Embodiment

[0035] Referring to FIG. **3**, based on the second embodiment, the first separator **10** continues to wind at the tail end of the upper portion B4 of the fourth wound layer, and the second separator **20** continues to wind at the tail end of the upper portion B3 of the third wound layer, until they exceed the tail end of the lower portion C4 of the fourth wound layer by a segment. By doing so, a contact of an outside surface of a bare cell and a packaging bag is changed from a current collector surface being in contact with the packaging bag to both of the current collector surface and part of the separator being in contact with the packaging bag. Because the contact between the separator and the packaging bag increases friction between the cell and the packaging bag, it is possible to prevent the cell from slipping out of or being displaced in the packaging bag during a drop or impact, and avoid the occurrence of maiposition of the positive electrode and negative electrode inside the cell during the second drop or impact. Thus, the extended separator helps improve the anti-dropping performance of the cell. Other features of this embodiment are identical to the second embodiment.

Fourth Embodiment

[0036] Referring to FIG. **4**, based on the third embodiment, the first separator **10** and the second separator **20** are wound around the outside of the bare cell for one circle, so as to increase the friction between the bare cell and the packaging bag to a maximum extent, and further improve the anti-dropping performance of the cell. Other features of this embodiment are identical to the third embodiment.

Fifth Embodiment

[0037] Referring to FIG. **5**, in order to improve abuse performance of the cell, based on the third embodiment, the outermost layers of the positive electrode current collector **31** (aluminum foil) and the negative electrode current col-

lector **41** (copper foil) of the cell continue to wind around the bare cell for one circle, so as to form a protective layer (also called outer jacket) at both sides in the thickness direction H of the cell. In the case of abusing the cell or in an abuse performance test of the cell, when an external short circuit occurs to an outer layer of the cell because the cell is damaged by an external force or a foreign object, the protective layer is preferentially short-circuited. When the protective layer is short-circuited, it will not cause combustion because there is no active material at the short-circuit point. Meanwhile, since the short circuit occurs at the outermost side of the cell, the heat generated by the short circuit can be radiated outwards along the current collector with good thermal conductivity, thereby avoiding fire and explosion. Therefore, this embodiment can improve safety performance of the cell. Other features of this embodiment are identical to the third embodiment.

[0038] Additionally, it should be noted that the protective layer may not be provided to the outermost layer, and may not need to be wound for one circle, but instead, the protective layer can be provided to other positions of the cell and have a suitable winding length according to requirements.

Sixth Embodiment

[0039] Referring to FIG. **6**, based on the fifth embodiment, the positions of the positive electrode and negative electrode of the cell can be changed by changing the relative position of the first electrode tab **50** and the second electrode tab **60**, such that the wound-type cell of the present disclosure can be mounted to various portable apparatus. For example, the positions of the first electrode tab **50** and the second electrode tab **60** in the width direction W are exchanged, so as to satisfy a portable apparatus with reversed positions of the positive electrode and negative electrode compared with the conventional apparatus. Other features of this embodiment are identical to the fifth embodiment.

Seventh Embodiment

[0040] Referring to FIG. **7**, based on the first embodiment, the first separator **10** and the second separator **20** inside the wound-type cell of this embodiment can be redundantly wound into a four-layer structure, as in the related art. Other features of this embodiment are identical to the first embodiment. In the present disclosure, "being redundantly wound" means that the first separator **10** and the second separator **20** are wound with no separation effect on the positive electrode **30** and the negative electrode **40**.

[0041] In practical applications, the first electrode tab **50** can be specifically provided at any position of the positive electrode current collector **31**, and the second electrode tab **60** can be specifically provided at any position of the negative electrode current collector **41**, which can be flexibly set based on the specific use situation and location of the cell.

[0042] Although the winding of the cell is explained by example of counterclockwise winding in the above embodiments, the winding manner of the wound-type cell is not particularly defined in the present disclosure, as long as both sides of the negative electrode **40** are coated with the negative electrode active material layer **42** to form the negative electrode double-sided coated area.

[0043] The above description only involves specific embodiments of the present disclosure, but the protection scope of the present disclosure is not limited thereto. Any changes or alternatives that can be easily conceived by those skilled in the art within the technical scope of the present disclosure should be included in the protection scope of the present disclosure.

What is claimed is:

1. A wound-type cell, comprising a negative electrode, wherein the negative electrode comprises a negative electrode current collector and a negative electrode active material layer, and the negative electrode is composed of a negative electrode double-sided coated area, where surfaces of both sides of the negative electrode current collector are coated with the negative electrode active material layer, and a negative electrode uncoated area where surfaces of the negative electrode current collector are not coated with the negative electrode active material layer.

2. The wound-type cell according to claim **1**, wherein the wound-type cell comprises an upper portion and a lower portion extending along a width direction, and a bent portion located between the upper portion and the lower portion;

the quantity of layer of the negative electrode double-sided coated area in the upper portion is identical to the quantity of layer of the negative electrode double-sided coated area in the lower portion; and

an assumed plane extends along the width direction of the wound-type cell and is orthogonal to a thickness direction of the wound-type cell, projections of all the negative electrode double-sided coated areas on the assumed plane overlap each other.

3. The wound-type cell according to claim **2**, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode single-sided coated area, where a surface of only one side of the positive electrode current collector is coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer; and

the quantity of layer of the positive electrode single-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode single-sided coated area in the lower portion, and projections of all the positive electrode single-sided coated areas on the assumed plane overlap each other.

4. The wound-type cell according to claim **2**, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode double-sided coated area, where surfaces of both sides of the positive electrode current collector are coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer; and

the quantity of layer of the positive electrode double-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode double-sided coated area in the lower portion, and projections of all

the positive electrode double-sided coated areas on the assumed plane overlap each other.

5. The wound-type cell according to claim 2, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode single-sided coated area, where a surface of only one side of the positive electrode current collector is coated with the positive electrode active material layer, a positive electrode double-sided coated area, where surfaces of both sides of the positive electrode current collector are coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer;

the quantity of layer of the positive electrode double-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode double-sided coated area in the lower portion, and projections of all the positive electrode double-sided coated areas on the assumed plane overlap each other; and

the quantity of layer of the positive electrode single-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode single-sided coated area in the lower portion, and projections of all the positive electrode single-sided coated areas on the assumed plane overlap each other.

6. The wound-type cell according to claim 1, wherein a section of the negative electrode uncoated area has a fold-back part.

7. The wound-type cell according to claim 3, wherein a section of the positive electrode uncoated area has a fold-back part.

8. The wound-type cell according to claim 1, wherein the wound-type cell further comprises a separator, a winding end of the separator exceeds a winding end of the negative electrode, the separator is wound around an outer side of the wound-type cell, and the winding end of the separator exceeding the winding end of the negative electrode by at least one circle.

9. The wound-type cell according to claim 3, wherein the wound-type cell further comprises a separator, a winding end of the separator exceeds a winding end of the positive electrode, the separator is wound around an outer side of the wound-type cell, and the winding end of the separator exceeding the winding end of the positive electrode by at least one circle.

10. The wound-type cell according to claim 3, wherein the positive electrode uncoated area is wound around the wound-type cell by a predetermined length at the outermost layer of the wound-type cell.

11. The wound-type cell according to claim 3, wherein a first electrode tab is coupled to any position of the positive electrode uncoated area, and a second electrode tab is coupled to any position of the negative electrode uncoated area, in which the first electrode tab does not overlap the second electrode tab in the thickness direction of the wound-type cell.

12. The wound-type cell according to claim 1, wherein the wound-type cell further comprises a separator, and the quantity of layer of the separator being only wound with itself inside the wound-type cell is less than four.

13. An electrochemical device, comprising a wound-type cell,

the wound-type cell comprising a negative electrode, wherein the negative electrode comprises a negative electrode current collector and a negative electrode active material layer, and the negative electrode is composed of a negative electrode double-sided coated area, where surfaces of both sides of the negative electrode current collector are coated with the negative electrode active material layer, and a negative electrode uncoated area where surfaces of the negative electrode current collector are not coated with the negative electrode active material layer.

14. The electrochemical device according to claim 13, wherein the wound-type cell comprises an upper portion and a lower portion extending along a width direction, and a bent portion located between the upper portion and the lower portion;

the quantity of layer of the negative electrode double-sided coated area in the upper portion is identical to the quantity of layer of the negative electrode double-sided coated area in the lower portion; and

an assumed plane extends along the width direction of the wound-type cell and is orthogonal to a thickness direction of the wound-type cell, projections of all the negative electrode double-sided coated areas on the assumed plane overlap each other.

15. The electrochemical device according to claim 14, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode single-sided coated area, where a surface of only one side of the positive electrode current collector is coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer; and

the quantity of layer of the positive electrode single-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode single-sided coated area in the lower portion, and projections of all the positive electrode single-sided coated areas on the assumed plane overlap each other.

16. The electrochemical device according to claim 14, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode double-sided coated area, where surfaces of both sides of the positive electrode current collector are coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer; and

the quantity of layer of the positive electrode double-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode double-sided coated area in the lower portion, and projections of all the positive electrode double-sided coated areas on the assumed plane overlap each other.

17. The electrochemical device according to claim 14, wherein the wound-type cell further comprises a positive electrode, the positive electrode comprises a positive electrode current collector and a positive electrode active material layer;

the positive electrode is composed of a positive electrode single-sided coated area, where a surface of only one side of the positive electrode current collector is coated with the positive electrode active material layer, a positive electrode double-sided coated area, where surfaces of both sides of the positive electrode current collector are coated with the positive electrode active material layer, and a positive electrode uncoated area where surfaces of the positive electrode current collector are not coated with the positive electrode active material layer;

the quantity of layer of the positive electrode double-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode double-sided coated area in the lower portion, and projections of all the positive electrode double-sided coated areas on the assumed plane overlap each other; and

the quantity of layer of the positive electrode single-sided coated area in the upper portion is identical to the quantity of layer of the positive electrode single-sided coated area in the lower portion, and projections of all the positive electrode single-sided coated areas on the assumed plane overlap each other.

18. The electrochemical device according to claim 15, wherein a section of the positive electrode uncoated area has a fold-back part.

19. The electrochemical device according to claim 15, wherein the positive electrode uncoated area is wound around the wound-type cell by a predetermined length at the outermost layer of the wound-type cell.

20. The electrochemical device according to claim 13, wherein the wound-type cell further comprises a separator, and the quantity of layer of the separator being only wound with itself inside the wound-type cell is less than four.

* * * * *

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(54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

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CPC ***H01M 10/0525*** (2013.01); ***H01M 4/525*** (2013.01); ***H01M 4/133*** (2013.01); ***H01M 10/0587*** (2013.01)

(57) **ABSTRACT**

A nonaqueous electrolyte secondary battery including a positive electrode plate including a positive electrode current collector and a positive electrode mixture layer, formed thereon, containing a positive electrode active material; a negative electrode plate including a negative electrode current collector and a negative electrode mixture layer, formed thereon, containing a negative electrode active material; a separator; a nonaqueous electrolyte; an outer can; and a sealing body. The positive electrode and negative electrode plates are wound with the separator there between. The positive electrode active material contains a lithium-nickel composite oxide containing cobalt and aluminium as constituent elements. The negative electrode active material contains graphite and a silicon material. The negative electrode plate includes negative electrode current collector-exposed portions, located at both ends thereof in a longitudinal direction, not covered by the negative electrode mixture layer. The negative electrode current collector-exposed portions are each connected to a negative electrode tab.

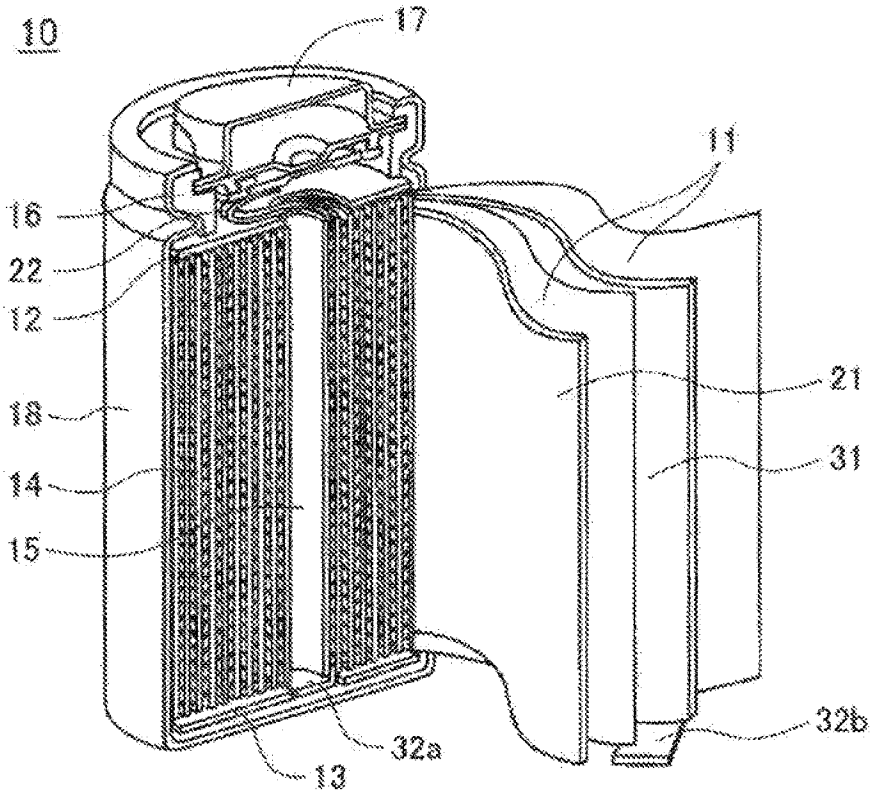


Figure 1

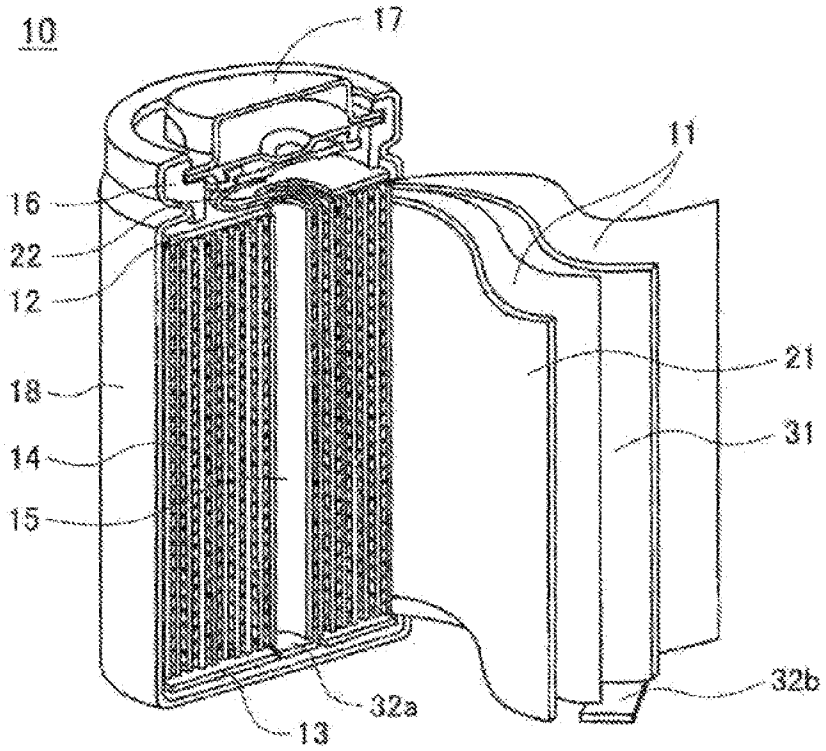


Figure 2

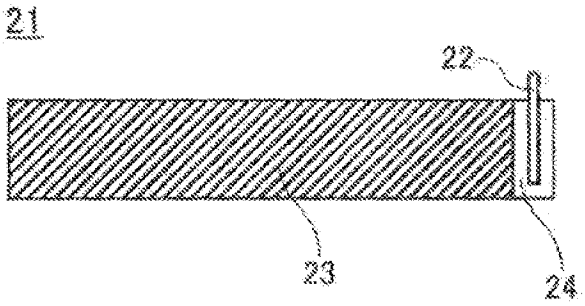
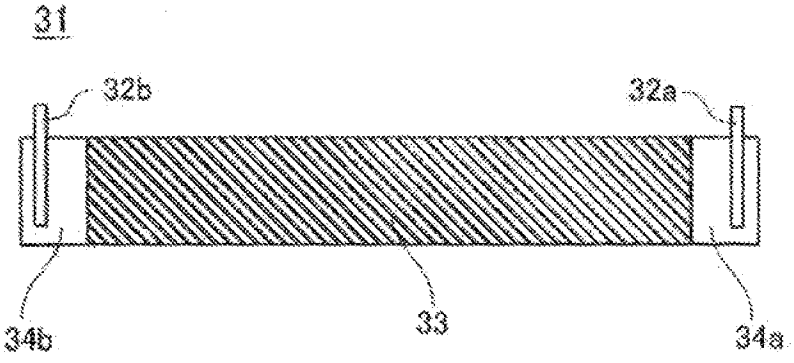


Figure 3



NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

TECHNICAL FIELD

[0001] The present invention relates to a nonaqueous electrolyte secondary battery including a negative electrode plate which contains graphite and a silicon material as negative electrode active materials and which has two ends each connected to a negative electrode tab.

BACKGROUND ART

[0002] In recent years, nonaqueous electrolyte secondary batteries have been widely used as power supplies for driving portable electronic devices such as smartphones, tablet computers, notebook personal computers, and portable music players. Furthermore, applications of the nonaqueous electrolyte secondary batteries extend to electric tools, power-assisted bicycles, and electric vehicles; hence, the nonaqueous electrolyte secondary batteries are required to have high capacity and high output.

[0003] A carbon material such as graphite is used as a negative electrode active material for the nonaqueous electrolyte secondary batteries. The carbon material has a discharge potential comparable to that of metallic lithium and can suppress the dendritic growth of lithium during charge. Therefore, using the carbon material as a negative electrode active material enables nonaqueous electrolyte secondary batteries excellent in safety to be provided. Graphite can store lithium ions to form the composition LiC_6 and exhibits a theoretical capacity of 372 mAh/g.

[0004] However, carbon materials currently used already exhibit a capacity close to the theoretical capacity thereof; hence, it is difficult to increase the capacity of nonaqueous electrolyte secondary batteries by improving negative electrode active materials. Therefore, in recent years, silicon materials, such as silicon and oxides thereof, having a capacity higher than that of the carbon materials have been attracting attention as negative electrode active materials for nonaqueous electrolyte secondary batteries. For example, silicon can store lithium ions to form the composition $Li_{4.4}Si$ and exhibits a theoretical capacity of 4,200 mAh/g. Therefore, using the silicon materials as negative electrode active materials allows nonaqueous electrolyte secondary batteries to have increased capacity.

[0005] The silicon materials, as well as the carbon materials, can suppress the dendritic growth of lithium during charge. However, the silicon materials show a larger change in volume due to charge and discharge as compared to the carbon materials and therefore have a problem of inferior cycle characteristics because of the pulverization of negative electrode active materials, the peel-off from conductive networks, or the like.

[0006] Patent Literature 1 discloses a nonaqueous electrolyte secondary battery including a negative electrode mixture layer containing a material containing Si and O as constituent elements and graphite as negative electrode active materials and a positive electrode mixture layer containing a lithium-transition metal composite oxide in which Ni, Mn, and the like are essential constituent elements as a positive electrode active material. It is reported that a nonaqueous electrolyte secondary battery having high capacity and good battery characteristics is obtained by regulating the proportion of the material containing Si and O as constituent elements in a predetermined range.

[0007] As a technique for enhancing output characteristics of a nonaqueous electrolyte secondary battery, Patent Literature 2 discloses that negative electrode tabs are connected to regions, set at both ends of a negative electrode plate of the nonaqueous electrolyte secondary battery, uncoated with a negative electrode active material.

CITATION LIST

Patent Literatures

[0008] PTL 1: Japanese Published Unexamined Patent Application No. 2010-212228

[0009] PTL 2: Japanese Published Unexamined Patent Application No. 2001-110453

SUMMARY OF INVENTION

Technical Problem

[0010] The inventors have performed investigations and have found a problem that in the case of using silicon oxide as a negative electrode active material, connecting a negative electrode tab to each of both ends of a negative electrode plate reduces cycle characteristics. The inventors have investigated the cause thereof and have found that an electrode assembly is deformed due to charge/discharge cycles. It is conceivable that the deformation of the electrode assembly inhibits a uniform electrode reaction to reduce the cycle characteristics. This is a problem common to not only silicon but also silicon materials containing silicon.

[0011] Negative electrode tabs connected to negative electrode plates are electrically connected to negative electrode external terminals. In the case of a cylindrical battery, an outer can functions as a negative electrode external terminal and therefore negative electrode tabs connected to both ends of a negative electrode plate are fixed to a bottom portion of the outer can. That is, both ends of the negative electrode plate are fixed by the outer can and therefore an electrode assembly is likely to be deformed because of the change in volume of a negative electrode active material due to charge or discharge. In particular, a negative electrode active material having a large change in volume due to charge or discharge like silicon materials such as silicon and silicon oxide is likely to cause the above problem.

[0012] The present invention has been made in view of the above circumstances and is intended to provide a nonaqueous electrolyte secondary battery having excellent output and cycle characteristics by reducing the deformation of an electrode assembly due to charge or discharge.

Solution to Problem

[0013] In order to solve the above problem, a nonaqueous electrolyte secondary battery according to an embodiment of the present invention includes a positive electrode plate including a positive electrode current collector and a positive electrode mixture layer, formed thereon, containing a positive electrode active material; a negative electrode plate including a negative electrode current collector and a negative electrode mixture layer, formed thereon, containing a negative electrode active material; a separator; a nonaqueous electrolyte; an outer can; and a sealing body. The positive electrode plate and the negative electrode plate are wound

with the separator therebetween. The positive electrode active material contains a lithium-nickel composite oxide. The lithium-nickel composite oxide is represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.8\leq b<1$, $0<c<0.2$, $0<d<0.05$, and $b+c+d=1$). The negative electrode active material contains graphite and a silicon material. The content of silicon oxide is 4% by mass to 20% by mass with respect to the sum of the masses of graphite and silicon oxide. The negative electrode plate includes negative electrode current collector-exposed portions, located at both ends thereof in a longitudinal direction, not covered by the negative electrode mixture layer. The negative electrode current collector-exposed portions are each connected to a negative electrode tab.

[0014] A nonaqueous electrolyte secondary battery according to another embodiment of present invention can use a lithium-nickel composite oxide represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.88\leq b<1$, $0<c<0.12$, $0<d<0.05$, and $b+c+d=1$) as a positive electrode active material.

[0015] A nonaqueous electrolyte secondary battery according to another embodiment of present invention can use a lithium-nickel composite oxide represented by the formula $Li_aNi_bCo_cAl_dM_eO_2$ (M is at least one element selected from the group consisting of Fe, Cu, Mg, Ti, Zr, Ce, and W; $0<a\leq1.2$; $0.8\leq b<1$; $0<c<0.2$; $0<d<0.05$; $0<e<0.01$; and $b+c+d+e=1$) as a positive electrode active material.

[0016] A nonaqueous electrolyte secondary battery according to another embodiment of present invention can use a lithium-nickel composite oxide represented by the formula $Li_aNi_bCo_cAl_dM_eO_2$ (M is at least one element selected from the group consisting of Fe, Cu, Mg, Ti, Zr, Ce, and W; $0<a\leq1.2$; $0.88\leq b<1$; $0<c<0.12$; $0<d<0.05$; $0<e<0.01$; and $b+c+d+e=1$) as a positive electrode active material.

[0017] Silicon and silicon oxide can be used as a silicon material. Silicon oxide used is preferably silicon oxide represented by the formula SiO_x ($0.5\leq x<1.6$). Silicon can be used alone and is preferably used in the form of a composite of silicon and graphite or lithium silicate represented by the formula $Li_{2z}SiO_{(2+z)}$ ($0<z<2$).

Advantageous Effects of Invention

[0018] According to an embodiment of the present invention, a nonaqueous electrolyte secondary battery having excellent output and cycle characteristics can be provided.

BRIEF DESCRIPTION OF DRAWINGS

[0019] FIG. **1** is a cross-sectional perspective view of a nonaqueous electrolyte secondary battery according to an embodiment of the present invention.

[0020] FIG. **2** is a plan view of a positive electrode plate according to an embodiment of the present invention.

[0021] FIG. **3** is a plan view of a negative electrode plate according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0022] Embodiments of the present invention are described in detail using experiment examples. The present invention is not limited to the embodiments below. Modifications can be appropriately made without departing from the scope of the present invention.

Experiment Example 1

[0023] (Preparation of Positive Electrode Active Material)

[0024] Lithium hydroxide was mixed with a nickel composite oxide represented by $Ni_{0.82}Co_{0.15}Al_{0.03}O_2$ such that the ratio of the number of moles of lithium element to the total number of moles of metal elements in the nickel composite oxide was 1.025. This mixture was fired at 750° C. for 18 hours in an oxygen atmosphere, whereby a lithium-nickel composite oxide represented by $LiNi_{0.82}Co_{0.15}Al_{0.03}O_2$ was prepared.

[0025] (Preparation of Positive Electrode Plate)

[0026] The following materials were mixed together: 100 parts by mass of $LiNi_{0.82}Co_{0.15}Al_{0.03}O_2$ serving as a positive electrode active material, 1 part by mass of acetylene black serving as a conductive agent, and 0.9 parts by mass of polyvinylidene fluoride (PVDF) serving as a binding agent. This mixture was put into N-methyl-2-pyrrolidone (NMP) serving as a dispersion medium, followed by kneading, whereby positive electrode mixture slurry was prepared. The positive electrode mixture slurry was applied to both surfaces of a positive electrode current collector, made of aluminium, having a thickness of 15 μm by a doctor blade process, followed by drying, whereby positive electrode mixture layers **23** were formed. In this operation, a positive electrode current collector-exposed portion **24** not covered by the positive electrode mixture layers **23** was set at a position corresponding to an end portion of a completed positive electrode plate **21**. The positive electrode mixture layers **23** were compressed with a roller and were cut to a predetermined size. Finally, a positive electrode tab **22** made of aluminium was connected to the positive electrode current collector-exposed portion **24**, whereby the positive electrode plate **21** was prepared as shown in FIG. **2**.

[0027] (Preparation of Negative Electrode Active Material)

[0028] A silicon material used was silicon oxide having the composition SiO (corresponding to the formula SiO_x, where x=1). SiO was heated in an inert gas atmosphere containing a hydrocarbon gas and particles of SiO were surface-coated with carbon by a chemical vapor deposition (CVD) process in such a manner that the hydrocarbon gas was pyrolyzed. The coating amount of carbon was 10% by mass with respect to the mass of SiO. Next, the SiO particles coated with carbon was subjected to a disproportionation reaction at 1,000° C. in an inert gas atmosphere such that a fine Si phase and SiO_2 phase were formed in the SiO particles, followed by classification to a predetermined particle size, whereby SiO used for a negative electrode active material was obtained. SiO was mixed with graphite such that the content of SiO was 5% by mass with respect to the sum of the masses of graphite and SiO, whereby the negative electrode active material was prepared.

[0029] (Preparation of Negative Electrode Plate)

[0030] Into water serving as a dispersion medium, 97 parts by mass of the negative electrode active material, 1.5 parts by mass of carboxymethylcellulose (CMC) serving as a thickening agent, and 1.5 parts by mass of styrene-butadiene rubber (SBR) serving as a binding agent were put, followed by kneading, whereby negative electrode mixture slurry was prepared. The negative electrode mixture slurry was applied to both surfaces of a negative electrode current collector, made of copper, having a thickness of 8 μm by a doctor blade process, followed by drying, whereby negative electrode mixture layers **33** were formed. In this operation, negative

electrode current collector-exposed portions **34***a* and **34***b* not covered by the negative electrode mix layers **33** were set at positions corresponding to both ends of a completed negative electrode plate **31**. The negative electrode mixture layers **33** were compressed with a roller and were cut to a predetermined size. Finally, negative electrode tabs **32***a* and **32***b* were connected to the negative electrode current collector-exposed portions **34***a* and **34***b*, respectively, whereby the negative electrode plate **31** was prepared as shown in FIG. **3**. The negative electrode tab **32***a* was located on the winding start side of the negative electrode plate **31** and was made of a cladding material having a nickel-copper two-layer structure. The negative electrode tab **32***b* was located on the winding end side of the negative electrode plate **31** and was made of a cladding material having a nickel-copper-nickel three-layer structure.

[0031] (Preparation of Electrode Assembly)

[0032] The positive electrode plate **21** and negative electrode plate **31** prepared as described above were wound with a separator **11**, composed of a polyethylene microporous membrane, therebetween using a core bar, followed by removing the core bar, whereby an electrode assembly **14** having a hollow portion **15** was prepared.

[0033] (Preparation of Nonaqueous Electrolyte)

[0034] Ethylene carbonate (EC) and dimethyl carbonate (DMC) were mixed at a volume ratio of 30:70 (1 atm, 25° C.), whereby a nonaqueous solvent was prepared. Lithium hexafluorophosphate ($LiPF_6$) serving as an electrolyte salt was dissolved in the nonaqueous solvent at a concentration of 1 mol/L, whereby a nonaqueous electrolyte was prepared.

[0035] (Preparation of Nonaqueous Electrolyte Secondary Battery)

[0036] An upper insulating plate **12** and a lower insulating plate **13** were provided on the top and bottom, respectively, of the electrode assembly **14**. Next, the negative electrode tab **32***a*, which was connected to the winding start side of the negative electrode plate **31**, was bent in the central direction of the electrode assembly **14**. Thereafter, the negative electrode tab **32***b*, which was connected to the winding end side of the negative electrode plate **31**, was bent so as to overlap the negative electrode tab **32***a* at the center of the electrode assembly **14** and the electrode assembly **14** was housed in an outer can **18**. The negative electrode tabs **32***a* and **32***b* were welded to the outer can **18** by resistance welding using a pair of electrodes. In particular, one of the electrodes was inserted into the hollow portion **15**, which corresponded to a core portion of the electrode assembly **14**, so as to be located on the negative electrode tab **32***a*, the other electrode was applied to the center of a bottom portion of the outer can **18**, and a voltage was applied between the electrodes. This allowed a contact between a nickel layer of the negative electrode tab **32***a* and a nickel layer of the negative electrode tab **32***b* and a contact between a nickel layer of the negative electrode tab **32***b* and the bottom portion of the outer can **18** to be welded. The positive electrode tab **22** was connected to a sealing body **17**. After the nonaqueous electrolyte was poured into the outer can **18**, the sealing body **17** was fixed to an opening of the outer can **18** by swaging with a gasket **16** therebetween, whereby a nonaqueous electrolyte secondary battery **10** having a diameter of 18 mm and a height of 65 mm was prepared as shown in FIG. **1**.

Experiment Example 2

[0037] A nonaqueous electrolyte secondary battery according to Experiment Example 2 was prepared in substantially the same manner as that used in Experiment Example 1 except for using a lithium-nickel composite oxide represented by $LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$ as a positive electrode active material.

Experiment Example 3

[0038] A nonaqueous electrolyte secondary battery according to Experiment Example 3 was prepared in substantially the same manner as that used in Experiment Example 1 except for using a lithium-nickel composite oxide represented by $LiNi_{0.91}Co_{0.06}Al_{0.03}O_2$ as a positive electrode active material.

Experiment Example 4

[0039] A nonaqueous electrolyte secondary battery according to Experiment Example 4 was prepared in substantially the same manner as that used in Experiment Example 2 except that the content of SiO was 4% by mass with respect to the sum of the masses of graphite and SiO.

Experiment Example 5

[0040] A nonaqueous electrolyte secondary battery according to Experiment Example 5 was prepared in substantially the same manner as that used in Experiment Example 2 except that the content of SiO was 7% by mass with respect to the sum of the masses of graphite and SiO.

Experiment Example 6

[0041] A nonaqueous electrolyte secondary battery according to Experiment Example 6 was prepared in substantially the same manner as that used in Experiment Example 2 except that the content of SiO was 10% by mass with respect to the sum of the masses of graphite and SiO.

Experiment Example 7

[0042] A nonaqueous electrolyte secondary battery according to Experiment Example 7 was prepared in substantially the same manner as that used in Experiment Example 2 except for using polycrystalline silicon (Si) with an average particle diameter (median diameter D50) of 5 μm instead of SiO coated with carbon.

Experiment Example 8

[0043] (Preparation of Silicon-Graphite Composite)

[0044] In a nitrogen atmosphere, monocrystalline Si particles were put into methylnaphthalene serving as a solvent together with a bead mill and were wet-milled so as to have an average particle diameter (median diameter D50) of 0.2 μm, whereby silicon-containing slurry was prepared. Graphite particles and carbon pitch were added to the silicon-containing slurry, followed by mixing and carbonizing the carbon pitch. The product was classified so as to have a particle diameter in a predetermined range, followed by adding carbon pitch. The carbon pitch was carbonized, whereby a silicon-graphite composite in which the Si particles and the graphite particles were bound with amorphous carbon was prepared. The content of silicon in this composite was 20.9% by mass.

[0045] A nonaqueous electrolyte secondary battery according to Experiment Example 8 was prepared in substantially the same manner as that used in Experiment Example 2 except for using the silicon-graphite composite prepared as described above instead of SiO coated with carbon.

Experiment Example 9

[0046] (Preparation of Silicon-Lithium Silicate Composite)

[0047] In an inert gas atmosphere, Si particles and lithium silicate (Li_2SiO_3) particles were mixed at a mass ratio of 42:58 and the mixture was milled in a planetary ball mill. The particles milled in the inert gas atmosphere were taken out and were then heat-treated at 600° C. for 4 hours in an inert gas atmosphere. The heat-treated particles (hereinafter referred to as the core particles) were milled and were mixed with coal pitch, followed by heat treatment at 800° C. for 5 hours in an inert gas atmosphere, whereby a conductive layer of carbon was formed on the surface of each core particle. The content of carbon contained in the conductive layer was 5% by mass with respect to the sum of the masses of the core particle and the conductive layer. Finally, the core particles were classified, whereby a silicon-lithium silicate composite with an average particle diameter of 5 μm was obtained.

[0048] (Analysis of Silicon-Lithium Silicate Composite)

[0049] A cross section of the silicon-lithium silicate composite was observed with a scanning electron microscope (SEM). As a result, the average diameter of the Si particles contained in the composite was less than 100 nm. Furthermore, it was confirmed that the Si particles were uniformly dispersed in a Li_2SiO_3 phase. In an XRD pattern of the silicon-lithium silicate composite, a diffraction peak assigned to each of Si and Li_2SiO_3 was observed. The full width at half maximum of the plane indices (111) of Li_2SiO_3 that was found at 2θ=27° in the XRD pattern was 0.233. In the XRD pattern, no peak assigned to SiO_2 was observed. The content of SiO_2 measured by Si-NMR was below the lower limit of detection.

[0050] A nonaqueous electrolyte secondary battery according to Experiment Example 9 was prepared in substantially the same manner as that used in Experiment Example 2 except for using the silicon-lithium silicate composite prepared as described above instead of SiO coated with carbon.

Experiment Example 10

[0051] A nonaqueous electrolyte secondary battery according to Experiment Example 10 was prepared in substantially the same manner as that used in Experiment Example 1 except that the content of SiO was 2% by mass with respect to the sum of the masses of graphite and SiO.

Experiment Example 11

[0052] A nonaqueous electrolyte secondary battery according to Experiment Example 11 was prepared in substantially the same manner as that used in Experiment Example 1 except for using a lithium-nickel composite oxide represented by $LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$ as a positive electrode active material.

Experiment Example 12

[0053] A nonaqueous electrolyte secondary battery according to Experiment Example 12 was prepared in substantially the same manner as that used in Experiment Example 1 except that a negative electrode tab **32***a* was not connected to a negative electrode current collector-exposed portion **34***a*.

[0054] (Cycle Test)

[0055] The battery according to each of Experiment Examples 1 to 12 was charged with a constant current of 1,500 mA in a 25° C. environment until the voltage of the battery reached 4.2 V. Thereafter, the battery was charged with a constant voltage of 4.2 V until the current reached 60 mA. Next, the battery was discharged with a constant current of 10 A until the battery voltage reached 2.5 V. The charge-discharge was repeated for 100 cycles.

[0056] (Measurement of Cross-Sectional Area of Hollow Portion in Electrode Assembly)

[0057] A cross section of the battery according to each of Experiment Examples 1 to 12 was photographed by X-ray computerized tomography (CT) before and after a cycle test, the cross section being perpendicular to the winding axis of the electrode assembly **14**. The cross-sectional area of the hollow portion **15** of the battery was measured from an obtained photograph. The electrode assembly strain was calculated from the following equation using the cross-sectional area A1 of the hollow portion **15** before the cycle test and the cross-sectional area A2 of the hollow portion **15** after the cycle test:

$$\text{Electrode assembly strain (\%)}=(A1-A2)/A1\times 100$$

[0058] Obtained results are summarized in Table 1.

TABLE 1

	Positive electrode	Negative electrode			Electrode
	Positive electrode active material	Si material	Content of Si material	Number of tabs	assembly strain
Experiment Example 1	$LiNi_{0.82}Co_{0.15}Al_{0.03}O_2$	SiO	5% by mass	2	21%
Experiment Example 2	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	SiO	5% by mass	2	15%
Experiment Example 3	$LiNi_{0.91}Co_{0.06}Al_{0.03}O_2$	SiO	5% by mass	2	7%
Experiment Example 4	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	SiO	4% by mass	2	13%

TABLE 1-continued

	Positive electrode	Negative electrode			Electrode
	Positive electrode active material	Si material	Content of Si material	Number of tabs	assembly strain
Experiment Example 5	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	SiO	7% by mass	2	22%
Experiment Example 6	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	SiO	10% by mass	3	41%
Experiment Example 7	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	Si	5% by mass	2	18%
Experiment Example 8	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	Si-graphite composite	5% by mass	2	16%
Experiment Example 9	$LiNi_{0.88}Co_{0.09}Al_{0.03}O_2$	Si-Li_2SiO_3 composite	5% by mass	3	13%
Experiment Example 10	$LiNi_{0.82}Co_{0.15}Al_{0.03}O_2$	SiO	2% by mass	2	18%
Experiment Example 11	$LiNi_{0.7}Co_{0.2}Mn_{0.1}O_2$	SiO	5% by mass	2	55%
Experiment Example 12	$LiNi_{0.88}Co_{0.12}Al_{0.03}O_2$	SiO	5% by mass	1	6%

[0059] As is clear from Table 1, Experiment Examples 1 to 10 exhibit reduced electrode assembly strain as compared to Experiment Example 11. This result shows that cobalt and aluminium need to be constituent elements of each lithium-nickel composite oxide. The reason why the electrode assembly strain is reduced is not clear but is probably because a positive electrode plate containing a lithium-cobalt composite oxide containing cobalt and aluminium as a positive electrode active material exhibits the physical effect of buffering the deformation of a negative electrode due to charge or discharge.

[0060] Comparing results of Experiment Examples 1 to 3 shows that the increase in nickel content of each lithium-nickel composite oxide reduces the electrode assembly strain. In particular, Experiment Example 3, in which the nickel content of the lithium-nickel composite oxide is 91% by mole, exhibits an electrode assembly strain substantially equal to that of Experiment Example 12, in which a single negative electrode tab only is used. The reason for this is not clear but is probably as follows. With the increase in content of nickel, a NiO phase is likely to be formed on the surface of a positive electrode active material. The NiO phase affects the electronic conductivity and ionic conductivity of a lithium-nickel composite oxide. Therefore, the increase in amount of nickel affects the behavior of a negative electrode in the final stage of charge or discharge controlled by the battery voltage and acts to reduce the deformation of an electrode assembly. However, Mn in a positive electrode active material suppresses the formation of NiO. Therefore, the electrode assembly strain of Experiment Example 11 is probably increased.

[0061] From the above results, the content of nickel in a lithium-nickel composite oxide is preferably 80% by mole or more and more preferably 88% by mole or more.

[0062] Comparing results of Experiment Examples 3 to 6 shows that the increase in content of SiO increases the electrode assembly strain. With the increase in content of SiO, which varies greatly in volume during charge and discharge, the increase of the electrode assembly strain is inevitable. However, even when the content of SiO is high, the following effect is exhibited: the effect of reducing the electrode assembly strain by using a predetermined lithium-nickel composite oxide for a silicon material in a negative electrode active material as a positive electrode active material. Therefore, the upper limit of the content of SiO is not particularly limited and the content of SiO is preferably 20% by mass or less with respect to the sum of the masses of graphite and the silicon material and more preferably 10% by mass or less. The lower limit of the content of SiO is also not particularly limited. In order to obtain a high-capacity nonaqueous electrolyte secondary battery, the content of SiO is preferably 4% by mass or more.

[0063] Experiment Examples 7 to 9, in which silicon or the composite containing silicon is used, exhibit an electrode assembly strain substantially equal to that of Experiment Example 2, in which SiO is used. In the case of using silicon alone or in the form of a composite as described above, the electrode assembly strain is suppressed as is the case with SiO.

[0064] The embodiments of the present invention are further described with reference to the above experiment results.

[0065] A lithium-nickel composite oxide serving as a positive electrode active material needs to contain cobalt and aluminium as constituent elements. The nickel content of the lithium-nickel composite oxide is preferably 80% by mole or more. Therefore, a lithium-nickel composite oxide according to an embodiment of the present invention can be represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.8\leq b<1$, $0<c<0.2$, $0<d<0.05$, and $b+c+d=1$).

[0066] The results of the experiment examples show that the nickel content of the lithium-nickel composite oxide is more preferably 88% by mole or more. Therefore, a lithium-nickel composite oxide according to another embodiment of the present invention can be represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.88\leq b<1$, $0<c<0.12$, $0<d<0.05$, and $b+c+d=1$).

[0067] In the above formulas, a, which represents the content of Li, is set within the above range in consideration of the fact that a varies during charge and discharge. In nonaqueous electrolyte secondary batteries immediately after being prepared, a preferably satisfies $0.95\leq a\leq1.2$.

[0068] In the present invention, a lithium-nickel composite oxide may contain at least one element selected from the group consisting of Fe, Cu, Mg, Ti, Zr, Ce, and W instead of any of Ni, Co, and Al. The total content of these elements

is preferably less than 1% by mole with respect to the number of moles of metal elements, excluding lithium, in the lithium-nickel composite oxide. This enables the safety of nonaqueous electrolyte secondary batteries to be improved. Incidentally, the above formulas do not exclude any impurity element inevitably contained in the lithium-nickel composite oxides.

[0069] A silicon material used may be silicon oxide. Silicon oxide used is preferably silicon oxide represented by the formula SiO_x ($0.5 \leq x < 1.6$). When x is less than 0.5, the proportion of Si in SiO_x is large. Therefore, the dilatation and shrinkage of a negative electrode active material during charge and discharge are excessively large to reduce cycle characteristics. When x is 1.6 or more, the irreversible capacity of a negative electrode during initial charge and discharge is large and therefore the battery capacity is reduced. Therefore, x is preferably 0.5 to less than 1.6.

[0070] SiO_x has lower electronic conductivity as compared to graphite. Therefore, the surface of SiO_x is preferably coated with carbon as shown in the experiment examples. The coating amount of carbon is preferably 0.1% by mass to 10% by mass with respect to SiO_x. However, it is not necessarily essential that the surface of SiO_x is coated with carbon, in the case where the surface of SiO_x is not coated with carbon, effects of the present invention are sufficiently exhibited.

[0071] The silicon material used may be silicon alone or a composite of silicon and another material. Silicon used may be any of microcrystalline silicon, polycrystalline silicon, and amorphous silicon. Polycrystalline silicon with a grain size of 60 nm or less and amorphous silicon are preferable. Using such silicon reduces the cracking of particles during charge and discharge to enhance cycle characteristics. The average particle diameter (median diameter D50) of silicon is preferably 0.1 μm to 10 μm and more preferably 0.1 μm to 5 μm. Techniques for obtaining silicon having such an average particle diameter include dry milling processes using a jet mill or a ball mill and wet milling processes using a bead mill or a ball mill. Silicon may be alloyed with at least one metal element selected from the group consisting of nickel, copper, cobalt, chromium, iron, silver, titanium, molybdenum, and tungsten.

[0072] As a material that forms a composite together with silicon, a material having the effect of absorbing the significant change in volume of silicon due to charge or discharge is preferably used. Examples of such a material include graphite and lithium silicate.

[0073] In a silicon-graphite composite, silicon particles and graphite particles are preferably bound to each other with amorphous carbon as shown in Experiment Example 8. The graphite particles used may be particles of any of synthetic graphite and natural graphite. As a precursor of amorphous carbon used to bind the silicon particles and the graphite particles together, a pitch material, a tar material, and a resin material can be used. Examples of the resin material include vinyl resins, cellulose resins, and phenol resins. These amorphous carbon precursors can be converted into amorphous carbon by heat treatment at 700° C. to 1,300° C. in an inert gas atmosphere. In the case where the silicon particles and the graphite particles are bound together with amorphous carbon, amorphous carbon is included in components of the silicon-graphite composite. The content of silicon in the silicon-graphite composite is preferably 10% by mass to 60% by mass.

[0074] A silicon-lithium silicate composite preferably has a structure in which silicon particles are dispersed in a lithium silicate phase as shown in Experiment Example 9. The surface of the silicon-lithium silicate composite, as well as SiO_x, may be coated with carbon. In this case, carbon is an arbitrary component and is not any component of the silicon-lithium silicate composite. The content of silicon in the silicon-lithium silicate composite is preferably 40% by mass to 60% by mass.

[0075] Incidentally, SiO_x microscopically has a structure in which Si particles are dispersed in a matrix made of SiO_2. It is conceivable that the SiO_2 acts to absorb the expansion and contraction of Si during charge and discharge. However, in the case of using SiO_x in a negative electrode active material, SiO_2 reacts with lithium (Li) as shown by Equation (1).

$$2SiO_2 + 8Li^+ + 8e^- \rightarrow Li_4Si + Li_4SiO_4 \quad (1)$$

[0076] Li_4SiO_4, which is formed by the reaction of SiO_2 with Li, cannot reversibly intercalate or deintercalate lithium. Therefore, the irreversible capacity due to the formation of Li_4SiO_4 during the first charge is accumulated in a negative electrode containing SiO_x as a negative electrode active material. However, unlike SiO_x, lithium silicate does not cause any chemical reaction accumulating irreversible capacity and therefore can absorb the change in volume of Si during charge and discharge without reducing the initial charge/discharge efficiency of the negative electrode.

[0077] Lithium silicate used is not limited to Li_2SiO_3 shown in Experiment Example 9 and may be lithium silicate represented by the formula $Li_{2z}SiO_{(2+z)}$ ($0 < z < 2$). In an XRD pattern, the full width at half maximum of the diffraction peak corresponding to the (111) plane of lithium silicate is preferably 0.05° or more. This further enhances the lithium ion conductivity in particles of the silicon-lithium silicate composite and the effect of absorbing the change in volume of Si.

[0078] Examples of graphite used as a negative electrode active material include synthetic graphite and natural graphite, which may be used alone or in combination. The surface of graphite may be coated with carbon.

[0079] A separator used may be a microporous membrane made of a polyolefin such as polyethylene (PE) or a polypropylene (PP). The microporous membrane may be used in the form of a single layer or a stack of two or more layers. In a layered separator composed of two or more layers, it is preferable that an intermediate layer is made of polyethylene (PE) having a low melting point and a surface layer is made of polypropylene (PP) having excellent oxidation resistance. The separator may contain inorganic particles such as aluminum oxide (Al_2O_3), titanium oxide (TiO_2), and silicon oxide (SiO_2). The inorganic particles may be supported in the separator or may be applied to a surface of the separator together with a binding agent. An aramid resin may be applied to a surface of the separator.

[0080] A nonaqueous electrolyte used may be one obtained by dissolving a lithium salt serving as an electrolyte salt in a nonaqueous solvent. A nonaqueous electrolyte containing a gelled polymer instead of or together with the nonaqueous solvent can be used.

[0081] The nonaqueous solvent used may be any of cyclic carbonates, linear carbonates, cyclic carboxylates, and linear carboxylates, which are preferably used in combination. Examples of the cyclic carbonates include ethylene carbon-

ate (EC), propylene carbonate (PC), and butylene carbonate (BC). A cyclic carbonate, such as fluoroethylene carbonate (FEC), in which hydrogen is partially substituted with fluorine can be used. Examples of the linear carbonates include dimethyl carbonate (DMC), ethyl methyl carbonate (EMC), diethyl carbonate (DEC), and methyl propyl carbonate (MPC). Examples of the cyclic carboxylates include γ-butyrolactone (γ-BL) and γ-valerolactone (γ-VL). Examples of the linear carboxylates include methyl pivalate, ethyl pivalate, methyl isobutyrate, and methyl propionate.

[0082] Examples of the lithium salt include $LiPF_6$, $LiBF_4$, $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$, $LiN(C_2F_5SO_2)_2$, $LiN(CF_3SO_2)(C_4F_9SO_2)$, $LiC(CF_3SO_2)_3$, $LiC(C_2F_5SO_2)_3$, $LiAsF_6$, $LiClO_4$, $Li_2B_{10}Cl_{10}$, and $Li_2B_{12}Cl_{12}$. Among these, $LiPF_6$ is particularly preferable. The concentration of $LiPF_6$ in the nonaqueous electrolyte is preferably 0.5 mol/L to 2.0 mol/L. $LiPF_6$ may be mixed with another lithium salt such as $LiBF_4$.

[0083] In each experiment example, the nonaqueous electrolyte secondary battery, which is cylindrical, has been exemplified. In the case of using a prismatic nonaqueous electrolyte secondary battery, effects of the present invention are equally exhibited. That is, a bottomed cylindrical outer can according to the present invention includes cylindrical outer cans and prismatic outer cans.

INDUSTRIAL APPLICABILITY

[0084] According to the present invention, a nonaqueous electrolyte secondary battery having excellent output characteristics and excellent cycle characteristics can be provided. Therefore, the industrial applicability of the present invention is significant.

REFERENCE SIGNS LIST

[0085] **10** Nonaqueous electrolyte secondary battery
[0086] **11** Separator
[0087] **12** Upper insulating plate
[0088] **13** Lower insulating plate
[0089] **14** Electrode assembly
[0090] **15** Hollow portion
[0091] **16** Gasket
[0092] **17** Sealing body
[0093] **18** Outer can
[0094] **21** Positive electrode plate
[0095] **22** Positive electrode tab
[0096] **23** Positive electrode mixture layers
[0097] **24** Positive electrode current collector-exposed portion
[0098] **31** Negative electrode plate
[0099] **32***a*, **32***b* Negative electrode tab
[0100] **33** Negative electrode mixture layers
[0101] **34***a*, **34***b* Negative electrode current collector-exposed portion

1. A nonaqueous electrolyte secondary battery comprising a positive electrode plate including a positive electrode current collector and a positive electrode mixture layer, formed thereon, containing a positive electrode active material; a negative electrode plate including a negative electrode current collector and a negative electrode mixture layer, formed thereon, containing a negative electrode active material; a separator; a nonaqueous electrolyte; an outer can; and a sealing body,

wherein the positive electrode plate and the negative electrode plate are wound with the separator therebetween;

the positive electrode active material contains a lithium-nickel composite oxide;

the lithium-nickel composite oxide is represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.8\leq b<1$, $0<c<0.2$, $0<d<0.05$, and $b+c+d=1$);

the negative electrode active material contains graphite and a silicon material;

the negative electrode plate includes negative electrode current collector-exposed portions, located at both ends thereof in a longitudinal direction, not covered by the negative electrode mixture layer; and

the negative electrode current collector-exposed portions are each connected to a negative electrode tab.

2. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the lithium-nickel composite oxide is represented by the formula $Li_aNi_bCo_cAl_dO_2$ ($0<a\leq1.2$, $0.88\leq b<1$, $0<c<0.12$, $0<d<0.05$, and $b+c+d=1$).

3. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the lithium-nickel composite oxide is represented by the formula $Li_aNi_bCo_cAl_dM_eO_2$ (M is at least one element selected from the group consisting of Fe, Cu, Mg, Ti, Zr, Ce, and W; $0<a\leq1.2$; $0.8\leq b<1$; $0<c<0.2$; $0<d<0.05$; $0<e<0.01$; and $b+c+d+e=1$).

4. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the lithium-nickel composite oxide is represented by the formula $Li_aNi_bCo_cAl_dM_eO_2$ (M is at least one element selected from the group consisting of Fe, Cu, Mg, Ti, Zr, Ce, and W; $0<a\leq1.2$; $0.88\leq b<1$; $0<c<0.12$; $0<d<0.05$; $0<e<0.01$; and $b+c+d+e=1$).

5. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the silicon material is represented by the formula SiO_x ($0.5\leq x<1.6$).

6. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the silicon material is a composite in which silicon particles and graphite particles are bound to each other with amorphous carbon.

7. The nonaqueous electrolyte secondary battery according to claim **1**, wherein the silicon material is a composite in which silicon particles are dispersed in a lithium silicate phase represented by the formula $Li_{2z}SiO_{(2+z)}$ ($0<z<2$).

8. The nonaqueous electrolyte secondary battery according to claim **5**, wherein the content of the silicon material is 4% by mass to 20% by mass with respect to the sum of the masses of the graphite and the silicon material.

9. The nonaqueous electrolyte secondary battery according to any one of claim **6**, wherein the content of the silicon material is 4% by mass to 20% by mass with respect to the sum of the masses of the graphite and the silicon material.

10. The nonaqueous electrolyte secondary battery according to any one of claim **7**, wherein the content of the silicon material is 4% by mass to 20% by mass with respect to the sum of the masses of the graphite and the silicon material.

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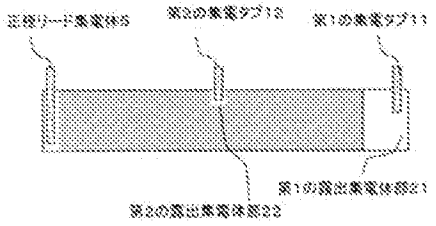
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最終頁に続く

(54)【発明の名称】非水電解質二次電池

(57)【要約】
【課題】異常時に電池内で内部短絡が生じた場合でも高い安全性を確保することが可能な非水電解質二次電池を提供する。
【解決手段】電池缶の極とは異なる極板において、電極群の最外周側で１周以上の長さにわたって活物質層が塗着されずに集電体が露出した第１の露出集電体部と、第１の露出集電体部には第１の集電タブが設けられ、封口板に接続された極板にはさらに活物質層が塗着されずに集電体が露出した第２の露出集電体部と第２の露出集電体部には第２の集電タブが設けられており、第１の集電タブと第２の集電タブが電極群外で接続されていること非水電解質二次電池。
【選択図】図２



【特許請求の範囲】
【請求項１】
正極集電体上の両面に正極活物質層が塗着された正極板と負極集電体上の両面に負極活物質層が塗着された負極板との間にセパレータを介して巻回した電極群と、電極群のいずれか一方の極の端子をなす電池缶と、電池缶と絶縁体を介して封口する他方極の端子をなす封口板からなる非水電解質二次電池において、
前記封口板に接続された極板は、電極群の最外周側で１周以上の長さにわたって活物質層が塗着されずに集電体が露出した第１の露出集電体部と、さらに活物質層が塗着されずに集電体が露出した第２の露出集電体部とを備え、前記第１の露出集電体部には第１の集電タブが設けられ、前記第２の露出集電体部には第２の集電タブが設けられており、前記第１の集電タブと前記第２の集電タブが電極群外で接続されていることを特徴とする非水電解質二次電池。
【請求項２】
前記第２の露出集電体部は巻回方向に１周以上の長さを有していることを特徴とする請求項１に記載の非水電解質二次電池。
【請求項３】
前記第２の露出集電体部の反対面の集電体部も集電体が露出していることを特徴とする請求項１から２のいずれかに記載の非水電解質二次電池。
【請求項４】
前記第１の露出集電体部の反対面の集電体部も集電体が露出していることを特徴とする請求項１から３のいずれかに記載の非水電解質二次電池。
【請求項５】
前記封口板に接続された極板は前記第１の露出集電体部と前記第２の露出集電体部とは別に、巻回方向に１周以上の長さの活物質層が塗着されずに集電体が露出した第３の露出集電体部を具していることを特徴とする請求項１から４のいずれかに記載の非水電解質二次電池。
【請求項６】
前記第１の露出集電体部に対向する、電池缶と同極の極板の部分はその集電体部分が露出していることを特徴とする請求項１から５のいずれかに記載の非水電解質二次電池。
【請求項７】
前記第２の露出集電体部に対向する、電池缶と同極の極板の部分はその集電体部分が露出していることを特徴とする請求項２または３のいずれかに記載の非水電解質二次電池。
【請求項８】
前記第３の露出集電体部に対向する、電池缶と同極の極板の部分はその集電体部分が露出していることを特徴とする請求項５に記載の非水電解質二次電池。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、非水電解質二次電池に関し、特に極板構造と集電構造を好適にしたものに関する。
【背景技術】
【０００２】
近年、ノート型パーソナルコンピュータ、携帯電話等のポータブル機器の普及により、その電源である電池の需要が高まっている。特に、小型かつ軽量で、エネルギー密度が高く、繰り返し充放電が可能な二次電池の需要が高まっている。また、最近では、電動工具、ハイブリッドカー、電気自動車などの駆動用電源としての新しい需要が増加しつつある。
【０００３】
このような需要に対して、リチウムイオン二次電池に代表される非水電解質二次電池の研究開発が活発に行われている。非水電解質二次電池は、機器の高性能化および高出力化

に伴って、より大きなエネルギーを保有するようになってきており、異常時に発生する熱量も大きなものとなっている。電池の異常な発熱とは、例えば、電池の内部短絡または過充電時の発熱である。電池の内部短絡の中でも釘刺し等の外部異物による電池缶および電極群の変形により電極群内で正極と負極の短絡が生じた場合、正極活物質への短絡電流による発熱に起因して電池の安全性が問題になる。

【０００４】

高容量および高出力の非水電解質二次電池の安全性の向上に対して様々な検討が行われている。

【０００５】

例えば，特許文献１または２では、巻回型電極群を電池缶に収容した非水電解質二次電池において、正極集電体の集電体露出部分に対向するように負極の集電体露出部分を１周以上形成することが提案されている。特に正極集電体露出部分および対向する負極集電体露出部分が巻回型電極群の最外周部に形成されている構成は、外部異物による電池缶への衝撃に対して有用性が高いと述べられている。

電極群の最外周側に設けられた正極および負極集電体露出部分がまず接触し、短絡することで、電気抵抗の小さな金属同士の短絡のため、電池の急激な温度上昇を抑制すると考えられている。

【０００６】

特許文献３では、正極集電体の側縁部に正極合剤層を塗布しない露出金属部分を形成し、その露出金属部分に正極リードを複数本形成することが提案されている。

【先行技術文献】

【特許文献】

【０００７】

【特許文献１】特開平０８－１５３５４２号公報

【特許文献２】特開平０９－１８０７６１号公報

【特許文献３】特開平０９－３０６４７０号公報

【発明の概要】

【発明が解決しようとする課題】

【０００８】

近年の非水電解質二次電池の高容量化・高出力化に伴って，電池の内部短絡が生じた場合の短絡電流も増大しており、上記の対策のみでは十分に対応できない。

【０００９】

巻回型電極群を電池缶に収容した非水電解質二次電池において、釘等の異物が電池缶の外部に刺さった場合、電池缶が変形したのちに、電極群に応力が加わり、電極群の最外周側の正極と負極の短絡が生じやすい。さらに外部からの応力が加わることで、電極群の外周側から内部に向かって短絡が順次生じる。この場合、特許文献１、２で提案されているように、電極群の正極の集電体露出部分と対向する負極の集電体露出部分が外周部側に形成されている場合、この外周部側の金属集電体同士の短絡のほうが内部の正極合剤と負極合剤同士の短絡によりも抵抗が小さいため、集中的に短絡電流が生じると考えられる。しかしながら、外周部側で金属集電体同士の短絡が生じた場合でも、電極群の内周部側の活物質は電位、即ち電気エネルギーを有しているため、正極、負極それぞれの金属集電体を通じて短絡箇所の方に短絡電流が流れる。つまり内周部側から集電体を通じて短絡箇所へ向かう方向に短絡電流が生じる。そのとき外周部側での抵抗よりも比較的大きな抵抗と考えられる電極群内部で生じた短絡箇所において、集電体を通じて短絡電流が集中し、局所的に大きな発熱が生じるため、電池の安全性を確保することが難しいことが分かった。

【００１０】

特許文献３では正極集電体の側縁部に形成した正極合剤層を塗布しない露出金属部分に正極リードを複数本形成した集電タブ構造とすることで出力特性の向上を図っている。しかしながら、セパレータを介して対向する正極集電体と負極集電体において正極集電体の側縁部に形成された露出金属部分に対して負極集電体の露出金属部分が対向した構造では

なく、内部短絡などの安全性の向上を図る効果は見出せない。

【課題を解決するための手段】

【００１１】

本発明の目的は、異常時に電池内で内部短絡が生じた場合でも高い安全性を確保することが可能な非水電解質二次電池を提供することにある。

【００１２】

本発明の非水電解質二次電池は、正極集電体上の両面に正極活物質層が塗着された正極板と負極集電体上の両面に負極活物質層が塗着された負極板との間にセパレータを介して捲回または積層した電極群と、電極群のいずれか一方の極の端子をなす電池缶と、電池缶に対して絶縁体を介して封口する他方極の端子をなす封口板からなり、前記封口板に接続された極板において、前記封口板に接続された極板は、電極群の最外周側で１周以上の長さにわたって活物質層が塗着されずに集電体が露出した第１の露出集電体部と、さらに活物質層が塗着されずに集電体が露出した第２の露出集電体部とを備え、前記第１の露出集電体部には第１の集電タブが設けられ、前記第２の露出集電体部には第２の集電タブが設けられており、前記第１の集電タブと前記第２の集電タブが電極群外で接続されているというものである。

【００１３】

本発明の非水電解質二次電池を用いることによって、釘等の外部異物による電池缶への応力が加わることで電極群に内部短絡が生じても、第１の露出集電体部で小さな抵抗による内部短絡が発生すると同時に、電極群内部に生じる短絡電流を第２の露出集電体部より第１の露出集電体部へ分流できるため、高容量・高出力化した電池においても安全性の高い電池を提供することができる。

【発明の効果】

【００１４】

本発明によれば、異常時に電池内で内部短絡が生じた場合でも高い安全性を確保することが可能な非水電解質二次電池を提供することができる。さらに非水電解質二次電池の高容量化・高出力化の技術革新が進んだ場合においても、本発明の構成を用いることで、高容量・高出力・高安全な非水電解質二次電池を提供することができる。

【００１５】

本発明の新規な特徴を添付の請求の範囲に記述するが、本発明は、構成および内容の両方に関し、本発明の他の目的および特徴と併せ、図面を照合した以下の詳細な説明によりさらによく理解されるであろう。

【図面の簡単な説明】

【００１６】

【図１】本発明の一実施の形態の円筒型リチウムイオン電池の概略縦断面図
【図２】本発明の一実施の形態の正極板を示した模式平面図
【図３】本発明の別の実施の形態の正極板を示した模式平面図
【図４】本発明の別の実施の形態の正極板を示した模式平面図
【図５】本発明の別の実施の形態の正極板を示した模式平面図
【図６】本発明の別の実施の形態の正極板を示した模式平面図
【図７】本発明の別の実施の形態の正極板を示した模式平面図
【図８】本発明の別の実施の形態の正極板を示した模式平面図
【図９】本発明の別の実施の形態の正極板を示した模式平面図
【図１０】本発明の別の実施の形態の正極板を示した模式平面図
【図１１】本発明の別の実施の形態の正極板を示した模式平面図
【図１２】本発明の一実施の形態の負極板を示した模式平面図
【図１３】本発明の別の実施の形態の負極板を示した模式平面図

【発明を実施するための形態】

【００１７】

本発明は、正極集電体上の両面に正極活物質層が形成された正極板と負極集電体上の両

面に負極活物質層が塗着された負極板との間にセパレータを介して巻回または積層した電極群と、電極群のいずれか一方の極の端子をなす電池缶と、電池缶と絶縁体を介して封口する他方極の端子をなす封口板からなる非水電解質二次電池に関する。前記封口板と接続した極板は、電極群の最外周側で１周以上の長さにわたって活物質層が塗着されずに集電体が露出した第１の露出集電体部と、前記第１の露出集電体部には第１の集電タブが設けられ、前記封口板に接続された極板にはさらに活物質層が塗着されずに集電体が露出した第２の露出集電体部と前記第２の露出集電体部には第２の集電タブが設けられており、第１の集電タブと第２の集電タブが電極群外で接続されている。

【００１８】

釘等の外部異物により、電池缶への応力が加わることで、電極群に内部短絡が生じたとき、電極群の最外周側に設けられた第１の露出集電体部と対向する極板との間で小さな抵抗による内部短絡が発生する。このとき第１の露出集電体部と第２の露出集電体部とは第１の集電タブと第２の集電タブとで電極群外で接続されているため、電極群の外周側で内部短絡が生じた場合、電極群内部に発生する電流を第２の露出集電体部より第１の集電タブおよび第２の集電タブを介して第１の露出集電体部へ集電体とは別に分流することができる。従って、電極群の内部でさらに内部短絡が発生した場合でも、その箇所への集電体を通じての短絡電流を小さくすることができることにより、異常発熱を抑制することが可能となる。一方、第１の集電タブと第２の集電タブのない通常の電池の場合、電極群内部で短絡時に生じる電流は集電体を通じて第１の露出集電体部の内部短絡点に流れる。従って、電極群のさらに内部で内部短絡が発生した場合では、その箇所での短絡電流の流れ込みによる異常発熱を回避することが困難となる場合が生じてしまう。

【００１９】

第２の露出集電体部は巻回方向に１周以上の長さを有してもよいし、反対面の集電体部も露出していてもよい。この場合、第１の露出集電体部で生じた抵抗の低い短絡に加えて、抵抗の小さな内部短絡箇所を電極群内に分散して設けることができる。

【００２０】

第１の露出集電体部の背面側の一部もしくは全部に活物質層が塗着されずに集電体が露出してもよい。最外周露出集電体部で生じる短絡抵抗を小さくすることができる。

【００２１】

封口板に接続された極板において、第１の露出集電体部と第２の露出集電体部とは別に、巻回方向に１周以上の長さで活物質層が塗着されずに片側面、もしくは両側面に集電体が露出した第３の露出集電体部を具していてもよい。この場合も、第１の露出集電体部での抵抗の小さな短絡に加えて、抵抗の小さい内部短絡箇所を電極群内に分散して設けることができる。

【００２２】

電池缶に接続された極板において、最外周露出集電体部または内部露出集電体部に対向するその集電体部分が露出していてもよい。この場合、抵抗の小さな内部短絡となるため、より安全性を確保することができる。

【００２３】

電池缶に接続された極板において、電極群の最内周側と最外周側のいずれか一方に集電体が露出しており、集電体が露出した箇所と電池缶が集電タブを介して接続しているとよい。最内周側と最外周側の両方から集電タブが電池缶に接続している場合は、短絡時における内周側の出力電流を、集電タブと電池缶を通じて最外周側の露出芯材へと分流することができることからさらによい。

【００２４】

電池缶に接続された極板において、活物質層が塗着されている極板端部の中央部に集電体が露出しており、集電体が露出した箇所と電池缶が集電タブを介して接続する構成でもよい。

【００２５】

電池缶が負極板に接続されている場合、正極板に第１の露出集電体部と第２の露出集電

体部を設け、それぞれを集電タブの導電体で接続することで、内部短絡時の短絡電流を集電体とは別に分流することで、正極活物質の発熱に起因する電池の異常発熱を抑制することが可能となる。電池缶が正極板に接続されている場合、正極板は最内周側もしくは極板端部の中央部に露出集電体箇所を設け、そこ箇所と電池缶を接続する構成とすると、電池缶を通じた短絡電流の分流ができるのでさらによい。

【００２６】

なお、電池缶が例えばラミネートフィルムのような絶縁材料から構成され、正極板および負極板のどちらとも電気的に接続されていない非水電解質二次電池の場合でも、本発明の技術的思想を用いることで、釘刺しなどの外部異物に起因した内部短絡による異常発熱を抑制し、安全性の高い電池を提供することができる。

【００２７】

以下、本発明の実施の形態における非水電解質二次電池について、効果が最も顕著な円筒型リチウムイオン電池の図面を参照しながら説明するが、本発明は、以下の実施形態に限定されるものではない。

【００２８】

図１は本発明の実施の形態における円筒型リチウムイオン電池の概略縦断面図である。

【００２９】

図１において円筒型リチウムイオン電池は、アルミニウム箔集電体に正極合剤が塗着された正極板１と、銅箔集電体に負極合剤が塗着された負極板２と、それら両極間に厚み１６μｍのセパレータ３を配置して、渦巻き状に巻かれた円筒状の電極群４を備えている。アルミニウム箔集電体には正極リード集電体５が抵抗溶接されている。正極リード集電体５は集電体上に塗着されている正極活物質層の２つの端部のほぼ中央部に形成された合剤未塗着部上に形成されている。負極板２には負極リード集電体６が抵抗溶接されている。負極リード集電体６は銅箔集電体に形成された合剤未塗着部上に形成されている。正極リード集電体５と負極リード集電体６は電極群４の巻回軸方向にそれぞれ逆方向になるようにそれぞれの極板に接続されている。電極群４は電池缶７に収納されている。電池缶７は鉄製で底部と開口端部を有しており、内部はニッケルめっきが施されている。電極群４の上部および下部には上部絶縁板１０ａおよび下部絶縁板１０ｂが配置されている。負極リード集電体６は電池缶７の底部と抵抗溶接され電気的に接続されている。正極リード集電体５は電池缶７の開口端から封口板８の金属製フィルター９にレーザ溶接され電気的に接続されている。電池缶７の開口端から非水電解液を注入する。電池缶７の開口端には溝を入れて座が形成され、正極リード集電体５を折り曲げ、電池缶７の座部に樹脂製のガスケット１０ｃと封口板８が装着され、電池缶７の開口端全周囲をかしめて封口されている。

【００３０】

図２に本発明の一形態の正極板１を示した模式平面図を示す。図２の正極板１ａには電極群４の内周側に位置する箇所に正極リード集電体５が設けられており、集電体の最外周端部に電極群４の最外周側面の１周以上にわたる部分に正極合剤が塗着されずにアルミニウム箔集電体が露出した第１の露出集電体部２１を設け、第１の集電タブ１１が形成されている。さらに正極板１には正極合剤が塗着されずにアルミニウム箔集電体が露出した第２の露出集電体部２２を設け、第２の集電タブ１２が形成されている。第１の集電タブ１１と第２の集電タブ１２は電極群４の巻回軸方向と同方向に正極板１から突設されている。正極板１から突設された第１の集電タブ１１と第２の集電タブ１２は電極群４の端部で抵抗溶接またはレーザ溶接されて電気的に接続される。

【００３１】

第１の露出集電体部２１と第２の露出集電体部２２はそれらの間に存在するアルミニウム箔集電体やその上に塗着された正極活物質層とは別に第１の集電タブ１１と第２の集電タブ１２により電気的に接続された構造となる。第１の露出集電体部２１で内部短絡が生じた場合、電極群４内部で生じる短絡電流は、第１の集電タブ１１と第２の集電タブ１２がない通常の電池の場合は、アルミニウム箔集電体とその上に塗着された正極活物質層を流れる。釘等の外部異物により、電極群４のさらに内部の活物質層が塗着された箇所で内

部短絡が生じると、その短絡箇所にも電極群内部で生じる短絡電流が流れて発熱が生じて、電池の安全性に問題が生じる場合がある。本発明の正極板１では、電極群４の内部で生じる短絡電流を、アルミニウム箔集電体とその上に塗着された正極活物質層に流れるのとは別に、第１の集電タブ１１と第２の集電タブ１２を介して第１の露出集電体部２１へ分流することができる。従って、釘等の外部異物により電極群４の外周側から短絡箇所が内部へ進行する場合でも、第１の露出集電体部２１への短絡電流の分流により、正極合剤に流れる短絡箇所での短絡電流を抑制することで異常発熱を抑えることができる。

【００３２】

図３に本発明の別の実施の形態の正極板１を示した模式平面図を示す。図３の正極板１ｂは図２の正極板１ａの第２の露出集電体部２２において、電極群４の巻回方向に１周以上の長さを有するように集電体部が露出している。この第２の露出集電体部２２で短絡が生じた場合、活物質が塗着されていないため抵抗の小さな短絡を電極群４内部で生じさせることで安全性を高めることができる。

【００３３】

図４に本発明の別の実施の形態の正極板１を示した模式平面図を示す。図４の正極板１ｃは、図２の正極板１ａにおいて、電極群４の巻回方向に１周以上の長さを有するように正極合剤が塗着されずにアルミニウム箔集電体が露出した第３の露出集電体部２３が形成されている。この第３の露出集電体部２３で短絡が生じた場合でも、活物質が塗着されていないため抵抗の小さな短絡を電極群４内部で生じさせることで安全性を高めることができる。

【００３４】

図２から図４に示した本発明の正極板（１ａ、１ｂ、１ｃ）において、正極リード集電体５は電極群４の最内周側、即ち、正極板１において第１の露出集電体部と反対側に位置する場合を示しているが、それに限定されることは無く、正極板１の内部のいずれかに設けられていても、もちろん良い。正極リード集電体５が正極板１のほぼ中央部に形成された本発明の別の実施の形態の正極板１を示した模式平面図を図５の正極板１ｄに示す。

【００３５】

第２の集電タブ１２は正極リード集電体５を兼用する構造であってもよい。この場合、第２の集電タブ１２に電極群の外側で接続する第１の集電タブ１１は正極リード集電体５と直接もしくは封口板８の金属製フィルター９を介して接続してもよい。図６、図７に第２の集電タブ１２が正極リード集電体５を兼用した本発明の別の実施の形態の正極板１を示した模式平面図を示す。正極リード集電体兼第２の集電タブ１３が電極群の最内周側に設けられた場合を図６の正極板１ｅに、極板内に設けられた場合を図７の正極板１ｆに示す。第２の集電タブ１２が正極リード集電体５を兼用して正極リード集電体兼第２の集電タブ１３を用いる場合、部品点数やプロセス工数を減らすことが出来る。

【００３６】

第２の集電タブ１２と正極リード集電体５を兼用する正極リード集電体兼第２の集電タブ１３を極板中央部に設け、巻回方向に１周以上の長さで集電体が露出する第２の露出集電体部２２を形成した場合の本発明の別の実施の形態の正極板１を示した模式平面図を図８の正極板１ｇに、第３の露出集電体部２３を形成した場合の本発明の別の実施の形態の正極板１を示した模式平面図を図９の正極板１ｈに示す。第２の集電タブ１２と正極リード集電体５を兼用する正極リード集電体兼第２の集電タブ１３を用いる場合、部品点数やプロセス工数を減らすことが出来る。

【００３７】

以上では、第１の集電タブ１１と第２の集電タブ１２を電池缶７の開放端側で接続する場合、即ち、第１の集電タブ１１と第２の集電タブ１２が正極リード集電体５と巻回軸と同方向に形成された場合示したが、電池缶７の底部側で接続することでも本発明は達成される。正極リード集電体５とこれら集電タブが巻回軸と異方向に形成される。この場合の本発明の１形態の別の正極板１を図１０の正極板１ｉに、図１１の正極板１ｊに示す。第１の集電タブ１１と第２の集電タブ１２が正極リード集電体５と反対側、すなわち負極リ

ード集電体６と同じ側に形成され、電極群４の端部で抵抗溶接やレーザ溶接などにより電気的に接続される。接続された集電タブが負極リード集電体６と電気的に干渉しないように絶縁を施すようにするとよい。

【００３８】

第２の集電タブ１２は、集電体上に正極合剤を塗着した２つの端部である電極群４の最内周合剤端部から最外周合剤端部の長さをＬとしたとき、最内周合剤端部から３／４Ｌの範囲のいずれかの箇所に設けるとよい。この範囲内であると第１の露出集電体部２１で生じた短絡箇所への短絡電流の分流効果が高く、釘などが電極群４内部へ進行するなどして、電極群４の内部で短絡箇所が発生した場合でも、その箇所への短絡電流の流れ込みを回避して安全性を高めることができる。

【００３９】

電池缶に接続された負極板２において、正極板１の第１の露出集電体部または第２の露出集電体部に対向するその集電体部分が露出していてもよい。特に第１の露出集電体部に対向する負極板２において負極活物質層が塗着されずに銅箔集電体が露出することにより、金属箔同士の小さな抵抗が生じる。この場合、抵抗の小さな内部短絡となるため、安全性を確保することができる。

【００４０】

電池缶に接続された負極板２において、電極群の最内周側と最外周側のいずれか一方に集電体が露出しており、集電体が露出した箇所と電池缶が集電タブ１６を介して接続してもよい。また、負極板２において活物質層が形成されている極板端部の中央部に集電体が露出しており、集電体が露出した箇所と電池缶が集電タブを介して接続していてもよい。電池缶７に接続された集電タブ１６は負極リード集電体６を兼用した構成とみることができる。

【００４１】

釘等の外部異物により電極群４の外周部で内部短絡が生じた場合、負極板２に設けられた集電タブ１６、電池缶７、釘等の外部異物を介して負極板２の最外周側集電体部と電気的に接続した状態となる。したがって、電極群４の内周部の負極板２で生じた短絡電流は、銅箔集電体と外周部側の短絡点との間で流れるのとは別に、電池缶７と接続された集電タブ１６と電池缶７を通じて外周部側の短絡点へと分流することができる。電極群４のさらに内部で内部短絡が生じた場合、銅箔集電体を流れる短絡電流を分流すると同時に、外周側の抵抗の低い短絡点に短絡電流を分流することができるため、電極群４の内部で短絡が生じた場合でも、異常な発熱を生じることを抑制することができ、異常時でも安全な電池とすることができる。特に、負極リード集電体６が負極板２の最外周側に設けられると同時に、内周部のいずれかの箇所に集電タブ１６が設けられているとなおよい。釘等の外部異物による電気的な接続が無くても、第２の集電タブ１２と電池缶７と負極リード集電体６との電気的な接続が形成されるため、短絡電流の分流を効果的に発現することが可能となる。

【００４２】

図１２に本発明の一形態の負極板２を示す。電極群４における最外周側および最内周側に銅箔集電体が露出したそれぞれの箇所に負極リード集電体６と集電タブ１６が形成され図１２に示す負極板２ａとなり、それらが電池缶７の底部で抵抗溶接により電気的に接続されている。

【００４３】

集電タブ１６が負極リード集電体６を兼用して、負極板２の中央部に負極リード集電体６を設ける場合の本発明の一形態の別の負極板２を図１３の負極板２ｂに示す。ここで負極板２における極板の中央部とは、負極活物質層が塗着されている最外周および最内周端部のそれぞれから負極活物質層が塗着されている長さの２／３以内に位置する部分を示している。

【００４４】

次に、本発明の非水電解質二次電池の各構成要素について、さらに具体的に説明する。

【００４５】
正極板１は、正極集電体と正極活物質層とを含む。
【００４６】
正極活物質にはリチウム含有遷移金属複合酸化物、具体的にはコバルト酸リチウム、ニッケル酸リチウム、マンガン酸リチウムや、それらの変性体などを用いることができる。変性体として、マグネシウム、バリウム、スカンジウム、イットリウム、チタン、バナジウム、ニオブ、タンタル、クロム、タングステン、銅、亜鉛、ボロン、アルミニウム、鉛などの元素を含有させることができる。また、コバルト、ニッケルおよびマンガン元素を混合して含有させることもできる。
【００４７】
導電剤としては、正極電位下で安定な天然黒鉛や人造黒鉛のグラファイト類、アセチレンブラック、ケッチェンブラック、チャンネルブラック、ファーネスブラック、ランプブラック、サーマルブラックなどのカーボンブラック類、炭素繊維や金属繊維などの導電性繊維類、フッ化カーボン、アルミニウムなどの金属粉末類、酸化亜鉛やチタン酸カリウムなどの導電性ウィスカー類、酸化チタンなどの導電性金属酸化物、フェニレン誘導体などの有機導電性材料金属粉末などが用いられる。
【００４８】
結着剤としては、正極電位下で安定なポリフッ化ビニリデン（ＰＶＤＦ）・ポリテトラフルオロエチレン（ＰＴＦＥ）などが用いられる。
【００４９】
正極集電体としては、アルミニウム、アルミニウム合金、ステンレス鋼、チタンなどを含有する金属箔、穿孔体などが用いられる。中でも、アルミニウム箔およびアルミニウム合金箔が好ましい。正極集電体の厚さは特に制限されないが、１～５００μｍが好ましく、１０μｍ～４０μｍがより望ましい。集電体の厚さを上記範囲とすることにより、極板の強度を保持しつつ軽量化することができる。
【００５０】
結着剤および導電剤の添加量は、正極板１および非水電解質二次電池の設計に応じて適宜選択できる。結着剤および導電剤は、それぞれ、１種を単独でまたは２種以上を組み合わせて使用できる。
【００５１】
正極活物質層は、たとえば、正極合剤スラリーを正極集電体表面に塗布し、乾燥し、圧延することにより塗着できる。正極合剤スラリーは、たとえば、正極活物質、結着剤、導電剤などを有機溶媒または水に溶解または分散させることにより調製できる。有機溶媒には、Ｎ－メチル－２－ピロリドンなどを使用できる。
【００５２】
正極集電体の所望の箇所に未塗着部を設け正極リード集電体５および第１の集電タブ１１、第２の集電タブ１２を溶接し取りつけることにより正極板１が作製される。
正極集電体に形成される正極リード集電体５および第１の集電タブ１１、第２の集電タブ１２は、アルミニウムなどから形成される。
【００５３】
負極板２は、負極集電体と負極活物質層とを含む。
【００５４】
本実施形態では負極集電体の厚さ方向における両方の表面に設けられるが、片方の表面に設けられてもよい。負極活物質層は、負極活物質を含有し、さらに結着剤、導電剤、増粘剤などを含有してもよい。
【００５５】
負極活物質には、非水電解質二次電池の分野で常用されるものを使用できる。具体的には、炭素材料、リチウムと合金化可能な元素、珪素化合物、錫化合物、リチウム金属、合金などがある。
【００５６】

炭素材料には、天然黒鉛、人造黒鉛，ハードカーボンなどがある。

【００５７】

リチウムと合金化可能な元素には、Ａｌ、Ｓｉ、Ｚｎ、Ｇｅ、Ｃｄ、Ｓｎ、Ｔｉ、Ｐｂなどがある。これらの中でも、ＳｉおよびＳｎが好ましい。珪素化合物には、式ＳｉＯｘ（０＜ｘ＜２）で表される珪素酸化物などがある。錫化合物には、ＳｎＯなどの錫酸化物がある。合金には，Ｌｉ－Ａｌ合金などのリチウム合金、Ｎｉ－Ｓｉ合金、Ｔｉ－Ｓｉ合金などのリチウムを含有しない合金などがある。

【００５８】

負極活物質は１種を単独でまたは２種以上を組み合わせて使用できる。

結着剤には、ポリフッ化ビニリデン、アクリル酸モノマーを含むスチレンブタジエンゴム（ＢＭ－５００Ｂ）、スチレンブタジエンゴム（ＢＭ－４００Ｂ）、ポリアクリル酸などがある。

【００５９】

導電剤には、正極活物質層に含まれる導電剤と同じものを使用できる。

【００６０】

増粘剤には、カルボキシメチルセルロース、ポリエチレンオキシド、変性ポリアクリロニトリルゴムなどがある。変性ポリアクリロニトリルゴムには、商品名ＢＭ－７２０Ｈ（日本ゼオン（株）製）などがある。

【００６１】

結着剤、導電剤および増粘剤の添加量は，負極および非水電解質二次電池の設計に応じて適宜選択できる。

【００６２】

負極集電体としては、例えばステンレス鋼、ニッケル、銅などの金属箔、穿孔体などが用いられる。負極集電体の厚さは、特に限定されないが、１～５００μｍが好ましく、５～２０μｍがより望ましい。集電体の厚さを上記範囲とすることにより、極板の強度を保持しつつ軽量化することができる。

【００６３】

負極活物質層は、たとえば，負極合剤スラリーを負極集電体表面に塗布し，乾燥し、圧延することにより形成できる。負極合剤スラリーは、たとえば，負極活物質、結着剤、導電剤、増粘剤などを有機溶媒または水に溶解または分散させることにより調製できる。有機溶媒には、ＮＭＰなどを使用できる。

【００６４】

また，負極活物質が、リチウムと合金化可能な元素、珪素化合物，錫化合物などである場合は，気相法により負極活物質層を堆着してもよい。気相法には，化学気相成長法（ＣＶＤ）、真空蒸着法、スパッタリング法などがある。

【００６５】

負極集電体の所望の箇所に未塗着部を設け負極リード集電体６および集電タブ１６を溶接し取りつけることにより負極板２が作製される。

【００６６】

負極集電体に形成される負極リード集電体６および集電タブ１６は，ニッケル，ニッケル合金，銅、ニッケルで被覆した銅などから形成される。

【００６７】

これら正負極板（正極板１，負極板２）を、セパレータ３を介して正極リード集電体５と負極リード集電体６が逆方向から取り出されるように捲回することにより、本発明の電極群４が構成される。このあと電池缶７に上記電極群４を挿入し、負極リード集電体６と集電タブ１６を電池缶７の有底部に溶接して電気的に接続する。

【００６８】

セパレータ３としては、大きなイオン透過度を持ち，所定の機械的強度と、絶縁性とを兼ね備えた微多孔薄膜、織布、不織布などが用いられる。セパレータの材質としては、例えば，ポリプロピレン、ポリエチレンなどのポリオレフィンが耐久性に優れ，かつシャッ

トダウン機能を有しているため、非水電解質二次電池の安全性の観点から好ましい。セパレータの厚さは、一般的に１０～３００μｍであるが、４０μｍ以下とすることが望ましい。また，１５～３０μｍの範囲とするのがより好ましく、さらに好ましいセパレータ厚さの範囲は１０～２５μｍである。さらに微多孔フィルムは、１種の材料からなる単層膜であってもよく、１種または２種以上の材料からなる複合膜または多層膜であってもよい。また、セパレータの空孔率は、３０～７０％の範囲であることが好ましい。ここで空孔率とは、セパレータ体積に占める孔部の体積比を示す。セパレータの空孔率のより好ましい範囲は、３５～６０％である。

【００６９】

液状非水電解質（非水電解液）は、非水溶媒に電解質（例えば、リチウム塩）を溶解させることにより得られる。また、ゲル状非水電解質は、非水電解質と、この非水電解質が保持される高分子材料とを含むものである。この高分子材料としては、例えば、ポリフッ化ビニリデン、ポリアクリロニトリル、ポリエチレンオキサイド、ポリ塩化ビニル、ポリアクリレート、ポリビニリデンフルオライドヘキサフルオロプロピレン等が好適に使用される。

【００７０】

電解質を溶解する非水溶媒としては、公知の非水溶媒を使用することが可能である。この非水溶媒の種類は特に限定されないが、例えば、環状炭酸エステル、鎖状炭酸エステル、環状カルボン酸エステルなどが用いられる。環状炭酸エステルとしては、プロピレンカーボネート（ＰＣ）、エチレンカーボネート（ＥＣ）などが挙げられる。鎖状炭酸エステルとしては、ジエチルカーボネート（ＤＥＣ）、エチルメチルカーボネート（ＥＭＣ）、ジメチルカーボネート（ＤＭＣ）などが挙げられる。環状カルボン酸エステルとしては、γ－ブチロラクトン（ＧＢＬ）、γ－バレロラクトン（ＧＶＬ）などが挙げられる。非水溶媒は、１種を単独で用いてもよく、２種以上を組み合わせて用いてもよい。

【００７１】

非水溶媒に溶解させる電解質には、例えば$LiClO_4$、$LiBF_4$、$LiPF_6$、$LiAlCl_4$、$LiSbF_6$、LiSCN、$LiCF_3SO_3$、$LiCF_3CO_2$、$LiAsF_6$、$LiB_{10}Cl_{10}$、低級脂肪族カルボン酸リチウム，LiCl、LiBr、LiI、クロロボランリチウム、ホウ酸塩類、イミド塩類などを用いることができる。ホウ酸塩類としては、ビス（１，２－ベンゼンジオレート（２－）－Ｏ，Ｏ’）ホウ酸リチウム、ビス（２，３－ナフタレンジオレート（２－）－Ｏ，Ｏ‘）ホウ酸リチウム、ビス（２，２’－ビフェニルジオレート（２－）－Ｏ，Ｏ’）ホウ酸リチウム、ビス（５－フルオロ－２－オレート－１－ベンゼンスルホン酸－Ｏ，Ｏ’）ホウ酸リチウム等が挙げられる。イミド塩類としては、ビストリフルオロメタンスルホン酸イミドリチウム（$(CF_3SO_2)_2NLi$）、トリフルオロメタンスルホン酸ノナフルオロブタンスルホン酸イミドリチウム（$LiN(CF_3SO_2)(C_4F_9SO_2)$），ビスペンタフルオロエタンスルホン酸イミドリチウム（$(C_2F_5SO_2)_2NLi$）等が挙げられる。電解質は、１種を単独で用いてもよく、２種以上を組み合わせて用いてもよい。

【００７２】

また非水電解液には、添加剤として負極上で分解してリチウムイオン伝導性の高い被膜を形成し、充放電効率を高くすることができる材料を含んでいてもよい。このような機能を持つ添加剤としては、例えば、ビニレンカーボネート（ＶＣ），４－メチルビニレンカーボネート、４，５－ジメチルビニレンカーボネート、４－エチルビニレンカーボネート、４，５－ジエチルビニレンカーボネート、４－プロピルビニレンカーボネート、４，５－ジプロピルビニレンカーボネート，４－フェニルビニレンカーボネート、４，５－ジフェニルビニレンカーボネート、ビニルエチレンカーボネート（ＶＥＣ），ジビニルエチレンカーボネート等が挙げられる。これらは単独で用いてもよく、２種以上を組み合わせて用いてもよい。これらのうちでは、ビニレンカーボネート、ビニルエチレンカーボネート、およびジビニルエチレンカーボネートよりなる群から選ばれる少なくとも１種が好ましい。なお、上記化合物は、その水素原子の一部がフッ素原子で置換されていてもよい。電

解質の非水溶媒に対する溶解量は、０．５～２モル／Ｌの範囲内とすることが望ましい。

【００７３】

さらに，非水電解液には、過充電時に分解して電極上に被膜を形成し、電池を不活性化する公知のベンゼン誘導体を含有させてもよい。前記ベンゼン誘導体としては、フェニル基および前記フェニル基に隣接する環状化合物基を有するものが好ましい。前記環状化合物基としては、フェニル基、環状エーテル基、環状エステル基、シクロアルキル基、フェノキシ基などが好ましい。ベンゼン誘導体の具体例としては、シクロヘキシルベンゼン、ビフェニル、ジフェニルエーテルなどが挙げられる。これらは単独で用いてもよく、２種以上を組み合わせて用いてもよい。ただし、ベンゼン誘導体の含有量は、非水溶媒全体の１０体積％以下であることが好ましい。

【００７４】

以上の手順を経て電池缶７の開口部より取り出した正極リード集電体５は封口板８の金属製フィルター９に溶接され電気的に接続されている。第１の集電タブ１１および第２の集電タブ１２が正極リード集電体５と巻回軸同方向に取り出されている場合は、第１の集電タブ１１と第２の集電タブ１２を直接、もしくは金属製フィルター９に溶接する。第１の集電タブ１１と第２の集電タブ１２が正極リード集電体５と巻回軸異方向に突設している場合は、電極群４を電池缶７に挿入する前に，第１の集電タブ１１と第２の集電タブ１２を溶接して電気的に接続しておく。電池缶７の開放端から非水電解液を注入する。電池缶７の開放端には溝を入れて座が形成され封口板８を電池缶７に装着し、樹脂製のガスケット１０ｃを介して電池缶７の周囲をかしめて封口することにより、本発明の非水電解質二次電池が形成される。

【００７５】

なお、上述したのは巻回型電極群を含む円筒型の非水電解質二次電池の形態および構成手順について説明しているが、それに限定されず、本発明の非水電解質二次電池は、各種形態の二次電池を包含する。前記形態には、巻回型電極群を含む角型電池、巻回型電極群を加圧成形した扁平状電極群を含む角型電池、積層型電極群をラミネートフィルム製パックに収容したラミネートフィルム電池、積層型電極群を含む角型電池などがある。これら各種形態の非水電解質二次電池においても、上述内容と同様に本発明の効果を活用することができる。

【実施例】

【００７６】

以下、本発明の実施例を詳細に説明するが、本発明はこれらの実施例に限定されない。

【００７７】

本発明の非水電解質二次電池の安全性を評価するため、以下の手順で、正極板，負極板、非水電解液、円筒型非水電解質二次電池を作製し、評価した。

【００７８】

（実施例１）

（１）正極板の作製

正極板は以下のようにして作製した。１００重量部のコバルト酸リチウム粉末正極活物質に、導電剤として３重量部のアセチレンブラックと、Ｎ－メチルピロリドン（ＮＭＰ）の溶剤に結着剤として４重量部のポリフッ化ビニリデン（ＰＶＤＦ）を溶解した溶液とを混合し、正極合剤を含むペーストを得た。このペーストを、集電体となる厚さ１５μｍのアルミニウム箔の両面に塗布し、乾燥後、圧延して厚みを１７２μｍとした。
電極群の最外周部の両面に，電極群外周１周分の長さでアルミニウム箔集電体が露出するように第１の露出集電体部２１を形成した。

【００７９】

また正極活物質層が電極群の最内周部と最外周部を結ぶ中央部の両面にアルミニウム箔集電体が露出した第２の露出集電体部２２を形成した。

【００８０】

これを幅５８ｍｍ、長さ６３０ｍｍの寸法に裁断し、正極板１を作製した。正極板１の

第１の露出集電体部２１と第２の露出集電体部２２のそれぞれの箇所にアルミニウムからなる第１の集電タブ１１と第２の集電タブ１２の一端を接続した。正極板１の電極群４の最内周部にアルミニウム箔集電体が露出する箇所を設け、その箇所にアルミニウム製の正極リード集電体５の一端を接続して２つの集電タブと正極リード集電体が巻回軸同方向となるようにして図２に示すような正極板１ａを得た。

【００８１】

（２）負極板の作製

負極板は以下のようにして作製する。負極合剤として人造黒鉛粉末を１００重量部、及び１重量部のスチレン－ブタジエンゴム粒子の４０質量％水性分散液（商品名：ＢＭ－４００Ｂ、日本ゼオン（株）製）と１重量部のカルボキシメチルセルロースおよび適量の水とを混合撹拌してスラリー状の負極合剤を調整した。この負極合剤スラリーを厚み８μｍの銅箔集電体の両面に、塗布、乾燥した後、圧延して厚みを１７４μｍとした。

電極群の最外周部の両面に、アルミニウム箔集電体が露出した最外周露出集電体部と対向する長さ以上で銅箔集電体が露出している最外周露出集電体部を形成する。

【００８２】

これを幅５９ｍｍ、長さ６８５ｍｍの寸法に裁断し、負極板２を作製した。負極板２の最外周部に形成された負極集電体が露出する部分にニッケル製負極リード集電体の一端を接続して負極板２を得た。

【００８３】

（３）非水電解液の調整

非水電解液は以下のように調製する。非水溶媒として、エチレンカーボネートとエチルメチルカーボネートとジメチルカーボネートを体積比１：１：１の混合溶媒９９重量部に１重量部のビニレンカーボネートを添加し、１．０ｍｏｌ／Ｌの濃度で六フッ化リン酸リチウム（$LiPF_6$）を溶解し、非水電解液を得た。

【００８４】

（４）非水電解質二次電池の作製

正極板１と負極板２の間に厚み１６μｍのポリエチレン製微多孔質フィルムからなるセパレータを配置して捲回し、円筒状の電極群４を作製した。この電極群４の巻回軸方向両端に上部絶縁板１０ａおよび下部絶縁板１０ｂを装着した後、負極リード集電体６を電池缶７に溶接して挿入した。第１の集電タブ１１と第２の集電タブ１２を抵抗溶接して接続した。正極リード集電体５を封口板８の金属製フィルター９に溶接した。その後、電池缶７の内部に非水電解液５ｇを減圧方式により注入した。最後に、電池缶７の開口端部をガスケット１０ｃを介して封口板８にかしめることにより電池Ａを完成させた。得られた円筒型電池は直径１８．２ｍｍ、高さ６５ｍｍであり、電池容量は２８６０ｍＡｈであった。

【００８５】

（実施例２）

実施例１における第２の露出集電体部２２を巻回方向に１周の長さになるように形成して図３に示すような正極板１ｂを得たこと以外、電池Ａと同様にして作製した電池を電池Ｂとした。電池Ｂの電池容量は２７５０ｍＡｈであった。

【００８６】

（実施例３）

実施例１における電極群４の最内周部にアルミニウム箔集電体の露出箇所を設けずに、第２の集電タブ１２が正極リード集電体５を兼用する図７に示すような正極板１ｆを得たこと以外、電池Ａと同様にして作製した電池を電池Ｃとした。電池Ｃの電池容量は２８６０ｍＡｈであった。

【００８７】

（実施例４）

実施例３における第１の露出集電体部２１と第２の露出集電体部２２との間に、巻回方向に１周の長さになるようにアルミニウム箔集電体が片側露出した第３の露出集電体部２

３を形成して図８に示すような正極板１ｇを得たこと以外、電池Ｃと同様にして作製した電池を電池Ｄとした。電池Ｄの電池容量は２７４０ｍＡｈであった。

【００８８】

（実施例５）

実施例３の負極板において電極群４の最内周部に銅箔集電体が露出する箇所を設け、その箇所にニッケル製の集電タブ１６を接続して図１２に示すような負極板２ａを得た。負極板２のニッケル製の集電タブ１６を電池缶に新たに接続すること以外、電池Ｃと同様にして作製した電池を電池Ｅとした。電池Ｅの電池容量は２８６０ｍＡｈであった。

【００８９】

（実施例６）

実施例５における第２の露出集電体部２２を巻回方向に１周の長さになるように形成して図９に示すような正極板１ｈを作製し、第２の露出集電体部２２に対向する負極板は負極活物質層が塗着されずに銅箔集電体が露出した負極板２を得たこと以外、電池Ｅと同様にして同様にして作製した電池を電池Ｆとした。電池Ｆの電池容量は２６４０ｍＡｈであった。

【００９０】

（比較例１）

実施例１における第２の露出集電体部２２，第１の集電タブ１１，第２の集電タブ１２を形成しないこと以外、電池Ａと同様にして作製した電池を電池Ｘとした。電池Ｘの電池容量は２８６０ｍＡｈであった。

【００９１】

（比較例２）

実施例３における第１の露出集電体部２１に第１の集電タブ１１を形成しないこと以外、電池Ａと同様にして作製した電池を電池Ｙとした。電池Ｙの電池容量は２８６０ｍＡｈであった。

【００９２】

（評価試験）

実施例１～６および比較例１～２で得られた非水電解質二次電池を用いて，次に示す釘刺し試験を行い、安全性について評価した。

【００９３】

［釘刺し試験］

各電池に対して、以下の条件で充電を行った。そして、６０℃環境下で、充電状態の電池の側面から、直径３ｍｍの鉄釘を１０ｍｍ／秒の速度で２０ｍｍの深さまで突き刺し貫通して，内部短絡を発生させた。同じ試験を各５セルずつ行い、異常過熱に至るかどうか確認した。結果を（表１）における「異常過熱した電池数」に示す。

【００９４】

充電条件：

定電流充電；電流値０．５Ｃ／充電終止電圧４．３Ｖ

定電圧充電；電圧値４．３Ｖ／充電終止電流１００ｍＡ

【００９５】

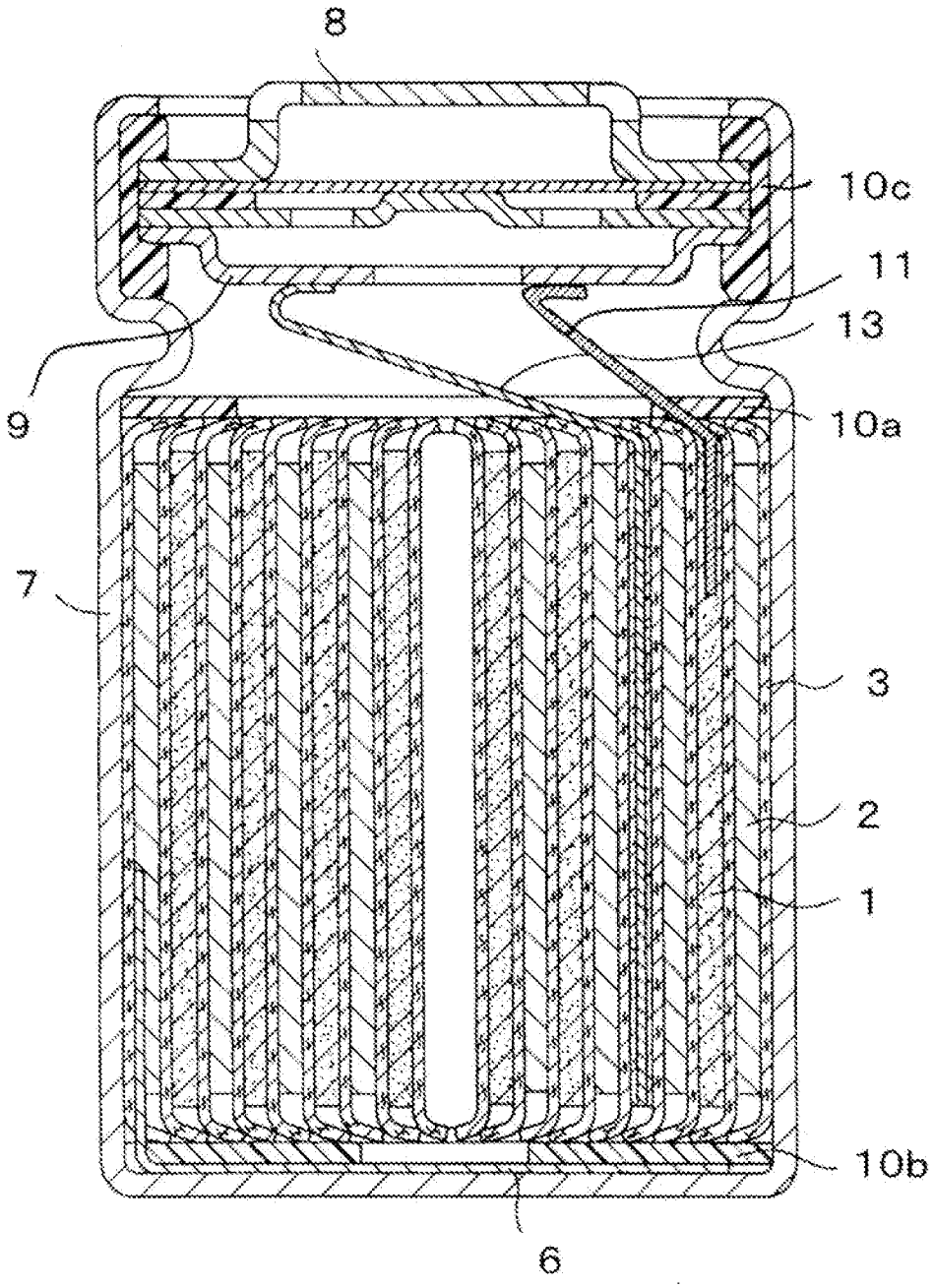
【表１】

	異常過熱した電池数 （過熱数／試験数）
実施例１	１／５
実施例２	０／５
実施例３	１／５
実施例４	０／５
実施例５	０／５
実施例６	０／５
比較例１	４／５
比較例２	４／５

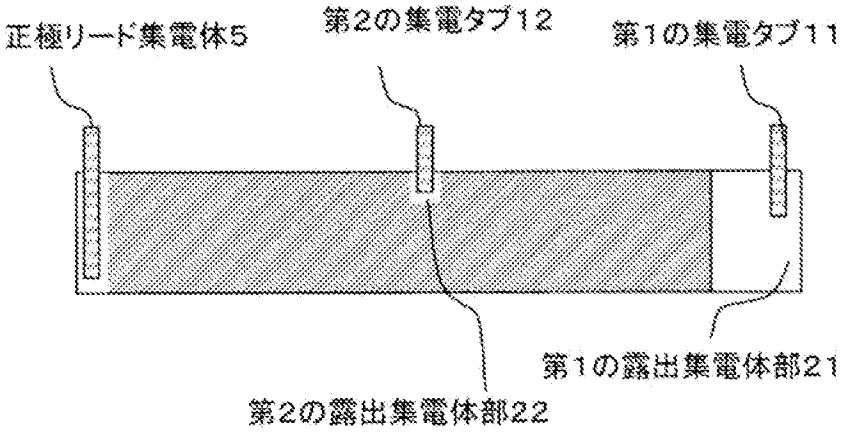
【００９６】
（表１）から、次のことが明らかである。実施例２、４～６は、釘刺し時の異常過熱もなく、電池容量も高い電池が得られた。実施例１および３は釘刺し時の異常過熱が５セル中１セル発生した。実施例１および３は正極板中央部と外周箔とを集電タブで接続しているが、正極板中央部は出力が高く、電極群内部での発熱がたまたま大きくなったと考えられる。正極板内部に第２の露出集電体部２２を設けた実施例２、４、６ではその箇所での低抵抗短絡により安全性が向上したと考えられる。実施例５、６では負極板に設けた集電タブ１６と負極リード集電体６とを接続した構成としたことでさらに安全性がした。
【００９７】
比較例１および２は、異常過熱が多く発生した。比較例１は外周部での集電体間短絡は発生するものの、外周部への短絡電流の分流効果が生じないため安全性が低かった。
【００９８】
以上より本発明の実施例１～６の非水電解質二次電池Ａ～Ｆは、比較例１～２の非水電解質二次電池Ｘ～Ｙに比べて、釘刺し等による外部異物による内部短絡に対する安全性が高いことが分かった。
【産業上の利用可能性】
【００９９】
本発明に係る非水電解質二次電池は、万一異常により電池内で内部短絡が生じた場合でも、発熱温度が小さく安全性が高い二次電池を提供することができる。本発明の非水電解質二次電池は、従来の非水電解質二次電池と同様の用途に使用でき、特に、携帯用電子機器の電源として有用である。携帯用電子機器には、パーソナルコンピュータ、携帯電話、モバイル機器、携帯情報端末（ＰＤＡ）、携帯用ゲーム機器、ビデオカメラなどがある。
【０１００】
また、本発明の非水電解質二次電池は、電気自動車、ハイブリッド電気自動車、プラグインＨＥＶなどにおける電気モーター駆動用の主電源または補助電源、燃料電池自動車における補助電源、電動工具、掃除機、ロボットなどの駆動用電源、電力貯蔵用電源などの用途にも応用可能である。
【符号の説明】
【０１０１】
１　　正極板

２　負極板
３　セパレータ
４　電極群
５　正極リード集電体
６　負極リード集電体
７　電池缶
８　封口板
９　金属製フィルター
１０ａ　上部絶縁板
１０ｂ　下部絶縁板
１０ｃ　ガスケット
１１　第１の集電タブ
１２　第２の集電タブ
１３　正極集電体リード兼第２の集電タブ
１６　集電タブ
２１　第１の露出集電体部
２２　第２の露出集電体部
２３　第３の露出集電体部

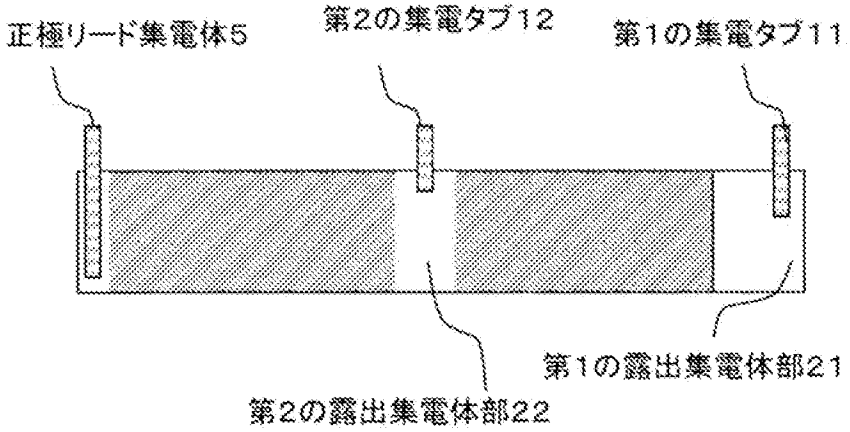
【図１】



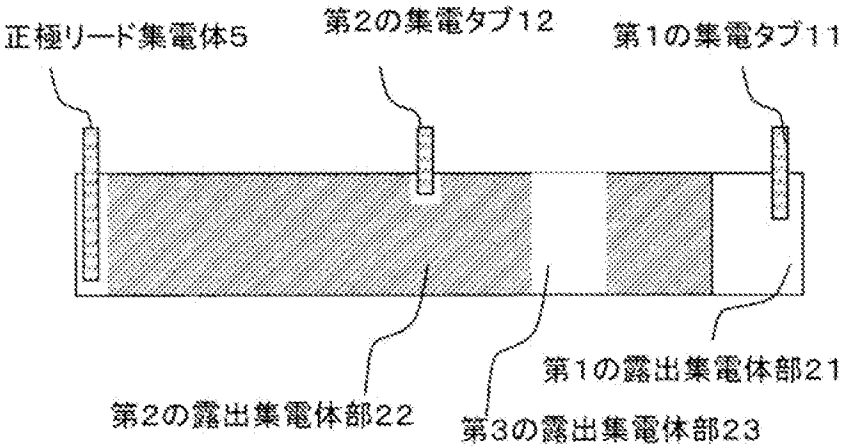
【図２】


正極リード集電体5
第2の集電タブ12
第1の集電タブ11
第1の露出集電体部21
第2の露出集電体部22

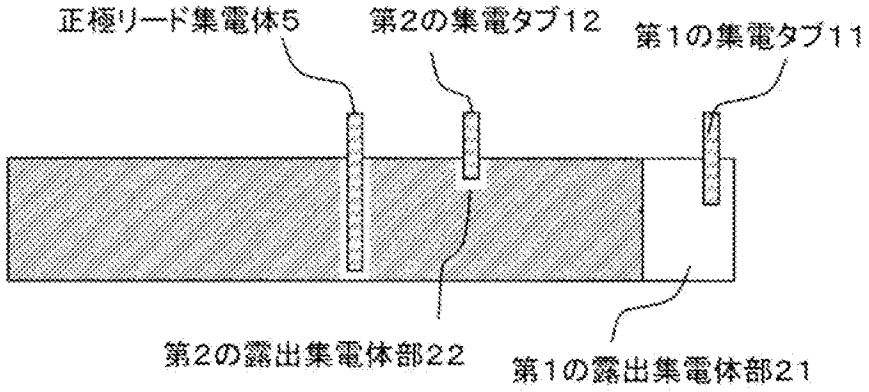
【図３】


正極リード集電体5
第2の集電タブ12
第1の集電タブ11
第1の露出集電体部21
第2の露出集電体部22

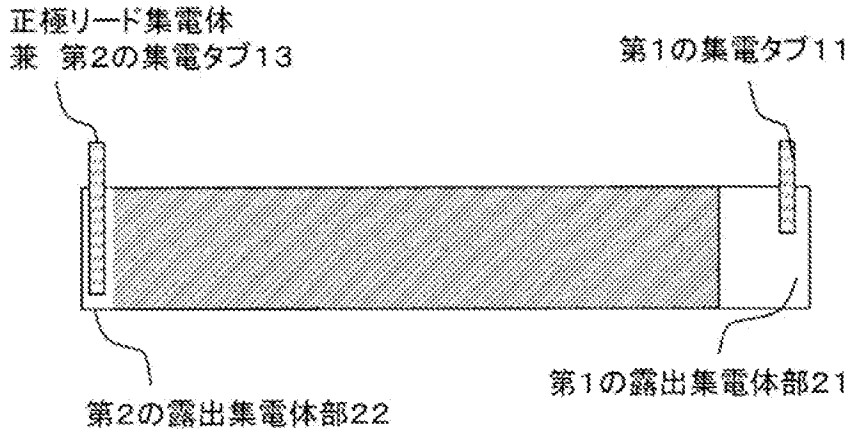
【図４】


正極リード集電体5
第2の集電タブ12
第1の集電タブ11
第1の露出集電体部21
第2の露出集電体部22
第3の露出集電体部23

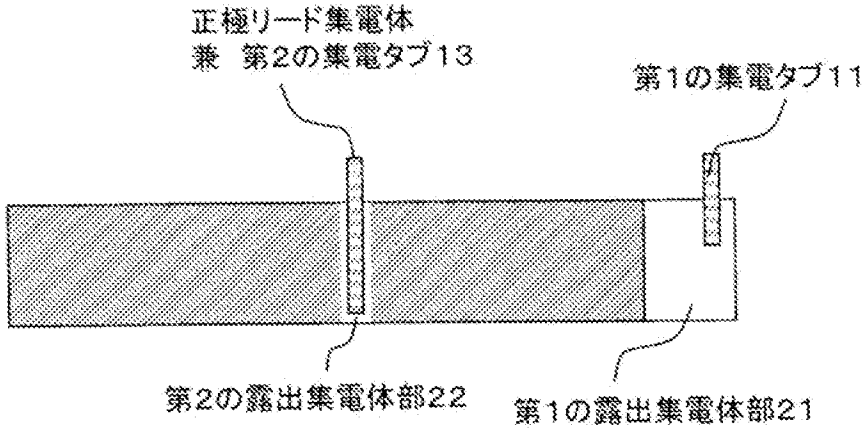
【図５】


正極リード集電体5
第2の集電タブ12
第1の集電タブ11
第2の露出集電体部22
第1の露出集電体部21

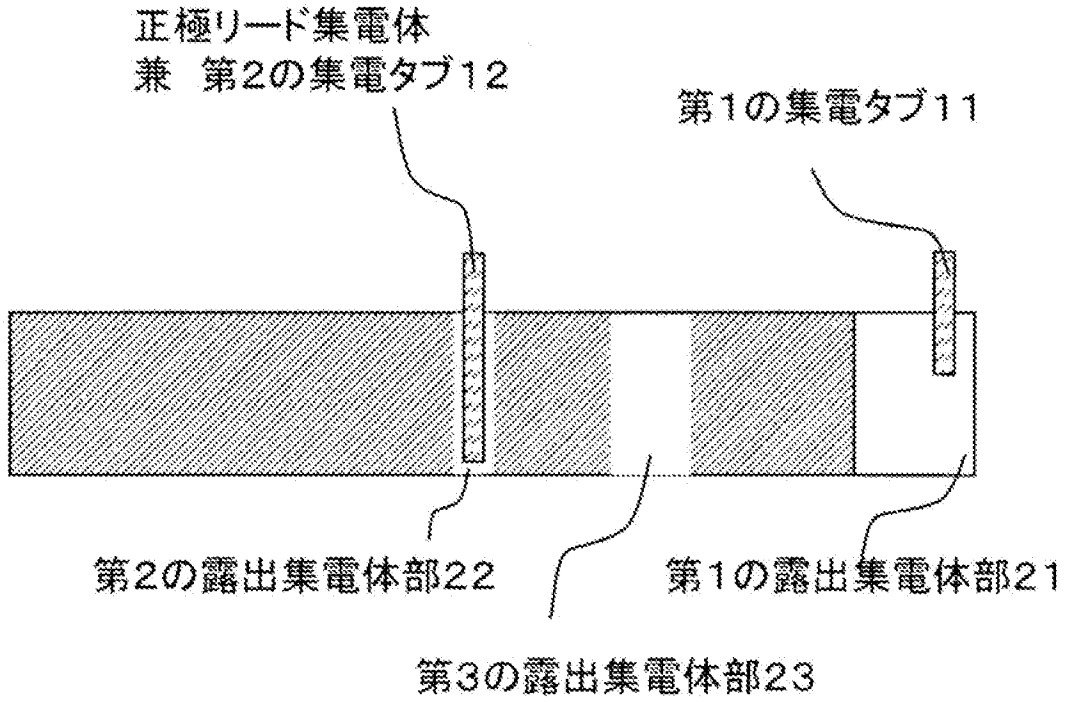
【図６】


正極リード集電体
兼 第2の集電タブ13
第1の集電タブ11
第2の露出集電体部22
第1の露出集電体部21

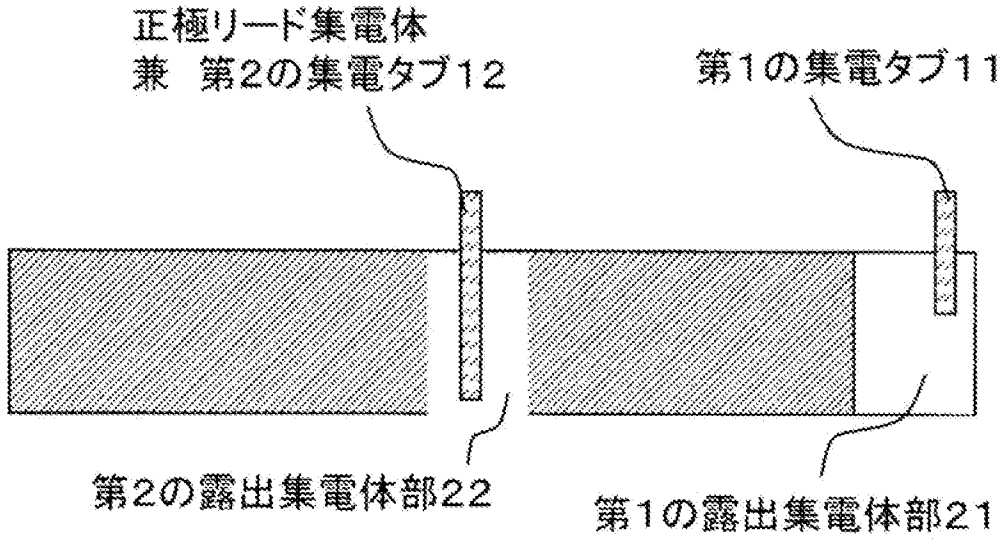
【図７】


正極リード集電体
兼 第2の集電タブ13
第1の集電タブ11
第2の露出集電体部22
第1の露出集電体部21

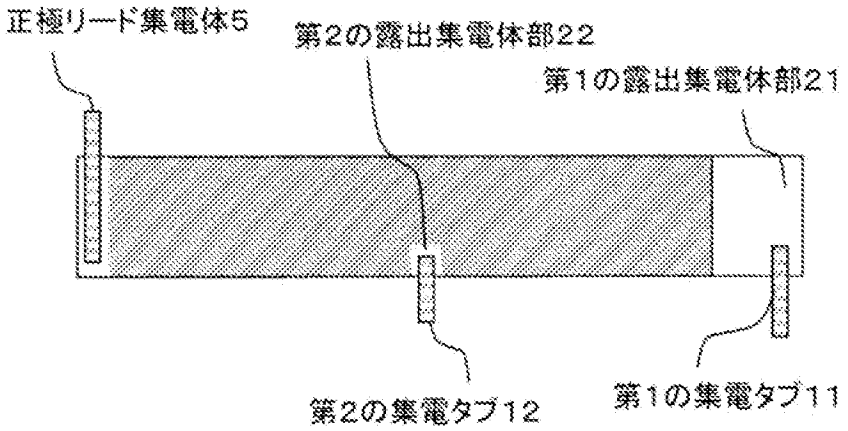
【図８】


正極リード集電体
兼　第2の集電タブ12
第1の集電タブ11
第2の露出集電体部22
第1の露出集電体部21
第3の露出集電体部23

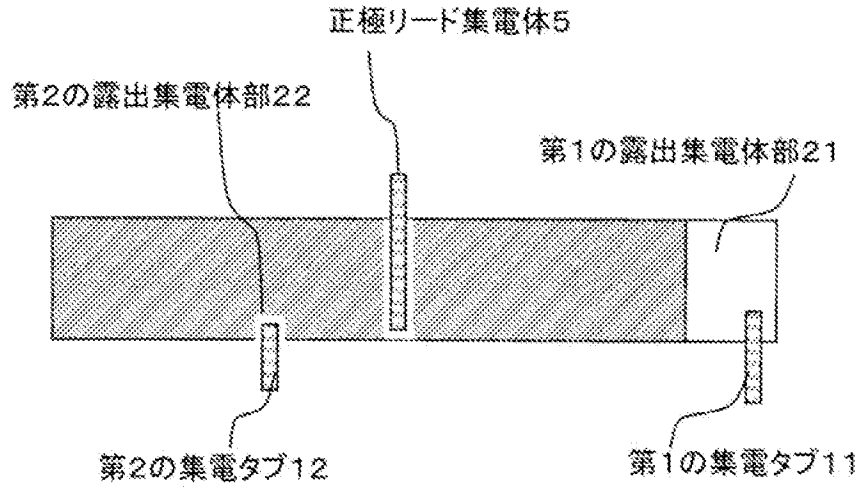
【図９】


正極リード集電体
兼　第2の集電タブ12
第1の集電タブ11
第2の露出集電体部22
第1の露出集電体部21

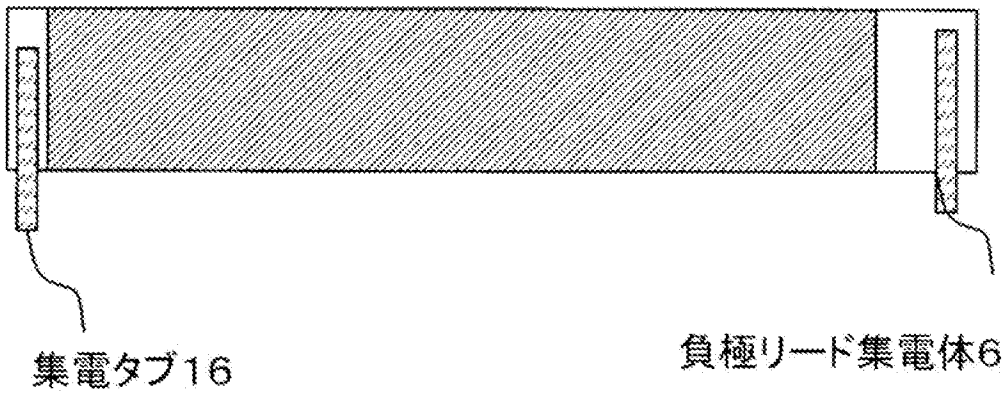
【図１０】


正極リード集電体5
第2の露出集電体部22
第1の露出集電体部21
第2の集電タブ12
第1の集電タブ11

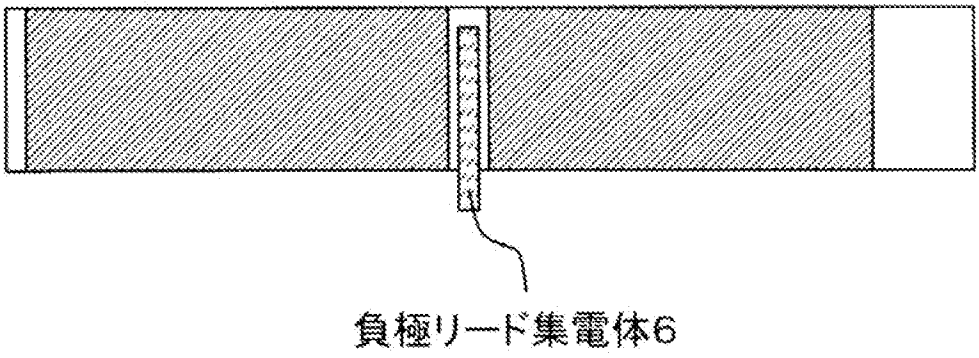
【図１１】


正極リード集電体5
第2の露出集電体部22
第1の露出集電体部21
第2の集電タブ12
第1の集電タブ11

【図１２】


集電タブ16
負極リード集電体6

【図１３】



フロントページの続き

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Ｆターム(参考) 5H029 AJ12 AK03 AL02 AL06 AL07 AL11 AL12 AM03 AM05 AM07
AM16 BJ02 BJ14 CJ07 DJ02 DJ05 DJ07 EJ01 HJ04 HJ12
5H043 AA04 BA17 CA03 CA12 DA03 EA06 EA09 GA24 JA11D JA12E
KA08E KA09E LA21E
5H050 AA15 BA15 BA16 BA17 CA08 CA09 CB02 CB07 CB08 CB11
CB12 DA07 DA08 DA20 EA10 EA24 EA27 EA28 FA05 GA09
HA04 HA12

25 July 2023 (25-07-2023)

LAVERY, DE BILLY, LLP
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Application No.	:	**3,164,572**
PCT No.	:	**CN2020087515**
Owner	:	NINGDE AMPEREX TECHNOLOGY LIMITED
Title	:	**ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS**
Classification	:	H01M 10/0587 (2010.01)
Your File No.	:	**G18013-00002-EKS**
Examiner	:	Chris Bowen

YOU ARE HEREBY NOTIFIED OF A REQUISITION BY THE EXAMINER IN ACCORDANCE WITH SUBSECTION 86(2) OF THE *PATENT RULES*. IN ORDER TO AVOID ABANDONMENT UNDER PARAGRAPH 73(1)(*a*) OF THE *PATENT ACT*, A WRITTEN REPLY MUST BE RECEIVED WITHIN **FOUR (4)** MONTHS AFTER THE ABOVE DATE.

This application has been examined taking into account the:

Description,	pages 1 - 28, as originally filed;
Claims,	1 - 10, as originally filed; and
Drawings,	pages 1/5 - 5/5, as originally filed.

This application has been examined taking into account applicant's correspondence received in this office on 12 July 2022 (12-07-2022).

The examiner has identified the following defects in the application:

Claims 1-10 do not comply with section 28.3 of the *Patent Act*. In the present case claims 1-10 are identical to the claim set that was examined in the International Preliminary Report on Patentability (IPRP), which concluded that claims 1-10 lack an inventive step as required under PCT Article 33(3). The prior art cited in the IPRP and the detailed reasons supporting a lack of inventive step have been considered and are found to be relevant and persuasive with respect to obviousness and section 28.3 of the *Patent Act*. Claims 1-10 encompass subject-matter that, in light of the teachings of the cited prior art, does not require any degree of invention and would have been obvious. Claims 1-10 therefore do not comply with section 28.3 of the *Patent Act*.

Claim 1 is indefinite and does not comply with subsection 27(4) of the *Patent Act*.

- Claim 1 defines "a distance between a central position of the negative tab and either end of the negative active material layer in a long axis direction is a first length". Since there is only one first length this statement implies that the tab is arranged in the middle of the

long length of the negative active material. If the tab is not centered on the long length, as shown in figures 4 and 5, then the applicant should define that a first length as the *shortest* distance between a central position of the tab and either end of the negative active material layer in a long axis direction.

- Claim defines "G is a weight percentage of the silicon-based material" but does not define of what weight percentage is measured against: the negative electrode, the negative active material, the electrochemical apparatus or some other feature.
- If G is a "weight percentage" then at a maximum of G=70%, the right hand side of the inequality becomes (0.6 X 70 = 42) and the inequality of formula 1: $0.5 \geq D \geq (0.6 \times G)$ is false. The applicant could use "weight fraction" as in 0.7 to make the inequality true.

The description does not comply with section 56 of the *Patent Rules*. Paragraphs 10-12 of the description teach that figures 1-3 form part of the prior art and are not part of the alleged invention. To avoid confusing the reader, the figures should be labelled as prior art.

In view of the foregoing defects, the applicant is requisitioned, under subsection 86(2) of the *Patent Rules*, to amend the application in order to comply with the *Patent Act* and the *Patent Rules* or to provide arguments as to why the application does comply.

Under section 102 of the *Patent Rules*, any amendment made in response to this requisition must be accompanied by a statement explaining the purpose of the amendment and identifying the differences between the new page and the replaced page.

Chris Bowen
Patent Examiner
819 639 8429

As per CIPO Client Service Standards, a response to a telephone enquiry or voice mail should be provided by the end of the next business day. In the event that attempts to reach the examiner are unsuccessful, the examiner's Section Head, Terry Diduch, can be reached at 819-639-8451.

For general inquiries: 1-866-997-1936 or for more options see http://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr00006.html.

CIPO values your feedback and invites you to complete a short and anonymous ongoing survey on patent examination products and services. You can access the survey at the following link: https://form.simplesurvey.com/f/s.aspx?s=91e23402-ee27-4868-a230-ab5c819f9d1c.

3164572A_CTB.docm

The Examination Search Report is provided for reference only and is not part of any requisition made by the examiner in accordance with the *Patent Act* or *Rules*. The applicant is not required to respond to the information contained in the Examination Search Report.

Examination Search Report

Box I: General Information

Application No.	3,164,572	Search Report Date	2023-06-28
Title	ELECTROCHEMICAL APPARATUS AND ELECTRONIC APPARATUS CONTAINING THE ELECTROCHEMICAL APPARATUS		
Examiner	Christopher Bowen	Search Conducted?	No
No search was conducted for the following reasons :			
- Search deferred - see report for reasoning (lack of unity, excluded subject matter etc.)			N/A
- Relied on previous search results (CIPO and/or by Foreign Office)			Yes

Box II: Family Prosecution

Family Member	File Wrapper Reviewed	Status of Prosecution
WO 2021/217423	2023-06-28	Completed
EP 4 142 012	2023-06-28	Not Started
US 2022/0223849	2023-06-28	Not Started

Box III: Search History

No Search Conducted

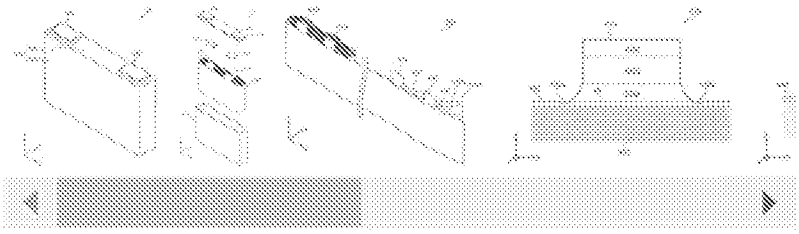
CIPO Search Record - Version 10

Power storage element

Abstract

To provide a power storage element capable of suppressing an electrode plate from being damaged, such as being broken.SOLUTION: A power storage element 10 includes an electrode body 410 having a positive electrode plate 430. The positive electrode plate 430 includes a body part 432 and a tab 431 projecting from the body part 432 in a first direction. The body part 432 includes a recessed portion 432a recessed in a curve shape in a direction opposite the first direction at a connection part with the tab 431. The tab 431 includes a base end portion 431a connected to the recessed portion 432a, and a central portion 431b closer on a first direction side than the base end portion 431a. The base end portion 431a expands more in a second direction crossing the first direction as goes in the direction opposite the first direction, and has a larger amount of expansion than the central portion 431b.SELECTED DRAWING: Figure 5

Images (9)



Classifications

- H02B80/10 Energy storage using batteries

JP2019046592A

Japan

Prioritized PTE Filed Prior Art Pending

Other languages: Japanese

Inventor: [redacted], Akio Kawai, [redacted]

Current Assignee : GS Yuasa Corp

Worldwide applications

2017 JP

Application JP2017166156A events

2017-08-30 Application filed by GS Yuasa Corp

2017-08-30 Priority to JP2017166156A

2019-03-22 Publication of JP2019046592A

Status Pending

Info: Cited by (2), Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (6)

Hide Dependent

translated from Japanese

An electrical storage element comprising an electrode body having an electrode plate.
The electrode plate has a main body part and a tab protruding in the first direction from the main body part,
The main body has a concave portion that is recessed in a curved shape in a direction opposite to the first direction at a connection portion with the tab,
The tab has a base end connected to the recess, and a central portion on the first direction side than the base end,
The base end portion spreads in a second direction intersecting the first direction as it goes in a direction opposite to the first direction, and the amount of spread is larger than that in the central portion. The power storage element according to claim 1, wherein the base end portion has an outer edge shape including at least one of a curve having a radius of curvature equal to or greater than the radius of curvature of the concave portion and a straight line inclined from the first direction. The electric storage element according to claim 2, wherein the base end portion has the outer edge shape including the curve or the straight line extending in a tangential direction of the concave portion at the boundary point from a boundary point between the concave portion and the base end portion. . The electric storage element according to claim 1, wherein an outer edge shape of a boundary portion between the base end portion and the central portion is formed by a curve. The said recessed part is formed in the curve from which the curvature radius of the part near the said base end part becomes a magnitude | size more than the curvature radius of the part far from the said base end part. Power storage element. The electric storage element according to claim 1, wherein the concave portion and the base end portion have an outer edge shape including a curve having a radius of curvature that increases toward the central portion.

Description

translated from Japanese

The present invention relates to a power storage device including an electrode body having an electrode plate

2. Description of the Related Art Conventionally, in a configuration including an electrode body having an electrode plate, an electricity storage element in which a tab is formed on the electrode plate is widely known. For example, in Patent Document 1, in an electrode plate having an electrode part and a tab formed so as to protrude from the upper side of the electrode part, the upper side of the electrode part and the side of the tab are continuous by a curve. Thus, there is disclosed a wound electrode battery (an electric storage element) that is configured such that a recess is formed in the tab and the electrode part, thereby suppressing breakage of the electrode plate.

JP 2013-73757 A

However, the power storage device having the above-described conventional configuration has a problem that the electrode plate cannot be sufficiently prevented from being damaged such as fracture. That is, in the configuration disclosed in Patent Document 1, a recess is formed at the base of the tab to suppress breakage of the electrode plate. However, even in this case, the inventor of the present application applied the load to the tab. It has been found that stress is concentrated on the electrode plate, and the electrode plate may be broken or damaged. In the electric storage element, when the electrode plate is broken or damaged, the active material on the electrode plate may be peeled off or the electrode plate may be displaced, causing a short circuit or the like.

This invention is made | formed in view of the said problem, and it aims at providing the electrical storage element which can suppress that an electrode plate damages, such as a fracture | rupture.

In order to achieve the above object, a power storage device according to one embodiment of the present invention is a power storage device including an electrode body having a plate, and the plate is formed in a first direction from the main body and the main body. The main body portion has a concave portion that is recessed in a curved shape in a direction opposite to the first direction at a connection portion with the tab, and the tab is connected to the concave portion. A base end portion and a central portion on the first direction side than the base end portion; the base end portion intersects the first direction as it goes in a direction opposite to the first direction. The amount spreads in two directions and is larger than the central portion.

According to this, in the electric storage element, the main body portion of the electrode plate has a concave portion that is recessed in a curved shape at a connection portion with the tab, and the tab has a base end portion connected to the concave portion and a central portion. Expands toward the opposite direction, and the amount of expansion is larger than the central part. That is, a base end portion that is larger than the central portion is formed at a connection location with the concave portion at the base of the tab. As a result, even when a load is applied to the tab, the stress applied to the concave portion at the base of the tab can be distributed to the base end side, and the stress can be prevented from concentrating on the concave portion, so that the electrode plate breaks. Equal damage can be suppressed.

The base end portion may have an outer edge shape including at least one of a curve having a curvature radius equal to or larger than the curvature radius of the concave portion and a straight line inclined from the first direction.

According to this, the base end portion of the tab has an outer edge shape including at least one of a curve having a curvature radius equal to or larger than the curvature radius of the concave portion at the base of the tab and an inclined straight line. In this way, by making the outer edge shape of the base end portion of the tab into a shape including a curve larger than the radius of curvature of the recess or an inclined straight line, the stress concentrated on the recess can be further dispersed on the base end side. Therefore, it is possible to further prevent the electrode plate from being damaged, such as breaking.

The base end portion may have the outer edge shape including the curve or the straight line extending in a tangential direction of the recess at the boundary point from a boundary point between the recess and the base end portion.

According to this, the base end portion of the tab has an outer edge shape including a curve or a straight line extending in a tangential direction of the concave portion from a boundary point with the concave portion at the base of the tab. In this way, since the outer edge of the base end portion of the tab extends in the tangential direction of the concave portion, it is possible to suppress stress concentration at the boundary portion between the base end portion and the concave portion. It is possible to further suppress damage such as breakage.

Further, the outer edge shape of the boundary portion between the base end portion and the central portion may be formed by a curve.

According to this, since the outer edge shape of the boundary portion between the base end portion and the central portion of the tab is formed with a curve, it is possible to suppress stress concentration at the boundary portion, and the electrode plate is broken or the like. Damage can be further suppressed.

The concave portion may be formed by a curve having a radius of curvature near the base end portion that is greater than or equal to the radius of curvature of the portion far from the base end portion.

According to this, the concave portion at the base of the tab is formed with a curve whose radius of curvature near the base end portion of the tab is larger than the radius of curvature of the far portion, so that the base end portion side of the concave portion is formed. It is possible to suppress the application of stress, and it is possible to further suppress damage to the electrode plate such as breakage.

The concave portion and the base end portion may have an outer edge shape including a curve having a curvature radius that increases toward the central portion.

According to this, the concave portion at the base of the tab and the proximal end portion of the tab have an outer edge shape including a curve whose radius of curvature increases toward the center portion of the tab, so that the concave portion and the proximal end portion are applied. The force can be dispersed, and damage to the electrode plate such as breakage can be further suppressed.

Note that the present invention can be realized not only as such a power storage element but also as an electrode plate of an electrode body included in the power storage element.

According to the electricity storage device of the present invention, it is possible to suppress the electrode plate from being damaged such as fracture.

It is a perspective view which shows the external appearance of the electrical storage element which concerns on embodiment. It is a disassembled perspective view of the electrical storage element which concerns on embodiment. It is a perspective view which shows the structure of the electrode body which concerns on embodiment. It is a top view which shows the structure of the positive electrode plate which concerns on embodiment. It is a top view which shows the structure of the negative electrode plate which concerns on embodiment. It is a top view which shows the structure of the recessed part and tab of the main-body part of the positive electrode plate which concern on embodiment. It is a figure for demonstrating the effect which the electrical storage element which concerns on embodiment has. It is a figure for demonstrating the effect which the electrical storage element which concerns on embodiment has. It is a perspective view which shows the structure of the electrode body which concerns on the modification of embodiment.

Hereinafter, a power storage device according to an embodiment of the present invention will be described with reference to the drawings. It should be noted that each of the embodiments described below shows a comprehensive or specific example. Numerical values, shapes, materials, constituent elements, arrangement positions and connection forms of constituent elements, and the like shown in the following embodiments are merely examples, and are not intended to limit the present invention. In addition, among the constituent elements in the following embodiments, constituent elements that are not described in the independent claims indicating the highest concept are described as optional constituent elements. In each drawing, dimensions and the like are not strictly illustrated.

In the following description and drawings in the embodiment, the direction in which the pair of electrode terminals included in the power storage element is aligned, the direction in which the pair of current collectors are aligned, or the opposing direction of the short side surface of the container is defined as the X-axis direction. To do. The opposing direction of the long side of the container, the short direction of the short side of the container, the thickness direction of the container, or the stacking direction of the electrode plates of the electrode body is defined as the Y-axis direction. Further, the direction in which the container body and the lid of the storage element are arranged, the longitudinal direction of the short side surface of the container, the winding axis direction of the electrode body, or the vertical direction is defined as the Z-axis direction. These X-axis direction, Y-axis direction, and Z-axis direction are directions that intersect (orthogonal in this embodiment). Although the case where the Z-axis direction does not become the vertical direction may be considered depending on the usage mode, the Z-axis direction will be described below as the vertical direction for convenience of explanation. In the following description, for example, the X axis direction plus side indicates the arrow direction side of the X axis, and the X axis direction minus side indicates the opposite side to the X axis direction plus side. The same applies to the Y-axis direction and the Z-axis direction.

(Embodiment)

[1 General Description of Power Storage Element 10]

First, a general description of the power storage element 10 in the present embodiment will be described with reference to FIGS. 1 and 2. FIG. 1 is a perspective view

showing an external appearance of a power storage element 10 according to the present embodiment. FIG. 2 is an exploded perspective view of the electricity storage device 10 according to the present exemplary embodiment.

The storage element 10 is a secondary battery that can charge electricity and discharge electricity, and specifically, is a non-aqueous electrolyte secondary battery such as a lithium ion secondary battery. The power storage element 10 is used, for example, for an automobile power source such as an electric vehicle (EV), a hybrid electric vehicle (HEV), or a plug-in hybrid electric vehicle (PHEV), an electronic device power source, and a power storage power source. In addition, the electrical storage element 10 is not limited to a nonaqueous electrolyte secondary battery, A secondary battery other than a nonaqueous electrolyte secondary battery may be sufficient, and a capacitor may be sufficient as it. Moreover, the electrical storage element 10 may be not a secondary battery but a primary battery that can use stored electricity without being charged by a user. Further, in the present embodiment, a rectangular (rectangular) power storage element 10 is illustrated, but the shape of the power storage element 10 is not limited to a rectangular shape, and may be a cylindrical shape, a long cylindrical shape, or the like. Alternatively, a laminate type power storage element may be used

As shown in FIG. 1, the electricity storage device 10 includes a container 100 having a container body 110 and a lid 120, a positive electrode terminal 200, and a negative electrode terminal 300. As shown in FIG. 2, a positive electrode current collector 130, a negative electrode current collector 140, an electrode body 400, and the like are accommodated inside the container 100.

Gaskets are provided between the lid 120 and the positive electrode terminal 200 and the negative electrode terminal 300, and between the lid 120 and the positive electrode current collector 130 and the negative electrode current collector 140 in order to improve insulation and airtightness. Etc. are arranged, but are omitted from the drawing. Moreover, although electrolyte solution (nonaqueous electrolyte) is enclosed inside the container 100, illustration is abbreviate | omitted. In addition, as long as the said electrolyte solution does not impair the performance of the electrical storage element 10, there is no restriction | limiting in particular in the kind, Various things can be selected. In addition to the above-described components, a spacer disposed on the side and above the electrode body 400, a gas discharge valve for releasing the pressure when the pressure in the container 100 rises, and an electrolyte in the container 100 A liquid injection part for injecting or an insulating film for wrapping the electrode body 400 or the like may be disposed.

The container 100 is a rectangular parallelepiped (box-shaped) case composed of a container body 110 having a rectangular cylindrical shape and a bottom, and a lid body 120 that is a plate-like member that closes the opening of the container body 110. In addition, the container 100 can be hermetically sealed by accommodating the electrode body 400 and the like inside the container body 110 and then welding the lid body 120 and the container body 110. In addition, although the material of the cover body 120 and the container main body 110 is not specifically limited, For example, it is preferable that they are weldable metals, such as stainless steel, aluminum, aluminum alloy, iron, and a plated steel plate.

The electrode body 400 includes a positive electrode plate, a negative electrode plate, and a separator, and is a power generation element that can store electricity. Specifically, the electrode body 400 is formed by winding what is arranged in layers so that a separator is sandwiched between a positive electrode plate and a negative electrode plate. Accordingly, the electrode body 400 includes a tab bundle 410 formed by laminating tabs of the positive electrode plate, and a tab bundle 420 formed by laminating tabs of the negative electrode plate. In the present embodiment, an elliptical shape is illustrated as a cross-sectional shape of the electrode body 400, but an elliptical shape, a circular shape, a polygonal shape, or the like may be used. The detailed description of the configuration of the electrode body 400 will be described later.

The positive electrode terminal 200 is an electrode terminal electrically connected to the positive electrode plate of the electrode body 400 via the positive electrode current collector 130. The negative electrode terminal 300 is an electrode terminal electrically connected to the negative electrode plate of the electrode body 400 via the negative electrode current collector 140. That is, the positive electrode terminal 200 and the negative electrode terminal 300 lead the electricity stored in the electrode body 400 to the external space of the power storage element 10, and in order to store the electricity in the electrode body 400, It is an electrode terminal made of metal for introducing. The positive electrode terminal 200 and the negative electrode terminal 300 are attached to the lid 120. The positive electrode terminal 200 and the negative electrode terminal 300 are formed of aluminum or an aluminum alloy.

The positive electrode current collector 130 and the negative electrode current collector 140 are disposed between the electrode body 400 and the lid body 120, and are U-shaped in a side view that electrically connects the electrode body 400, the positive electrode terminal 200, and the negative electrode terminal 300. It is a plate-shaped member. In the present embodiment, positive electrode current collector 130 is joined to tab bundle 410 on the positive electrode side of electrode body 400 by welding or the like, and negative electrode current collector 140 is welded to tab bundle 420 on the negative electrode side of electrode body 400 or the like. It is joined by. The positive electrode current collector 130 is formed of aluminum or an aluminum alloy, and the negative electrode current collector 140 is formed of copper or a copper alloy.

[Description of Configuration of 2 Electrode Body 400]
Next, the configuration of the electrode body 400 will be described in detail. FIG. 3 is a perspective view showing the configuration of the electrode body 400 according to the present embodiment. In the figure, a part of the wound state of the electrode body 400 is shown in a developed manner.

As shown in the figure, the electrode body 400 is formed by alternately stacking and winding positive and negative plates 430 and 440 and separators 450a and 450b. That is, the electrode body 400 is formed by stacking and winding the positive electrode plate 430, the separator 450a, the negative electrode plate 440, and the separator 450b in this order.

The positive electrode plate 430 is an electrode plate (electrode plate) in which a positive electrode active material layer is formed on the surface of a positive electrode base material layer which is a long metal foil made of aluminum or an aluminum alloy. Here, as the positive electrode active material used for the positive electrode active material layer, any known material can be used as long as it is a positive electrode active material capable of occluding and releasing lithium ions. For example, as a positive electrode active material, a polyanion compound such as $LiMPO_4$, $LiMSiO_4$, $LiMBO_3$ (M is one or more transition metal elements selected from Fe, Ni, Mn, Co, etc.), lithium titanate, Spinel type lithium manganese oxide such as $LiMn_2O_4$ and $LiMn_{1.5}Ni_{0.5}O_4$, $LiMO_2$ (M is one or more transition metals selected from Fe, Ni, Mn, Co, etc.) Lithium transition metal oxides such as (element) can be used.

The negative electrode plate 440 is an electrode plate (electrode plate) in which a negative electrode active material layer is formed on the surface of a negative electrode base material layer that is a long strip-shaped metal foil made of copper or a copper alloy. Here, as the negative electrode active material used for the negative electrode active material layer, any known material can be used as long as it is a negative electrode active material capable of occluding and releasing lithium ions. For example, as the negative electrode active material, lithium metal, lithium alloy (lithium metal-containing alloys such as lithium-silicon, lithium-aluminum, lithium-lead, lithium-tin, lithium-aluminum-tin, lithium-gallium, and wood alloy) Other alloys that can occlude and release lithium, carbon materials (eg, graphite, non-graphitizable carbon, graphitizable carbon, low-temperature calcined carbon, amorphous carbon, etc.), silicon oxide, metal oxide, lithium metal oxide ($Li_4Ti_5O_{12}$ etc.), polyphosphoric acid compounds, compounds of transition metals and group 14 to group 16 elements such as Co_3O_4 and Fe_2P, generally called conversion anodes, etc. It is done.

The separators 450a and 450b are microporous sheets made of resin. In addition, as a raw material of the separators 450a and 450b, a well-known material can be used suitably, unless the performance of the electrical storage element 10 is impaired.

Here, the positive electrode plate 430 has a plurality of rectangular tabs 431 protruding outward at one end in the winding axis direction. Similarly, the negative electrode plate 440 has a plurality of rectangular tabs 441 protruding outward at one end in the winding axis direction. This plurality of tabs 431 and the plurality of tabs 441 are portions where the active material is not coated and the base material layer is exposed (active material uncoated portion). The winding axis is a virtual axis serving as a central axis when winding the positive electrode plate 430, the negative electrode plate 440, and the like. In this embodiment, the winding axis extends in the Z-axis direction passing through the center of the electrode body 400. Parallel straight lines.

The plurality of tabs 431 and the plurality of tabs 441 are disposed on the same end in the winding axis direction (in the figure, the Z-axis direction plus side end), and the positive electrode plate 430 and the negative electrode plate 440 are laminated. Thus, the electrode body 400 is laminated at a predetermined position. As a result, on the electrode body 400, a tab bundle 410 formed by stacking a plurality of tabs 431 and a tab bundle 420 formed by stacking a plurality of tabs 441 are formed. The tab bundles 410 and 420 are collected, for example, toward the center in the stacking direction (Y-axis direction) and joined to the positive electrode current collector 130 and the negative electrode current collector 140 by welding or the like.

[3 Description of Configuration of Positive Electrode Plate 430 and Negative Electrode Plate 440]
Next, the structure of the positive electrode plate 430 and the negative electrode plate 440 will be described in more detail. FIG. 4A is a plan view showing a configuration of positive electrode plate 430 according to the present embodiment. FIG. 4B is a plan view showing the configuration of the negative electrode plate 440 according to the present embodiment. 4A is an enlarged view of the periphery of the tab 431 of the positive electrode plate 430 in FIG. 3, and FIG. 4B is an enlarged view of the periphery of the tab 441 of the negative electrode plate 440 in FIG.

First, as shown in FIG. 4A, the positive electrode plate 430 includes a main body portion 432 and the above-described tab 431 that protrudes from the main body portion 432 toward the Z axis direction plus side (hereinafter also referred to as the first direction). . That is, the Z axis direction minus side is the main body part 432 from the straight line L0 connecting the linear edges of the main body part 432, and the Z axis direction plus side is the tab 431 from the straight line L0. In addition, the main body 432 has a concave portion 432a that is recessed in a curved shape on the negative side in the Z-axis direction (the direction opposite to the first direction) at the connection portion with the tab 431. Specifically, the concave portion 432a is a portion recessed from the straight line L0, and the main body portion 432 has two concave portions 432a disposed adjacent to the tab 431 on both sides of the tab 431 (both sides in the X-axis direction). doing.

In addition, a positive electrode active material layer 433 is formed on the minus side in the Z-axis direction with respect to the concave portion 432 a of the main body portion 432. That is, in the positive electrode plate 430, the portion of the main body 432 excluding the positive electrode active material layer 433 and the tab 431 constitute the above-described positive electrode base material layer, and the positive electrode active material layer 433 is formed on the positive electrode base material layer. Yes. Thus, the recess 432a has a depth that does not reach the positive electrode active material layer 433, and the positive electrode active material layer 433 is not formed in the recess 432a. Therefore, the recess 432a is formed in the region of the positive electrode active material layer 433. By forming, the positive electrode active material layer 433 can be prevented from peeling off. Note that an insulating edge coat layer may be formed on the positive side of the positive electrode active material layer 433 in the Z-axis direction plus side to a position covering the concave portion 432a.

Here, the tab 431 includes a base end portion 431a connected to the recess 432a, a central portion 431b on the positive side in the Z-axis direction (first direction side) with respect to the base end portion 431a, and a Z-axis direction with respect to the central portion 431b. And a positive end 431c.

The base end portion 431a is an end portion of the tab 431 on the main body portion 432 side (Z-axis direction negative side), which is disposed adjacent to the concave portion 432a. For example, in the Z-axis direction, the base end portion 431a is an area of about 20% to 40% of the tab 431. Further, the base end portion 431a has a shape in which the width in the X-axis direction becomes narrower toward the positive side in the Z-axis direction, that is, a shape in which the width in the X-axis direction becomes wider toward the negative side in the Z-axis direction. In other words, the base end portion 431a has a shape that expands on both sides in the X-axis direction (second direction intersecting the first direction) toward the minus side in the Z-axis direction (the direction opposite to the first direction). .

The central part 431b is a part of the central part in the Z-axis direction of the tab 431 and is connected to the base end part 431a, and has the same shape (rectangular shape) in the X-axis direction. The distal end portion 431c is connected to the central portion 431b and is an end portion on the opposite side to the main body portion 432 of the tab 431 (Z-axis direction plus side), and has the same width (rectangular shape) in the X-axis direction. Shape). For example, in the Z-axis direction, the central portion 431b is a region of about 20% to 60% of the tab 431, and the tip portion 431c is a region of about 20% to 40% of the tab 431.

Thus, the front-end | tip part 431c and the center part 431b have the continuous edge parallel to a Z-axis direction. Accordingly, the base end portion 431a has a larger amount of spreading in the X-axis direction than the distal end portion 431c and the central portion 431b.

4B, the negative electrode plate 440 includes a main body 442 and the above-described tab 441 that protrudes from the main body 442 in the positive Z-axis direction (first direction). In addition, the main body 442 has a concave portion 442 a that is recessed in a curved shape on the minus side in the Z-axis direction (the direction opposite to the first direction) at the connection portion with the tab 441. The tab 441 includes a base end portion 441a connected to the recess 442a, a center portion 441b on the Z axis direction plus side (first direction side) with respect to the base end portion 441a, and a Z axis direction plus with respect to the center portion 441b. Side tip 441c. And the base end part 441a spreads to both sides in the X-axis direction as it goes to the negative side in the Z-axis direction, and the amount of spread is larger than that of the distal end part 441c and the central part 441b.

Also in the negative electrode plate 440, similarly to the positive electrode plate 430, a negative electrode active material layer 443 is formed on the minus side in the Z-axis direction with respect to the concave portion 442 a of the main body 442. The detailed configuration is omitted because it is the same as that of the positive electrode plate 430, but when the electrode body 400 is formed, the negative electrode active material layer 443 is disposed at a position covering the positive electrode active material layer 433. The material layer 443 is preferably formed up to a position outside the positive electrode active material layer 433 (in FIG. 4B, on the plus side in the Z-axis direction). Note that the negative electrode active material layer 443 may be formed further to the positive side in the Z-axis direction than the concave portion 442a of the main body portion 442. That is, the negative electrode active material layer 443 may be formed up to the middle of the base end portion 441a of the tab 441, or may be formed up to the middle of the center portion 441b. Moreover, since each component which the other negative electrode plate 440 has is the same as each component which the above-mentioned positive electrode plate 430 has, detailed description is abbreviate | omitted.

[4. Description of Configuration of Recess 432a and Tab 431 of Main Body 432 of Positive Electrode Plate 430]
Next, the structure of the recessed part 432a of the main body part 432 of the positive electrode plate 430 and the tab 431 is demonstrated in detail. FIG. 5 is a plan view showing the configuration of the recess 432a and the tab 431 of the main body 432 of the positive electrode plate 430 according to the present embodiment. Specifically, FIG. 4 is an enlarged view showing the configuration of the concave portion 432a and the tab 431 of the main body portion 432 of the positive electrode plate 430 of FIG. 4A. As described above, the configuration of the concave portion 442a and the tab 441 of the main body 442 of the negative electrode plate 440 is the same as the configuration of the positive electrode plate 430, and thus illustration and description thereof are omitted.

[4.1 Explanation of Configuration of Recess 432a]
As shown in FIG. 5, the main body portion 432 of the positive electrode plate 430 is formed with a concave portion 432 a that is recessed from the linear outer edge L <b> 1 of the main body portion 432 toward the negative side in the Z-axis direction. That is, the recess 432a is a recess that is recessed in the Z-axis direction minus side

from the straight line L0 including the outer edge L1, and has a curved outer edge extending from the boundary point P1 on the outer edge L1 side to the boundary point P2 on the base end 431a side. doing.

Specifically, the concave portion 432a is formed with a curve in which the radius of curvature near the base end 431a is larger than the radius of curvature of the portion far from the base end 431a. That is, the concave portion 432a has an outer edge L2 at a portion far from the base end portion 431a and an outer edge L3 at a portion close to the base end portion 431a, and the radius of curvature of the outer edge L3 is larger than the radius of curvature of the outer edge L2. It has become. In the present embodiment, the concave portion 432a is formed by a curve having the same radius of curvature at the portion close to the base end portion 431a and at the portion far from the base end portion 431a. That is, the recess 432a has an arcuate outer edge shape in which the outer edge L2 and the outer edge L3 have the same curvature radius.

For example, the width of the recess 432a in the X-axis direction (linear distance between the boundary point P1 and the boundary point P2) is about 20% to 30% (about 5 mm) of the width of the tab 431 in the X-axis direction. The depth in the Z-axis direction is about 2% to 8% (about 0.5 mm to 1 mm) of the height of the tab 431 in the Z-axis direction. However, as the curvature radii of the outer edge L2 and the outer edge L3 of the recess 432a are increased, the stress concentration applied to the recess 432a can be more relaxed. Therefore, the recess 432a has a larger curvature radius regardless of the size. Is preferred.

In addition, the recessed part 432a may be formed in the curve whose curvature radius of the part near the base end part 431a is larger than the curvature radius of the part far from the base end part 431a. That is, the concave portion 432a may be formed so that the radius of curvature of the outer edge L3 is larger than the radius of curvature of the outer edge L2.

Further, the shape of the outer edge at the boundary point P1 on the outer edge L1 side of the recess 432a is not particularly limited. However, at the boundary point P1, the linear outer edge L1 and the arc-shaped outer edge L2 intersect each other, and thus a pointed shape. It will have. For this reason, it is preferable to form the outer edge shape in the boundary point P1 with a curve. Thereby, it can suppress that the positive electrode plate 430 damages the separator 450a or 450b in the boundary point P1 of the recessed part 432a. The same applies to the negative electrode plate 440. Note that in the negative electrode plate 440, in the case where the negative electrode active material layer 443 is formed at a position covering the concave portion 442a, the negative electrode active material layer 443 can be prevented from peeling off.

Further, the outer edge shape at the boundary point P2 on the base end portion 431a side of the recess 432a is a shape in which the outer edge L3 of the recess 432a and the outer edge L4 of the base end portion 431a are smoothly connected. That is, the base end portion 431a has an outer edge shape including a curve or a straight line extending in a tangential direction of the recess portion 432a at the boundary point P2 from the boundary point P2 between the recess portion 432a and the base end portion 431a. In the present embodiment, the base end portion 431a has an outer edge shape including an arcuate outer edge L4 having the same radius of curvature as that of the concave portion 432a. That is, the base end portion 431a has a curved outer edge L4 that extends from the boundary point P2 in the tangential direction of the concave portion 432a. In other words, the outer edges L2 and L3 of the recess 432a and the outer edge L4 of the base end 431a form an arc-shaped outer edge.

[4.2 Explanation of Configuration of Tab 431]
The base end portion 431a of the tab 431 has an outer edge shape including a linear outer edge L5 inclined from the Z-axis direction. That is, the base end portion 431a has a linear outer edge L5 extending from the boundary point P3 in the tangential direction of the outer edge L4 at the boundary point P3. The inclination angle of the outer edge L5 from the Z-axis direction is not particularly limited, but is preferably 15 ° to 45 °, more preferably 20 ° to 40 °, and more preferably 25 ° to 35 °. More preferably, it is around 30 °. The height of the outer edge L5 in the Z-axis direction is about 5% to 15% (about 2 mm to 3 mm) of the height of the tab 431 in the Z-axis direction.

As described above, the base end portion 431a has at least one of a curve having a radius of curvature equal to or greater than the radius of curvature of the recess 432a and a straight line inclined from the Z-axis direction plus side (first direction) (both in the present embodiment). It has the outer edge shape containing.

In addition, the base end part 431a may have an outer edge shape including a straight line extending in a tangential direction of the concave part 432a at the boundary point P2 from the boundary point P2 between the concave part 432a and the base end part 431a. That is, the outer edge L4 of the base end portion 431a may be a linear outer edge extending in the tangential direction of the recess 432a. Further, the outer edge L4 of the base end portion 431a may be a curved outer edge having a radius of curvature larger than that of the concave portion 432a. Further, the outer edge L5 of the base end portion 431a may be a curved outer edge having a radius of curvature equal to or greater than the radius of curvature of the recess 432a.

In addition, the outer edge shape at the boundary point P4 on the central portion 431b side of the base end portion 431a is a shape in which the outer edge L5 of the base end portion 431a and the outer edge L6 of the central portion 431b are smoothly connected. That is, the outer edge shape of the boundary portion between the base end portion 431a and the central portion 431b is formed by a curve. In the present embodiment, the outer edge L6 of the central portion 431b is a linear outer edge extending in the Z-axis direction, so that a recessed corner is not formed at the intersection with the linear outer edge L5 of the base end portion 431a. The outer edge shape at the boundary point P4 is a curved shape.

Further, the outer edge shape at the boundary point P5 on the tip portion 431c side of the center portion 431b is a shape in which the outer edge L6 of the center portion 431b and the outer edge L7 of the tip portion 431c are smoothly connected. In the present embodiment, the outer edge L7 of the distal end portion 431c is a linear outer edge extending in the Z-axis direction from the boundary point P5 with the outer edge L6 of the central portion 431b, so the outer edge L6 and the outer edge L7 are the boundary point P5. It is connected smoothly.

With such a configuration, the base end portion 431a expands in the X-axis direction toward the minus side in the Z-axis direction, and the amount of expansion is larger than that of the distal end portion 431c and the central portion 431b. If the amount of the base end portion 431a spreading in the X-axis direction is larger than that of the tip end portion 431c and the center portion 431b, the tip end portion 431c and the center portion 431b move in the X-axis direction toward the minus side in the Z-axis direction. You may have the shape which spreads. Alternatively, if the amount of the base end portion 431a spreading in the X-axis direction is larger than that of the central portion 431b, the distal end portion 431c is closer to the negative side of the Z-axis direction than the base end portion 431a or the central portion 431b. You may have the shape which spreads in a direction. However, if the amount of the tip portion 431c and the central portion 431b that spread in the X-axis direction is large, the tab 431 rises when the positive electrode plate 430 is pressed (compressed with a roller) during manufacturing. Smaller is preferable.

[5 Description of effects]
Next, the effect which the electrical storage element 10 has is demonstrated in detail. FIG. 6A and FIG. 6B are diagrams for explaining the effects exerted by power storage element 10 according to the present embodiment. Specifically, FIG. 6A shows a configuration in which the main body portion 512 of the electrode plate 510 is only formed with a recess 512a, and the base end portion 511a of the tab 511 is not widened more than the central portion 511b. FIG. 6 corresponds to FIG. 6B is a diagram showing a configuration in a case where the base end portion 521a of the tab 521 is made wider than the central portion 521b without forming a recess in the main body portion 522 of the electrode plate 520, and FIG. It corresponds to.

First, as shown in FIG. 6A, when the concave portion 512a is formed in the main body portion 512 of the electrode plate 510, the stress concentration when a load is applied to the tab 511 is smaller than when the concave portion 512a is not formed. Distributed. However, the inventor of the present application has found that in this configuration, stress concentrates in the vicinity of the bottom P10 of the recess 512a, so that the electrode plate may be damaged, such as fracture, starting from the

bottom P10 of the recess 512a. For this reason, in order to avoid this stress concentration, it is necessary to make the recess 512a large (increase the radius of curvature of the outer edge of the recess 512a). However, even if there is no space for forming the concave portion 512a large, or even if the concave portion 512a can be formed large, the area of the active material layer that can be formed in the main body portion 512 is reduced and the capacity of the power storage element is reduced. Problems arise.

In addition, as shown in FIG. 6B, if the base end portion 521a of the tab 521 is shaped so as to expand larger than the central portion 521b, the base end portion 521a is not expanded wider than the central portion 521b. The stress concentration when a load is applied is dispersed. However, the inventor of the present application has the possibility that the electrode plate may be damaged by breakage or the like starting from the boundary point P20 because stress concentrates on the boundary point P20 between the base end part 521a and the main body part 522 in this configuration. I found it. For this reason, in order to avoid this stress concentration, it is necessary to further widen the base end portion 521a (increase the radius of curvature of the outer edge of the base end portion 521a). However, if the base end portion 521a is greatly widened, it becomes difficult to insulate, and there arises a problem that short-circuiting with a different polar plate is likely to occur.

As described above, the inventors of the present application have found the configuration of the present invention by paying attention to the fact that both the configuration shown in FIG. 6A and the configuration shown in FIG. 6B have problems. In other words, the structure shown in FIGS. 6A and 6B has an effect of suppressing breakage such as breakage of the electrode plate, and conventionally, there has been no idea of suppressing damage such as breakage of the electrode plate beyond this. However, the inventor of the present application thought to further suppress the electrode plate from being damaged such as breaking. And this inventor does not form the recessed part of the main-body part of an electrode plate large like the structure of FIG. 6A, or enlarges the base end part of a tab much more like the structure of FIG. The structure of the electricity storage element 10 that can further suppress damage such as breakage has been found.

Specifically, the power storage device 10 according to the embodiment of the present invention includes a plate body (a body portion 432 of the positive electrode plate 430 and a body portion 442 of the negative electrode plate 440) as a tab (a tab 431 of the positive electrode plate 430). In addition, the connecting portion with the tab 441) of the negative electrode plate 440 has concave portions (concave portion 432a and concave portion 442a) that are recessed in a curved shape. Then, the tab expands and widens as the base end portions (base end portion 431a, base end portion 441a) connected to the concave portion are directed in the opposite direction to the central portion (center portion 431b, central portion 441b). The amount is larger than the central part. That is, a base end portion that is larger than the central portion is formed at a connection location with the concave portion at the base of the tab. As a result, even when a load is applied to the tab, the stress applied to the concave portion at the base of the tab can be distributed to the base end side, and the stress can be prevented from concentrating on the concave portion, so that the electrode plate breaks. Equal damage can be suppressed.

Further, the base end portion of the tab has an outer edge shape including at least one of a curve having a curvature radius equal to or larger than the curvature radius of the concave portion at the base of the tab and an inclined straight line. In this way, by making the outer edge shape of the base end portion of the tab into a shape including a curve larger than the radius of curvature of the recess or an inclined straight line, the stress concentrated on the recess can be further dispersed on the base end side. Therefore, it is possible to further prevent the electrode plate from being damaged, such as breaking.

Further, the base end portion of the tab has an outer edge shape including a curve or a straight line extending in a tangential direction of the concave portion from a boundary point with the concave portion at the base of the tab. In this way, since the outer edge of the base end portion of the tab extends in the tangential direction of the concave portion, it is possible to suppress stress concentration at the boundary portion between the base end portion and the concave portion. It is possible to further suppress damage such as breakage.

In addition, since the outer edge shape of the boundary portion between the base end portion and the central portion of the tab is formed with a curve, it is possible to suppress stress concentration at the boundary portion, and the electrode plate may be broken or damaged. Can be further suppressed.

In addition, since the concave portion at the base of the tab is formed with a curve whose radius of curvature near the base end portion of the tab is larger than the radius of curvature of the far portion, stress is applied to the base end portion side of the concave portion. Can be suppressed, and damage to the electrode plate such as breakage can be further suppressed.

In the storage element 10, when the electrode plate is broken or damaged, the active material on the electrode plate may be peeled off or the position of the electrode plate may be shifted to cause a short circuit or the like, but the electrode plate may be broken or the like. If damage can be suppressed, the occurrence of these problems can be suppressed. In particular, in the negative electrode plate 440, when the negative electrode active material layer 443 is formed at a position covering the concave portion 442a of the main body portion 442, the concave portion 442a can be prevented from being broken or damaged, and thus the negative electrode The active material layer 443 can be prevented from peeling off. For this reason, the beneficial effect peculiar to an electrical storage element can be acquired by suppressing damage, such as a fracture | rupture of an electrode plate.

[6. Description of Modified Example of Embodiment]
The power storage element 10 according to the embodiment of the present invention has been described above, but the present invention is not limited to this embodiment. That is, the embodiment disclosed this time should be considered as illustrative in all points and not restrictive. The scope of the present invention is defined by the terms of the claims, rather than the description above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

For example, in the above embodiment, the electrode body has a so-called horizontal winding shape having a winding axis in the Z-axis direction. However, the electrode body may have, for example, a so-called vertical winding shape having a winding axis in the X-axis direction, or a shape in which the electrode plate is folded in a bellows shape. Further, as shown in FIG. 7, a stacked electrode body 401 in which a plurality of flat plate plates (a positive plate 460 and a negative plate 470) are stacked may be used. That is, the configuration of the above embodiment may be applied to the main body portions and tabs of the positive electrode plate 460 and the negative electrode plate 470. FIG. 7 is a perspective view showing a configuration of an electrode body 401 according to a modification of the present embodiment. Thus, the structure in the said embodiment is applicable to any electrode body provided with the electrode plate which has a tab.

Moreover, in the said embodiment, both the positive electrode plate and the negative electrode plate decided to have the said structure. However, the positive electrode plate or the negative electrode plate may not have the above configuration.

Moreover, in the said embodiment, the electrode plate has the recessed part of the main-body part of the said structure, and the base end part which spreads in the both sides of a tab. However, the electrode plate may have the concave portion of the main body portion and the base end portion that expands only on one side of the tab.

Moreover, the outer edge shape of the recessed part of the main-body part of an electrode plate and the base end part of a tab is not limited to the said embodiment, The following may be sufficient. That is, the concave portion may be formed with a curve in which the radius of curvature of the portion near the base end is smaller than the radius of curvature of the portion far from the base end. Further, the base end portion does not have to have an outer edge shape extending in a tangential direction of the recess from a boundary point with the recess. Further, the base end portion may have an outer edge shape including a curve having a radius of curvature smaller than the radius of curvature of the concave portion.

Moreover, the recessed part of the main-body part of an electrode plate and the base end part of a tab may have the outer edge shape containing the curve from which a curvature radius becomes large as it goes to the center part of a tab. With this configuration, it is possible to disperse the force applied to the concave portion and the base end portion, and it is possible to further suppress damage such as breakage of the electrode plate. Specifically, the outer edge shape of the concave portion and the base end portion may be a curve whose curvature changes according to a relaxation curve, for example. Here, the relaxation curve is a curve including at least one of a clothoid curve, a sine half-wavelength decreasing curve, a McConnell curve, a Remnice skate curve, and a cubic parabola. A clothoid curve is a curve whose curvature changes in proportion to the length of the curve, and a sine half-wavelength decreasing curve is a curve whose curvature changes in a sine shape with respect to the length of the curve. In addition, the McConnell curve is a relaxation curve used mainly for designing a bicycle travel route in a bicycle stadium or the like. The Lemnis skate curve is a curve whose curvature changes in proportion to the length of the chord of the curve, and the cubic parabola is a curve defined by a cubic function. In addition, about these relaxation curves, since the function conventionally utilized in the specific field [area can be used, detailed description is abbreviate [omitted.

Moreover, the form constructed [assembled combining the said embodiment and its modification arbitrarily is also contained in the scope of the present invention.

In addition, the present invention can be realized not only as such a power storage element 10 but also as an electrode plate of an electrode body included in the power storage element 10.

The present invention is applicable to power storage elements such as lithium ion secondary batteries.

DESCRIPTION OF SYMBOLS 10 Power storage element 100 Container 110 Container main body 120 Cover body 130 Positive electrode current collector 140 Negative electrode current collector 200 Positive electrode terminal 300 Negative electrode terminal 400, 401 Electrode body 410, 420 Tab bundle 430, 460 Positive electrode plate 431, 441, 511, 521 Tab 431a, 441a, 511a, 521a Base end part 431b, 441b, 511b, 521b Central part 431c, 441c Tip part 432, 442, 512, 522 Main body part 432a, 442a, 512a Recess 433 Positive electrode active material layer 440, 470 Negative electrode plate 443 Negative electrode active material layer 450a, 450b Separator 510, 520 Electrode plate

Cited By (2)

Publication number	Priority date	Publication date	Assignee	Title
CN114464901A *	2020-11-10	2022-05-10	[redacted]	Battery with a battery cell
CN115458848A *	2021-06-09	2022-12-09	[redacted]	Battery with fixing member
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
JP6008662B2	2016-10-05	Power storage device and method for manufacturing power storage device
CN108886128B	2023-01-13	Energy storage device
JP6709822B2	2020-06-12	Storage element
KR20180132231A	2018-12-04	A stepwise electrode assembly, and a battery cell, battery pack and device comprising the same
JP6237849B2	2017-11-29	Power storage device and method for manufacturing power storage device
US10811721B2	2020-10-20	Accumulator device
US20220311057A1	2022-09-29	Electrode assembly and secondary battery comprising same
US20190013507A1	2019-01-10	Stack-type battery
US10886182B2	2020-06-16	Secondary battery
JP6270613B2	2018-01-31	Prismatic secondary battery
US20130260845A1	2013-10-10	Battery
JP2019046582A	2019-03-22	Power storage element
CN108022833B	2021-09-03	Electrochemical energy storage device
WO2018159581A1	2018-09-07	Electricity storage element
JP2011054378A	2011-03-17	Nonaqueous electrolyte secondary battery
JP5585866B2	2014-09-28	Secondary battery
WO2022168616A1	2022-08-04	Electricity storage element and electricity storage device
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JP7318383B2	2023-08-01	Storage element
WO2022163636A1	2022-08-04	Power storage element
JP7155883B2	2022-10-19	Storage element
JP2018056017A	2018-04-05	Power storage element

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
JP2017168156A	2017-08-30	2017-08-30	Power storage element

Applications Claiming Priority (1)

Application	Filing date	Title
JP2017168156A	2017-08-30	Power storage element

Concepts

machine-extracted

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Name	Image	Sections	Count	Query match
storage		title,claims,abstract,description	56	0.000
suppression		absvract,description	14	0.000

Show all concepts from the description section

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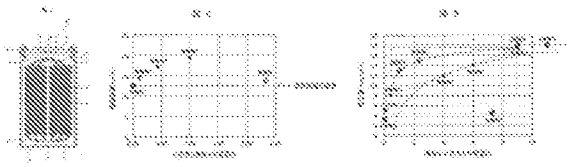
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Lithium ion secondary battery

Abstract

PROBLEM TO BE SOLVED: To increase an initial capacity by increasing a coating amount and raise a capacity-keeping rate, in a lithium ion secondary battery having a negative electrode in which a Si alloy is used.SOLUTION: A lithium ion secondary battery comprises: a positive electrode including a positive electrode active material; a negative electrode arranged by coating the surface of a negative electrode collector with a negative electrode active material mixture including a negative electrode active material, a conductive assistant material and a binder; a separator disposed between the positive and negative electrodes; and an electrolyte. The negative electrode active material includes graphite and a Si alloy, and satisfies the following conditions: 0.43≤x≤9.0; and 8≤y<18, where x is a mass ratio of the graphite to the Si alloy, and y(mg/cm) is a coating amount of the negative electrode active material mixture.SELECTED DRAWING: Figure 3

Images (3)



Classifications

- H01M4/133 Electrodes based on carbonaceous material, e.g. graphite-intercalation compounds or CFx

View 9 more classifications

JP2016018654A

Japan

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Other languages: Japanese

Inventor: 徳二 関, Deji Seki, 英二 関, 英樹 木村, Hideki Kimura, 英樹 木村, ソクチュ ヒョ, Seogchul Shin, ソクチュ ヒョ

Current Assignee : Hitachi Ltd

Worldwide applications

2014 JP 2015 US CN

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Status Pending

Info: Patent citations (14), Cited by (8), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (8)

Hide Dependent
translated from Japanese

Between a positive electrode containing a positive electrode active material, a negative electrode obtained by coating a negative electrode active material mixture containing a negative electrode active material, a conductive additive and a binder on the surface of a negative electrode current collector, and between the positive electrode and the negative electrode A separator disposed and an electrolyte;
The negative electrode active material includes graphite and a Si alloy,

When the mass ratio of the graphite and the Si alloy is x and the coating amount of the negative electrode active material mixture is y (mg / cm ^{2}), 0.43 ≦ x ≦ 9.0 and 8 ≦ A lithium ion secondary battery satisfying y <18. The lithium ion secondary battery according to claim 1, wherein the relationship between x and y satisfies the following formula (1).

y ≦ −4.29x $^{-1}$ +17.86 Formula (1) 3. The lithium ion secondary battery according to claim 1, wherein the relationship between x and y satisfies the following formula (2).
y ≧ 1.31x + 7.5 (2) The lithium ion secondary battery according to claim 1, wherein the relationship between x and y satisfies the following formula (3).
y <1.11x + 7.5 Formula (3) 5. The lithium ion secondary battery according to claim 1, wherein x satisfies 0.5 ≦ x ≦ 2.0. The capacity retention rate of the negative electrode is equal to or higher than the capacity retention rate of the positive electrode when a value calculated by dividing the 1C discharge capacity by the 0.2C discharge capacity is defined as a capacity retention rate. Lithium ion secondary battery. The lithium according to any one of claims 1 to 6, wherein the Si alloy contains Si and one or more elements selected from the group consisting of Al, Ni, Cu, Fe, Ti, and Mn. Ion secondary battery. The lithium ion secondary battery according to claim 7, wherein the composition of the Si alloy is 50 to 90% by atomic ratio.

Description

Translated from Japanese

The present invention relates to a lithium ion secondary battery.

In recent years, lithium ion secondary batteries have attracted attention as secondary batteries having a high energy density, and their research, development, and commercialization are being rapidly promoted. At present, small consumer lithium-ion secondary batteries are widely used for mobile phones and notebook computers. Furthermore, due to problems such as global warming, depleted fuel, and nuclear power plants, large-capacity secondary batteries with higher capacities than conventional batteries are demanded as storage batteries for household use, industrial use, and vehicle use.

Conventionally, as a measure for increasing the capacity of a lithium ion secondary battery, it is known to apply silicon (Si) or a compound containing Si to the negative electrode material and increase the amount of electrode coating. However, Si has a problem in rate characteristics because its powder resistance is two orders of magnitude higher than that of graphite. Moreover, since there exists a subject in cycle life, examination which increases electrode coating amount is not made ; formed.

Patent Document 1 discloses a surface of a composite particle containing graphite particles, Si fine particles and amorphous carbon (A) in order to increase the initial charge / discharge capacity of a lithium secondary battery and to improve charge / discharge cycle characteristics. A negative electrode material for a lithium secondary

battery, wherein carbonaceous material particles containing at least one or more selected from graphite or carbon black are disposed, and the carbonaceous material particles are coated with amorphous carbon (B). The use is described. With the above configuration, it is possible to alleviate the volume change of the Si fine particles during charge / discharge, maintain the electrical contact of the active material, and improve the charge / discharge cycle characteristics.

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However, in order to further increase the capacity, it is necessary to further increase the mixing ratio of Si and increase the coating amount. Further, when the amount of Si mixed and the amount of coating are increased, the capacity retention rate is lowered although the capacity is increased.

An object of the present invention is to provide a lithium ion secondary battery in which a Si alloy is applied to the negative electrode, the initial capacity is increased, and the capacity retention rate is improved.

The present invention relates to a negative electrode obtained by applying a negative electrode active material mixture containing a positive electrode containing a positive electrode active material, a negative electrode active material, a conductive additive and a binder to the surface of the negative electrode current collector, and a positive electrode and a negative electrode. A lithium ion secondary battery comprising a separator disposed between and an electrolyte, wherein the negative electrode active material includes graphite and a Si alloy, and a mass ratio of the graphite and the Si alloy is x, When the coating amount of the material mixture is y (mg / cm ^{2}), 0.43 ≦ x ≦ 9.0 and 8 ≦ y <18 are satisfied.

According to the present invention, in a lithium ion secondary battery in which a Si alloy is applied to the negative electrode, the initial capacity can be increased by increasing the coating amount, and the capacity retention rate can be improved.

It is a schematic cross section showing a lithium ion secondary battery of one embodiment. It is a graph which shows the negative electrode capacity | capacitance with respect to mass ratio of Si alloy and graphite. It is a graph which shows the coating amount with respect to mass ratio of graphite and Si alloy, its capacity retention, and negative electrode capacity.

As a result of intensive investigations, the present inventors have found that when a Si alloy is applied to the negative electrode, it is effective to set the mass ratio of the Si alloy to graphite and the coating amount of the negative electrode active material mixture within appropriate ranges. I found out.

The graphite particles and the Si alloy particles in the negative electrode active material have a mass ratio of 30:70 to 90:10. That is, a value obtained by dividing the mass of graphite by the mass of Si alloy (graphite mass / Si alloy mass) is in a range of 0.43 to 9.0 (hereinafter, this value is referred to as a mass ratio x of graphite and Si alloy).) Further, the coating amount of the negative electrode active material mixture materials in the negative electrode, as well as to make the capacity of the capacity of the positive electrode and the negative electrode is equal, the coating amount y (mg / cm ^{2}) is a 8~18mg / cm ^{2} To do. As a result, it is possible to increase the initial capacity and improve the capacity maintenance rate.

In particular, the relationship between x and y is preferably y ≦ −4.29x $^{-1}$ +17.98 because high rate characteristics are obtained. Furthermore, when the coating amount y of the negative electrode active material mixture is adjusted so that y ≧ 1.11x + 7.5, a higher capacity can be achieved.

(Configuration of lithium ion secondary battery)
Hereinafter, an embodiment of a lithium ion secondary battery will be described with reference to FIG.

The lithium ion secondary battery 20 is an electrode group G in which a positive electrode plate 1 (positive electrode) and a negative electrode plate 2 (negative electrode) are wound through a separator 3, and a steel-made bottomed cylindrical battery made of nickel. A can 4 is provided. The electrode group G is accommodated in the battery can 4.

On the upper side of the electrode group G, a positive electrode current collecting lead portion 7 made of aluminum for collecting a potential from the positive electrode plate 1 is disposed on a substantially extension line of the winding center. The positive electrode current collecting lead portion 7 is ultrasonically bonded to the end portion of the positive electrode current collecting lead piece 5 led out from the positive electrode plate 1. A disk-shaped battery lid 9 serving as a positive electrode external terminal is disposed above the positive electrode current collecting lead portion 7.

The battery lid 9 is composed of a steel disk-shaped terminal plate whose central portion protrudes upward, and an aluminum annular plate having a gas discharge opening formed in the central portion. An annular positive terminal portion 11 is disposed between the protruding portion of the terminal plate and the flat plate. The upper surface and the lower surface of the positive electrode terminal portion 11 are in contact with the lower surface of the terminal plate and the upper surface of the flat plate, respectively. The inner diameter of the positive electrode terminal portion 11 is larger than the inner diameter of the opening formed in the flat plate. On the upper side of the opening of the flat plate, a rupture valve 10 that cleaves when the battery internal pressure rises is disposed so as to close the opening. The peripheral edge portion of the rupture valve 10 is sandwiched between the lower surface of the inner edge portion of the positive electrode terminal portion 11 and the flat plate. The peripheral part of the terminal plate and the peripheral part of the flat plate are fixed). The upper surface of the positive electrode current collector lead portion 7 is joined to the lower surface of the flat plate, that is, the bottom surface of the battery lid 9 (surface on the electrode group G side) by resistance welding.

On the other hand, a negative electrode current collecting lead portion 8 made of nickel for collecting a potential from the negative electrode plate 2 is disposed below the electrode group G. The negative electrode current collecting lead portion 8 is ultrasonically bonded to the end portion of the negative electrode current collecting lead piece 6 led out from the negative electrode plate 2. The negative electrode current collecting lead portion 8 is joined by resistance welding to the inner bottom portion of the battery can 4 that also serves as a negative electrode external terminal.

In addition, a non-aqueous electrolyte is injected into the battery can 4. In this example, the non-aqueous electrolyte is 1 mol / liter of lithium hexafluorophosphate (LiPF $_{6}$) in a mixed organic solvent having a volume ratio of 1: 2 of ethylene carbonate (EC) and ethyl methyl carbonate (EMC). What was dissolved so that it might become the density | concentration of a liter is used. A battery lid 9 is caulked and fixed to the upper part of the battery can 4 via a gasket 12. For this reason, the inside of the lithium ion secondary battery 20 is sealed.

The electrode group G accommodated in the battery can 4 is such that the positive electrode plate 1 and the negative electrode plate 2 are not in contact with each other via a microporous separator 3 made of polyethylene or the like. Has been wounded. The positive electrode current collecting lead piece 5 and the negative electrode current collecting lead piece 6 are respectively disposed on both end surfaces of the electrode group G opposite to each other. The entire outer peripheral surface of the electrode group G is provided with an insulating coating to prevent electrical contact with the battery can 4.

The positive electrode plate 1 is coated with a positive electrode mixture containing a positive electrode active material substantially evenly on both surfaces of the positive electrode current collector. Various lithium transition metal composite oxides conventionally used can be used for the positive electrode active material of the lithium ion secondary battery. For example, a part of the positive electrode active material such as lithium nickelate, lithium cobaltate, and lithium manganate, such as Ni, Co, and Mn, can be substituted with one or more transition metals.

In addition to the positive electrode active material, a conductive material and a binder (binder) are used for the positive electrode active material mixture. Conventionally used materials such as carbon materials such as graphite can be used as the conductive material, and polyvinylidene fluoride (hereinafter abbreviated as PVDF) can be used as the binder.

For example, an aluminum foil having a thickness of 20 μm is used as a positive electrode current collector, a lithium-containing transition metal double oxide $LiNi_{1/3}Co_{1/3}Mn_{1/3}O_2$ is used as a positive electrode active material, and the positive electrode active material, graphite, and PVDF is applied to both surfaces of the positive electrode mixture adjusted to a weight ratio of 90: 5: 5 to produce a positive electrode.

On the other hand, in the negative electrode plate 2, a negative electrode mixture containing a negative electrode active material is applied substantially evenly on both surfaces of the negative electrode current collector. In order to form the coating layer of the composite material, in addition to the Si alloy particles and the natural graphite particles as the negative electrode active material, a negative electrode active material mixture in which a binder and a conductive additive are dispersed in a solvent is prepared. Is applied to the surface of the negative electrode current collector. As the binder, polyamide imide, polyimide, polyamide, or the like, or one containing one or more of these can be used.

As the negative electrode active material, a mixture of natural graphite and Si alloy is used. As graphite, a preferable one can be selected as appropriate, and natural graphite is inexpensive and preferable.

The Si alloy usually has a fine structure in which a plurality of phases are mixed. In other words, the Si alloy is in a state where fine particles of silicon (Si) are dispersed in each particle of other constituent elements, or in a state where other constituent elements are dispersed in each particle of Si. . Other constituent elements only need to include at least one of Al, Ni, Cu, Fe, Ti, and Mn. As a method for producing the Si alloy, there are a method of mechanical synthesis by a mechanical alloy method, and a method of heating and cooling a mixture of Si particles and other constituent elements.

The composition of the Si alloy is desirably 50:50 to 90:10 in terms of the atomic ratio between Si and other constituent elements. In other words, the Si ratio in the Si alloy is desirably 50 to 90% in terms of the atomic ratio. The atomic ratio is more preferably 60:40 to 80:20.

(Battery assembly)
Hereinafter, the manufacturing process of the lithium ion secondary battery 20 will be described.

The produced positive electrode plate 1 and the negative electrode plate 2 are vacuum-dried at 100 ° C. for 24 hours, the separator 3 is sandwiched between the positive electrode plate 1 and the negative electrode plate 2, and these are wound to produce the electrode group 6. . At this time, it is preferable to wind the positive electrode plate 1 and the negative electrode plate 2 so that the positive electrode current collector lead piece 5 and the negative electrode current collector lead piece 6 are positioned in opposite directions.

Next, all of the positive electrode current collector lead pieces 5 are ultrasonically bonded to the positive electrode current collector lead part 7, and all of the negative electrode current collector lead pieces 6 are ultrasonically bonded to the negative electrode current collector lead part 8. Thereafter, an insulating coating is applied to the periphery of the electrode group 6, and the electrode group 6 to which the positive electrode current collecting lead portion 7 and the negative electrode current collecting lead portion 8 are connected is placed with the negative electrode current collecting lead portion 8 facing the bottom side. Insert inside.

An electrode rod is passed through the winding center portion of the electrode group 6, the negative electrode current collector lead portion 8 and the inner bottom portion of the battery can 4 are resistance welded, and then the positive electrode current collector lead portion 7 and the battery lid 9 are joined by resistance welding. To do. Then, after pouring a non-aqueous electrolyte into the battery can 4, the battery lid 9 is caulked and fixed to the battery can 4 via the gasket 12, thereby completing the lithium ion secondary battery 20 having a battery capacity of 1 Ah. Let

Examples will be described below

A copper foil having a thickness of 10 μm was used as the negative electrode current collector, and a negative electrode mixture having a mass ratio of the negative electrode active material, the conductive additive and the binder of 93: 2: 5 was applied to both surfaces to prepare a negative electrode. The negative electrode active material is a mixture of natural graphite and Si alloy. Natural graphite was measured by X-ray diffraction (XRD), and as a result, the interlayer distance d (002) of the carbon hexagonal network layer was 0.336 nm, and the crystallite size was determined by the hexagonal network area layer direction Lc (002). The carbon hexagonal network surface direction La (110) was 120 nm or more and 110 nm or more. The Si alloy represented by the composition formula $Si_{70}Ti_{10}Fe_{10}Al_{10}$ was prepared by mixing Si with another metal and mechanical alloying. Polyamideimide was used as the binder, and acetylene black was used as the conductive aid. The mass ratio of the negative electrode active material, the conductive additive and the binder was 93: 2: 5. Further, N-methylpyrrolidone (NMP) was used as a solvent, and the viscosity was adjusted according to the amount.

After the coating layer formed on the surface of the negative electrode current collector was dried, it was roll pressed with a roll press device so that the density of the negative electrode active material mixture layer was 2.8 g / cm^3. The density of the negative electrode active material mixture layer is the maximum value that can be reached by a normal roll press. Thereafter, it was dried at 350 ° C. in order to cure the polyamideimide.

Various negative electrodes were prepared by changing the mixing ratio of natural graphite and Si alloy and the coating amount of the negative electrode active material mixture layer. In general, as the coating amount increases, the capacity retention rate decreases. On the other hand, when the coating amount is small, the capacity retention rate increases, but the negative electrode capacity decreases. Further, the coating amount can be increased as the ratio of graphite is increased. However, if the proportion of graphite is too large, the coating amount becomes almost constant, which is not preferable. On the other hand, the higher the Si ratio, the lower the coating amount and the lower the electrode density.

Table 1 shows the ratio of graphite and Si alloy constituting the negative electrode materials of Examples 1 to 6 and Comparative Examples 1 to 5, and the coating amount of the negative electrode active material mixture.

図 3

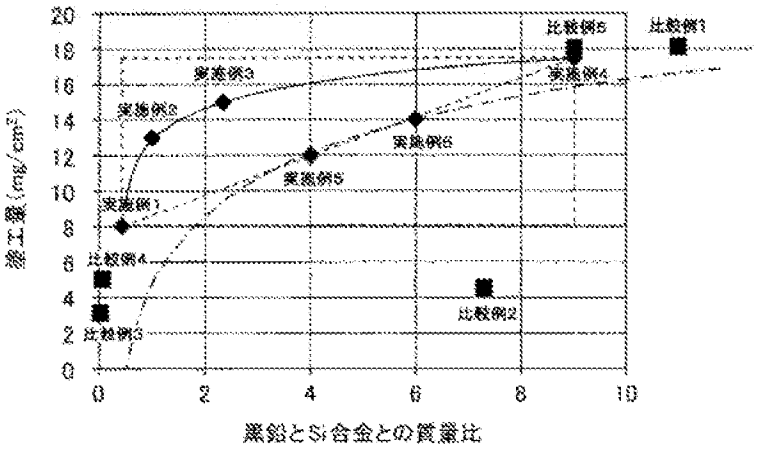
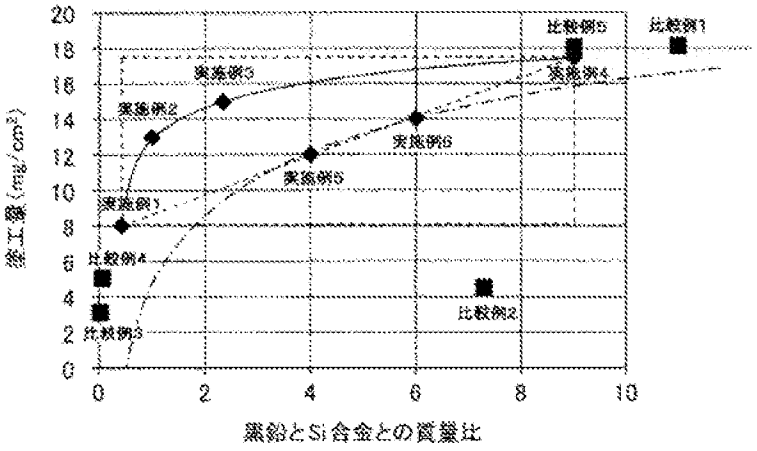


図 3



(Measurement of negative electrode capacity and capacity retention rate)

The negative electrode capacities and rate characteristics of Examples 1 to 6 and Comparative Examples 1 to 5 were measured as follows.

The prepared negative electrode was processed to a size of φ15 mm, and the negative electrode capacity was measured with Li as the counter electrode. The charge / discharge conditions were constant current and constant voltage charge at a voltage of 5 mV and a current of 0.2 C for 6 hours. The discharge conditions were a constant current discharge at a voltage of 1.5 V with a discharge current corresponding to 0.2C. The discharge capacity at this time was defined as the negative electrode capacity (initial capacity).

After measuring the negative electrode capacity, the 1C discharge capacity was measured to obtain rate characteristics. Here, the charging conditions were constant current and constant voltage charging with a current corresponding to 0.2 C and a voltage of 5 mV for 6 hours. The discharge conditions were a constant current discharge at a voltage of 1.5 V with a discharge current corresponding to 1C. The discharge capacity at this time was divided by 0.2 C capacity (negative electrode capacity) and calculated as a capacity retention rate.

Here, 1C is a current value at which charging or discharging of the battery capacity is completed in 1 hour, and 0.2C is a current value at which charging or discharging of the battery capacity is completed in 5 hours. Table 2 shows the measurement results of the negative electrode capacities and capacity retention rates of Examples 1 to 6 and Comparative Examples 1 to 5.

図 3

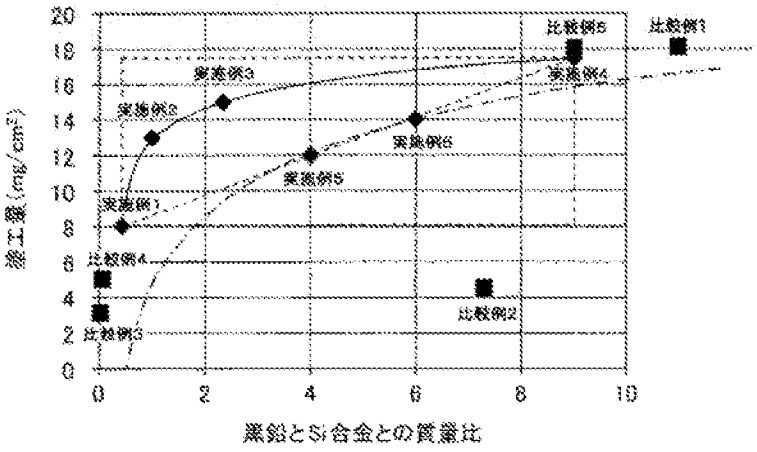
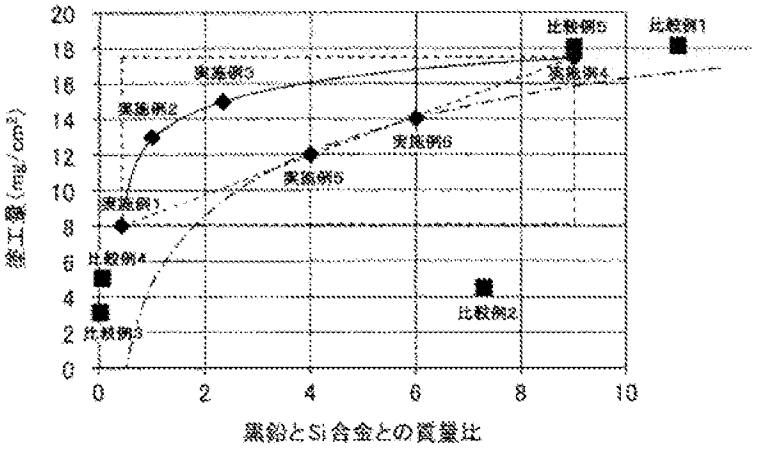


図 3



(Examination of measurement results)

In Examples 1 to 4, the graphite mass / Si alloy mass x was changed, and the coating amount was adjusted so that the capacity retention rate was 70%. In Examples 5 and 6, the capacity retention rate was 80%. The coating amount was adjusted so that in Examples 1 to 6, it was possible to increase the negative electrode capacity while maintaining the capacity retention rate as compared with Comparative Example 1, that is, 12.6 mAh or more.

Comparative Example 1 is a conventional example in which the negative electrode active material is only graphite (no Si alloy is used). The coating amount is adjusted so that the capacity retention rate is 70%, and is an example of 16 mg / cm ^{2} . Similarly, Comparative Example 3 is an example in which the negative electrode active material is only an Si alloy (no graphite is used), and the coating amount is adjusted to 3.3 mg / cm ^{2} so that the capacity retention rate is 70%. Comparative Example 4 is an example in which only the Si alloy is used as the negative electrode active material, and the coating amount is 5 mg / cm ^{2} which is larger than that of Comparative Example 3. Comparative Example 5 is an example in which the value of the graphite / Si alloy mass (x) is equal to that in Example 4, the coating amount is larger than that in Example 4, and 18 mg / cm ^{2} is the same as in Comparative Example 1. Comparative Example 2 is an example in which the value of graphite / Si alloy mass (x) is 7.3, and the coating amount is 4.5 mg / cm ^{2} so as to increase the capacity retention rate.

Hereinafter, the preferred embodiment of the present invention will be clarified by comparing the examples and comparative examples with graphs.

FIG. 2 is a diagram showing the relationship between the mixing ratio and the negative electrode capacity when the capacity retention rate is 70%.

Comparative Example 1 is an example corresponding to a graphite negative electrode (the mass ratio of Si alloy to graphite is 0) that has been put into practical use. When the Si alloy / graphite mass (1 / x) of Examples 1 to 4 is in the range of 0.1 to 2.3, the negative electrode capacity can be improved while maintaining the capacity retention rate of the graphite negative electrode at 70%. Outside this region, maintaining the capacity maintenance rate of the graphite negative electrode is not preferable because the negative electrode capacity decreases. Therefore, the mixing ratio of the negative electrode active material needs to be 30 to 90% by mass for graphite particles, 10 to 70% by mass for Si alloy, and 0.43 to 9.0 for graphite mass / Si alloy mass (x). . In particular, a high negative electrode capacity is preferable when the Si alloy / graphite mass (1 / x) is in the range of 0.5 to 1.7 and the graphite mass / Si alloy mass (x) is in the range of 0.6 to 2.0.

In FIG. 3, the coating amount with respect to the mass ratio of graphite and Si alloy is shown. The horizontal axis represents the mass ratio of graphite and Si alloy, and the vertical axis represents the coating amount. Examples are represented by ◆ and comparative examples are represented by ■.

The experimental data constituting the solid curve in FIG. 3 are Examples 1 to 4 in which the capacity retention rate is 70% and Comparative Example 1, and the experimental data constituting the one-dot chain line curve is the capacity maintenance rate. Example 5 and 6 which is 80%. These curves mean that the capacity

retention ratio decreases as the coating amount increases, and in order to achieve a certain capacity maintenance ratio, it is necessary to reduce the coating amount when the ratio of graphite is low. To do.

Since the capacity retention rate decreases as the coating amount increases, it is desirable that the coating amount be small in order to achieve a high capacity retention rate. In order to avoid the disadvantages due to the increase in coating amount, the coating amount y needs to be less than the coating amount (18 mg / cm^2) of Comparative Example 1. On the other hand, when the coating amount is reduced, the capacity decreases. In order to make the capacity higher than that in the case of Comparative Example 1, at least the coating amount y needs to be 8 mg / cm^2 or more.

In particular, in order to achieve a capacity retention ratio of 70% or more, it is preferable to set the coating amount below the solid curve, where x is the mass ratio of graphite and Si alloy, and y is the coating amount. From the approximate expression of this curve,

$y \leqq -4.29x^{-1} + 17.98$ Formula (1)

It is preferable that

Even when a high capacity retention ratio is achieved, when the ratio of graphite is high, the capacity per weight of the mixture is low, and when the ratio of graphite is low, the coating amount is small, resulting in a negative electrode Capacity decreases. In Examples 1, 5, 6, and 4, the negative electrode capacity is almost the same value when the negative electrode capacity is around 14 mAh. In order to achieve a high capacity, it is preferable that the coating amount be larger than this straight line. From the approximate expression of the hypotenuse, the desired coating amount y for achieving high capacity is represented by the following expression (2).

$y \geqq 1.11x + 7.5$ (2)

Similarly, by setting the area below the hypotenuse formed in the first, fifth, sixth, and fourth embodiments, high capacity can be maintained and high rate characteristics can be achieved. As described above, from the approximate expression of the hypotenuse, the coating amount y desirable for achieving the high rate characteristic is represented by the following expression (3).

$y < 1.11x + 7.5$ Formula (3)

According to the present invention, since the coating amount can be maximized while maintaining rate characteristics, the initial capacity can be improved.

Further, as described above, since the capacity retention rate of the negative electrode using the Si alloy can be increased, the negative electrode capacity retention rate is equal to or higher than the positive electrode capacity retention rate. Since the potential does not increase greatly (that is, there is no overdischarge) and the potential of the negative electrode does not exceed 3.0 V, which is the potential of elution of copper, it is possible to suppress elution of Cu constituting the negative electrode current collector. It can. Thereby, the safety | security of a lithium ion secondary battery can be improved.

1. positive electrode plate, 2. negative electrode plate, 4. battery can, 9. battery lid, 20. cylindrical lithium ion secondary battery.

Patent Citations (14)

Publication number	Priority date	Publication date	Assignee	Title
JP2009032998A *	2007-07-24	2009-02-12	Toyota Motor Corp	Electrode body for battery and its manufacturing method
JP2013546138A *	2010-11-09	2013-12-26	エリーエムイノベイティブパワーズ	High capacity alloy anode and lithium ion electrochemical cell including the same
WO2014051067A1 *	2012-09-28	2014-04-03	日本ゼオン株式会社	Lithium ion secondary battery
WO2014080903A1 *	2012-11-22	2014-05-30	日産自動車株式会社	Negative electrode for electric device and electric device using same
WO2014080897A1 *	2012-11-22	2014-05-30	日産自動車株式会社	Negative electrode for electrical device and electrical device provided with same
JP2015099775A *	2013-11-19	2015-05-28	三星エスディアイ株式会社Samsung SDI Co., Ltd.	Negative electrode active material, and negative electrode and lithium battery including the same, and method of manufacturing the negative electrode active material
WO2015111188A1 *	2014-01-24	2015-07-30	日産自動車株式会社	Electrical device
WO2015111189A1 *	2014-01-24	2015-07-30	日産自動車株式会社	Electrical device
Family To Family Citations				
CA2310374C *	1998-09-18	2007-05-04	Canon Kabushiki Kaisha	Electrode material for anode of rechargeable lithium battery, electrode structural body using said electrode material, rechargeable lithium battery using said electrode structurabody, process for producing said electrode structural body, and process for producing said rechargeable lithium battery
WO2007064803A1 *	2005-12-01	2007-06-07	3M Innovative Properties Company	Electrode compositions based on an amorphous alloy having a high silicon content
CN101210011B *	2006-12-29	2010-12-08	比亚迪股份有限公司	Silicon-containing composite material and its preparation method and application
JP2009277232A	2007-04-05	2009-11-26	Hitachi Chem Co Ltd	Negative electrode material for lithium secondary battery, its manufacturing method, negative electrode for lithium secondary battery using the negative electrode material, and lithium secondary battery
KR101078223B1 *	2009-11-18	2011-10-12	주식회사 엘지화학	anode mixture for lithium secondary battery and Lithium secondary battery using the same
JP6268729B2 *	2012-03-23	2018-01-31	三菱ケミカル株式会社	Negative electrode material for non-aqueous secondary battery, negative

	electrode for non-aqueous secondary battery, and non-aqueous secondary battery

* Cited by examiner, † Cited by third party

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Publication number	Priority date	Publication date	Assignee	Title
JP2016166839A *	2014-11-25	2016-09-30	イルジン エレクトリック カンパニー リミテッド	Negative electrode active material for secondary battery, and secondary battery arranged by use thereof
WO2017204213A1 *	2016-05-26	2017-11-30	日本碍子株式会社	Lithium ion secondary battery
JP2017536669A *	2015-01-07	2017-12-07	イルジン エレクトリック カンパニー リミテッド	Negative electrode active material for secondary battery and secondary battery using the same
JP2018502419A *	2014-11-25	2018-01-25	イルジン エレクトリック カンパニー リミテッド	Negative electrode active material for secondary battery and secondary battery using the same
Family To Family Citations				
KR102323022B1 *	2015-02-26	2021-11-10	삼성전기 주식회사	Negative electrode plate for secondary battery and secondary battery comprising the same
US20170271678A1 *	2016-03-15	2017-09-21	GM Global Technology Operations LLC	Primer Surface Coating For High-Performance Silicon-Based Electrodes
JP6807701B2 *	2017-04-18	2019-10-30	トヨタ自動車株式会社	Negative electrode mixture, negative electrode including the negative electrode mixture, and all-solid-state lithium ion secondary battery including the negative electrode
WO2021182943A1 *	2020-03-10	2021-09-16	Bioactivos Y Nutracéuticos De México S.A. De C.V.	Electrolytic battery

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title
JP6524653B2	2019-06-05	Positive electrode active material for non-aqueous electrolyte secondary battery and method for producing the same
JP2016018654A	2016-02-01	Lithium ion secondary battery
JP6524610B2	2019-06-05	Positive electrode active material for non-aqueous secondary battery and method for producing the same
WO2016002188A1	2016-01-07	Positive electrode active material for non-aqueous electrolyte secondary cell and non-aqueous electrolyte secondary cell using same
JP2016195172A	2016-11-03	lithium ion secondary battery
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JP2012054186A	2012-03-15	Electrochemical element electrode and lithium ion secondary battery
JP2015028855A	2015-02-12	Powder for negative electrode material of lithium ion secondary battery, and conductive assistant used therefor
JP2018006190A	2018-01-11	Negative electrode active material, negative electrode, lithium ion secondary battery, use method of lithium ion secondary battery, negative electrode active material manufacturing method, and lithium ion secondary battery manufacturing method
JP2008248309A	2008-10-09	Positive electrode for lithium ion secondary battery, and lithium ion secondary battery
JP6279567B2	2018-09-04	Nonaqueous electrolyte secondary battery
CN109935801B	2022-10-28	Anode active material for lithium secondary battery
JPWO2013014827A1	2015-02-23	Nonaqueous electrolyte secondary battery
JP6842506B2	2016-01-13	Positive electrode composition for non-aqueous electrolyte secondary battery and method for producing positive electrode slurry for non-aqueous electrolyte secondary battery
JP4770426B2	2011-09-14	Winding type power storage device
WO2014199782A1	2014-12-18	Anode active material for electrical device, and electrical device using same
JP2019106379A	2019-06-27	Positive electrode active material for nonaqueous electrolyte secondary battery, and method for manufacturing the same
US20200335782A1	2020-10-22	A cathode active material for lithium secondary battery and a lithium secondary battery comprising thereof

JP6554725B2	2019-08-07	Non-aqueous electrolyte battery
JP2006280784A	2006-09-28	Nonaqueous electrolyte secondary battery
JP2012204291A	2012-10-22	Lithium ion secondary battery, and positive electrode material therefor
JP2015216001A	2015-12-03	Electricity storage element
JP2019175650A	2019-10-10	Lithium ion secondary battery
JP5165875B2	2013-03-21	Non-aqueous electrolyte battery
TW201349633A	2013-12-01	Lithium ion cell, cathode thereof, cathode material thereof and manufacturing method of the same

Priority And Related Applications

Priority Applications (3)

Application	Priority date	Filing date	Title
JP2014140246A	2014-07-08	2014-07-08	Lithium ion secondary battery
US14/740,342	2014-07-08	2015-06-16	Lithium ion secondary battery
CN201510397243.8A	2014-07-08	2015-07-08	Lithium rechargeable battery

Applications Claiming Priority (1)

Application	Filing date	Title
JP2014140246A	2014-07-08	Lithium ion secondary battery

Legal Events

Date	Code	Title	Description
2017-01-23	A621	Written request for application examination	**Free format text**: JAPANESE INTERMEDIATE CODE: A621 **Effective date**: 20170123
2017-11-02	A977	Report on retrieval	**Free format text**: JAPANESE INTERMEDIATE CODE: A971007 **Effective date**: 20171031
2017-12-05	A131	Notification of reasons for refusal	**Free format text**: JAPANESE INTERMEDIATE CODE: A131 **Effective date**: 20171205
2018-01-04	A521	Request for written amendment filed	**Free format text**: JAPANESE INTERMEDIATE CODE: A523 **Effective date**: 20180104
2018-06-12	A02	Decision of refusal	**Free format text**: JAPANESE INTERMEDIATE CODE: A02 **Effective date**: 20180612

Concepts

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Name	Image	Sections	Count	Query match
Lithium ion		title,claims,abstract,description	27	0.000
lithium ion		title,claims,abstract,description	27	0.000
coating agent		claims,abstract,description	50	0.000
coating method		claims,abstract,description	50	0.000
carbon		claims,abstract,description	43	0.000

Si alloy	claims,abstract,description	46	0.000
graphite	claims,abstract,description	42	0.000
graphite	claims,abstract,description	42	0.000
negative electrode material	claims,abstract,description	33	0.000
mixture	claims,abstract,description	26	0.000
binding agent	claims,abstract,description	11	0.000
positive electrode material	claims,abstract,description	10	0.000
electrolyte	claims,abstract,description	3	0.000
maintenance of location	claims,description	29	0.000
lithium	claims,description	7	0.000
lithium	claims,description	6	0.000
aluminium	claims,description	5	0.000
conductive additive	claims,description	5	0.000
nickel	claims,description	5	0.000
copper	claims,description	3	0.000
manganese	claims,description	3	0.000
iron	claims,description	2	0.000
titanium	claims,description	2	0.000
ions	claims	1	0.000
material	abstract,description	3	0.000

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H01M 2/26	***(2006.01)***	H01M	2/26	Z	5H024
H01M 6/16	***(2006.01)***	H01M	6/16	D	5H029

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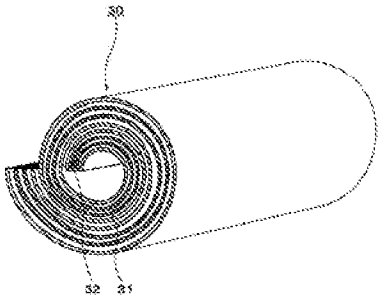
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最終頁に続く

(54)【発明の名称】電池装置

(57)【要約】
【課題】　電池内のインダクタンス成分を低減することにより、急激な電流断時の過電圧の発生を防止する電池構造を提供する。
【解決手段】　電極巻回体の作製時に、正電極箔と負電極箔をセパレータを解して重ねた後、各電極箔の長手方向中央部分より巻回し、正極、負極の各電極箔端部分が巻き終わりにくるようにして巻回電極体を作製する。また、従来どおり電極箔の端部分より螺旋状に巻回することにより電極巻回体を作製し、正電極箔および負電極箔に正極リードおよび負極リードを設置する際、できるだけ近い位置になるよう配置する。
【選択図】　図７



【特許請求の範囲】
【請求項１】
シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とを、セパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、
上記円筒型巻回電極体は、上記正極および上記負極の長手方向中央部分より巻回し、正極、負極の各電極箔端部分が巻き終わりにくるようにして作製することを特徴とする電池装置。
【請求項２】
シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とを、セパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、
上記正極集電体に接続した正極リードと上記負極集電体に接続した負極リードの距離が、極小になるよう配置することを特徴とする電池装置。
【請求項３】
請求項２に記載の電池装置において、
上記正極集電体および上記負極集電体のそれぞれのほぼ同一位置から上記正極リードおよび負極リードを導出することを特徴とする電池装置。
【請求項４】
シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とを、セパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、
上記正極集電体から正極リードを導出するとともに、上記負極集電体から負極リードを導出し、上記正極リードおよび上記負極リードの少なくとも一方を複数とすることを特徴とする電池装置。
【発明の詳細な説明】
【技術分野】
【０００１】
この発明は、一次電池、二次電池の電池装置に関する。
【背景技術】
【０００２】
近年、ノート型パソコン、携帯電話機等、携帯用電子機器の発達にともない、電池の需要が急速に伸びており、また電池の用途も拡大されている。そのような中、電池設計は小型化、かつ高容量化へ向かっており、それと伴に電池の使用時における、より高い安全性が求められている。
【０００３】
現在、小型化・高容量化という要求に応える電池として、リチウムおよびリチウムイオンを構成材料とする一次および二次電池（以下、リチウムイオン電池と適宜称する）が注目されている。
【０００４】
リチウムイオン電池は、負極にカーボンあるいはグラファイトを使用し、各種セラミック正極剤を組み合わせたものであり、電解質として非水溶媒を用いて作製される。
【０００５】
また、リチウムイオン二次電池は、リチウムイオンのドープ／脱ドープを利用した非水電解液電池である。リチウムイオン二次電池は、主として、リチウムイオンをドープ／脱ドープ可能な正極および負極と、非水電解液（リチウム塩を非プロトン性有機溶媒に溶解させてなる液）と、正極と負極との間に介在されたセパレータとから構成される。電極は

、集電体と、この集電体上に形成された活物質層とからなる。この活物質層は、活物質と、導電剤と、これらの材料を集電体に結着させる結着剤とから構成される。

【０００６】

リチウムイオン電池は、小型・軽量であり、エネルギー密度が高く長期保存にも耐えうるという利点がある。これを生かし、現在では円筒形や角型、コイン型等が製造されており、様々な電子機器に用いられている。

【０００７】

従来から、電池の過充電や外部短絡等に対する安全対策として、保護回路が設けられている。電池の保護回路の一例としては、熱感抵抗素子（Positive Temperature Coefficient：以下、ＰＴＣ素子と適宜称する）が挙げられる。ＰＴＣ素子は通常は極めて小さな抵抗を有する素子であるが、過剰な電流が流れた場合、あるいは高温になった場合に抵抗値が増大し、電池に流れる電流を制限する特性を有する。電池にＰＴＣ素子を備えることによって、例えば外部短絡が生じたときでも、一定温度に達するとＰＴＣ素子が働き、電池の電流を停止させるため、電池に過電流が流れることを防ぐことができる。

【０００８】

下記の特許文献１では、電池に流れる電流値が増大した場合であっても、電池が劣化・損傷する前に、電流値を減少させることができる保護回路が提案されている。

【０００９】

【特許文献１】特開２００３－９２８２６号公報

【発明の開示】

【発明が解決しようとする課題】

【００１０】

従来のリチウムイオン電池の内部構造は、帯状電極を重ね、螺旋状に巻いた巻回電極体である。このため、図１に示すように、概念的な等価回路はＣ（電池容量）、Ｒ（内部抵抗成分）、Ｌ（内部のインダクタンス成分）の直列回路であると考えられ、電池の両端に対応する。このため、電極から引き出されるリードの位置によってはインダクタンス成分を持つ。電池から大電流を断続的に取り出すような使用方法をした場合、インダクタンス成分によりｄｉ／ｄｔによる逆起電力が生じるため、電池の出力端子間に大きな電圧が発生する。特に電流を低減させた時に電池の出力端子が開放される構造を持った、例えば電動工具や玩具等の電気回路への使用において、過電圧の発生が著しい。

【００１１】

例えば、図２に、電気回路に断続的に電流を流した場合に電池端子に生じる電圧の計算例を示す。図２において、実線で示される波形は電池端子に生じる電圧を示し、点線で示される波形は負荷回路に加わる電圧を示す。

【００１２】

電流を流し始めると、電池端子に徐々に電圧が加わり、その後一定の電圧となる。ところが、電流を０にした場合、インダクタンス成分に蓄えられたエネルギーによって電池端子に急激に大電圧が生じてしまう。

【００１３】

また、特に高周波数域において電池のインダクタンス成分によりインピーダンスが増加し、負荷電流が急激に変化した場合は電池の電圧が不安定になる。例えば、図３は、円筒型のリチウムイオン二次電池のインピーダンス特性を示すグラフである。実線で示す波形は電池のインピーダンス特性であり、点線で示す波形は測定時のバックグラウンドである。実際のインピーダンスは実線で示す値と点線で示す値の差で求めることができる。高周波数域になる程、インピーダンスが増加している。

【００１４】

図４は、円筒型のリチウムイオン二次電池の電圧特性を示すグラフであり、負荷電流を１０Ａから０Ａへ切り替えた場合の電圧特性を一例として示す。負荷電流を１０Ａから０Ａへ急激に切り替えた時、４Ｖであった電池の電圧は８Ｖにまで上昇する。過電圧の程度によっては、電池の保護用のＦＥＴ（Field Effect Transistor）、使用機器側の制御回

路等の耐電圧性を超えてしまうため、ＦＥＴ、制御回路等が破壊される恐れがあった。このようなことから、過電圧が発生することは危険であり、過電圧防止の要求が高まっている。

【００１５】

従来は機器へ接続するセル数も少なく、負荷電流の変動が少ないような使用方法をとっていたため、上述したような過電圧の問題は比較的少なかった。しかし近年、電池の用途が拡大し、接続するセル数も多くなるにしたがって、過電圧の対策必要性が増している。使用機器側の制御回路の耐電圧性を向上させることで過電圧への対策をすることも可能ではあるが、耐電圧値の著しく高い制御回路が必要となり、コストが高くなるため、機器側ではなく電池側で過電圧への対策をすることが必要である。

【００１６】

したがって、この発明の目的は、電池内のインダクタンス成分を低減することにより、急激な電流断時の過電圧の発生を防止する電池装置を提供することにある。

【課題を解決するための手段】

【００１７】

上記課題を解決するために、この発明の第１の態様は、シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とをセパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、円筒型巻回電極体は、正極および負極の長手方向中央部分より巻回し、正極、負極の各電極箔端部分が巻き終わりにくるようにして作製することを特徴とする電池装置である。

【００１８】

また、この発明の第２の態様は、シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とをセパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、正極集電体に接続した正極リードと負極集電体に接続した負極リードの距離が、極小になるよう配置することを特徴とする電池装置である。

【００１９】

また、この発明の第３の態様は、シート状の金属箔よりなる正極集電体に正極活物質を塗布することにより作製した正極と、シート状の金属箔よりなる負極集電体に負極活物質を塗布することにより作製した負極とをセパレータを介して重ね、これを巻回することにより作製した円筒型巻回電極体を外装体に収納してなる電池装置において、正極集電体から正極リードを導出するとともに、負極集電体から負極リードを導出し、正極リードおよび負極リードの少なくとも一方を複数とすることを特徴とする電池装置である。

【発明の効果】

【００２０】

この発明によれば、特に、電動工具、電動玩具等の断続的に大電流を流すアプリケーションにおいて、急激な電流断による過電圧の発生を防止することが可能である。また、二次電池における充電制御等の負荷回路設置時における過電圧による誤動作、破壊等を防止することが可能となる。

【発明を実施するための最良の形態】

【００２１】

以下、この発明の一実施形態について図面を参照しながら説明する。

【００２２】

図５は、この発明の一実施形態によるリチウムイオン電池の構成の一例を示す断面図である。このリチウムイオン電池は、いわゆる円筒型といわれるものであり、ほぼ中空円柱状の電池缶１の内部に、帯状の正極１１と負極１２とがセパレータ１３を介して巻回された巻回電極体１０を有している。電池缶１は、例えば、ニッケルめっきが施された鉄（Ｆ

ｅ）により構成されており、一端部が閉鎖され、他端部が開放されている。電池缶１の内部には、巻回電極体１０を挟むように巻回周面に対して垂直に一対の絶縁板２，３がそれぞれ配置されている。

【００２３】

電池缶１の開放部には、電池蓋４と、この電池蓋４の内側に設けられた安全弁機構５およびＰＴＣ素子６とが、ガスケット７を介してかしめられることにより取り付けられており、電池缶１の内部は密閉されている。電池蓋４は、例えば、電池缶１と同様の材料により構成されている。安全弁機構５は、熱感抵抗素子６を介して電池蓋４と電気的に接続されており、内部短絡あるいは外部からの加熱などにより電池の内圧が一定以上となった場合にディスク板５ａが反転して電池蓋４と巻回電極体１０との電気的接続を切断するようになっている。熱感抵抗素子６は、温度が上昇すると抵抗値の増大により電流を制限し、大電流による異常な発生を防止するものであり、例えば、チタン酸バリウム系半導体セラミックスにより構成されている、ガスケット７は、例えば絶縁材料により構成されており、表面にはアスファルトが塗布されている。

【００２４】

巻回電極体１０は、例えばセンターピン１４を中心にして巻回されている。巻回電極体１０の正極１１には、アルミニウム（Ａｌ）などよりなる正極リード１５が接続されている。正極リード１５は、安全弁機構５に溶接されることにより電池蓋４と電気的に接続されている。負極リード１６は、電池缶１に溶接され電気的に接続されている。

【００２５】

＜正極１１＞

正極１１は、例えば、帯状の形状を有する正極集電体と、この正極集電体の片面または両面に形成された正極合剤層とからなる。正極集電体は、例えば、アルミニウム箔、ニッケル箔あるいはステンレス箔などの金属箔により構成されている。

【００２６】

正極合剤層は、正極活物質と結着剤とから構成される。正極合剤層の具体例としては、$LiCoO_2$、$LiNiO_2$が挙げられる。また、この正極合剤層に含有される結着剤としては、通常この種の電池に使用されている公知の結着剤を用いることができる。この結着剤として、例えばポリフッ化ビニル、ポリフッ化ビニリデン、ポリテトラフルオロエチレン等のフッ素系樹脂を挙げることができる。

【００２７】

また、正極合剤層には、必要に応じて導電材料、各種機能を発現する添加剤等を含有するようにしてもよい。この導電材料は、上記活物質に適量混合して導電性を付与できるものであれば特に制限はされず、例えば、グラファイト、カーボンブラック等の炭素粉末が挙げられる。

【００２８】

正極活物質層の形成方法としては、例えば、粉体状の正極活物質を結着剤（バインダー）とともに溶剤と混合し、必要に応じてボールミル、サンドミル、二軸混練機等により分散塗料化した後、正極集電体上に塗布して乾燥する方法が好適に用いられる。この場合、用いられる溶剤の種類は、正極集電体に対して不活性であり、且つバインダーを溶解しうる限り、特に制限されず、例えばＮ－メチル－２－ピロリドン等の一般に使用される無機、有機溶剤の何れも使用できる。塗布装置は、特に限定されるものではないが、例えばスライドコーティングやエクストルージョン型のダイコーティング、リバースロール、グラビア、ナイフコーター、キスコーター、マイクログラビア、ロッドコーター、ブレードコーター等を挙げることができる。乾燥方法は特に制限されず、例えば放置乾燥、送風乾燥機、温風乾燥機、赤外線加熱機、遠赤外線加熱機等を挙げることができる。

【００２９】

＜負極１２＞

負極１２は、例えば、帯状の形状を有する負極集電体と、この負極集電体の片面または両面に形成された負極合剤層とからなる。負極集電体は、例えば、銅箔、ニッケル箔ある

いはステンレス箔などの金属箔により構成されている。

【００３０】

負極合剤層は、負極活物質と結着剤とからなる。負極合剤層の具体例としては、例えば、熱分解炭素類、コークス類、グラファイト類、ガラス状炭素類、有機高分子化合物焼成体、炭素繊維、活性炭等の炭素質材料を挙げることができる。

【００３１】

この正極合剤層に含有される結着剤としては、通常この種の電池に使用されている公知の結着剤を用いることができる。この結着剤として、例えばポリフッ化ビニル、ポリフッ化ビニリデン、ポリテトラフルオロエチレン等のフッ素系樹脂を挙げることができる。

【００３２】

負極活物質層の形成方法としては、上述の正極活物質層と同様の方法を用いることができる。

【００３３】

＜セパレータ１３＞

セパレータ１３は、正極合剤層１１ｂと負極合剤層１２ｂとを離間するものである。このセパレータ１３は、例えば、ポリプロピレンあるいはポリエチレンなどのポリオレフィン系の材料からなる多孔質膜、またはセラミック製の材料の不織物などの無機材料よりなる多孔質膜であり、これら２種以上の多孔質膜を積層した構造としてもよい。

【００３４】

このような構造のリチウムイオン電池において、過電圧を防止するために以下のような構成を用いる。

【００３５】

この発明による第１の実施形態である過電圧防止策として、過電圧の発生を防止することが可能である電極の巻回構造について説明する。

【００３６】

図６に、既存のリチウムイオン電池における電極の巻回構造を模式的に示す。また、図７に、この発明を適用して作製した電池における電極の巻回構造を模式的に示す。なお、正電極箔、負電極箔の巻回構造を分かりやすく示すために、図６、図７ともに正電極箔、負電極箔間に配置されるセパレータ等の図示は省略する。

【００３７】

図６に示す既存のリチウムイオン電池における電極の巻回構造は、参照符号２１で示される正電極箔と、参照符号２２で示される負電極箔を重ね、電極箔の端部分より螺旋状に巻回することにより作製されている。

【００３８】

この発明を適用して作製した巻回電極体の一例を図７に示す。この巻回電極体は、参照符号３１で示される正電極箔と参照符号３２で示される負電極箔を、セパレータを介して重ねた後、各電極箔の長手方向中央部分より巻回し、正極、負極の各電極箔端部分が巻き終わりにくるようにして作製する。

【００３９】

この構成をとることにより、従来インダクタンス成分を発生していた部分について、電極箔内に生じる電流の方向を逆方向とすることができる。これにより、インダクタンス成分により発生する磁束の向きが逆となり、実質的にインダクタンス成分を減少させることができる。

【００４０】

図８は、図７に示す巻回電極体を用いて作製したリチウムイオン電池において、負荷電流を１０Ａから０Ａへ切り替えた場合の電圧特性を示す。負荷電流を１０Ａから０Ａへ急激に切り替えた時、従来のリチウムイオン電池では４Ｖであった電池の電圧は８Ｖにまで上昇するが、この発明を用いて作製したリチウムイオン電池の場合は５．８Ｖ程度の電圧上昇で抑えることが可能である。

【００４１】

次に、この発明による第２の実施形態である過電圧防止策として、電極リードの引き出し位置を変更することにより過電圧の発生を防止する方法について説明する。

【００４２】

図９に、既存のリチウムイオン電池の電極箔を展開した様子を模式的に示す。参照符号４１で示すのは正電極箔であり、参照符号４２で示すのは負電極箔である。この正電極箔４１および負電極箔４２の各電極箔に、電極箔と電池外装体を接続するための正極リード４１ａおよび負極リード４２ａを設置する。既存のリチウムイオン電池では、各電極箔の端部に正極リード４１ａ、負極リード４２ａを設置することにより巻回電極体を作製している。

【００４３】

図１０に、正極リード４１ａおよび負極リード４２ａを設置した場合の電流の流れを模式的に示す。なお、正電極箔４１および負電極箔４２間に配置されるセパレータの図示は省略し、また正電極箔４１および負電極箔４２の周囲には電解液が満たされているものとする。

【００４４】

この場合，負極リード４２ａから導入された電流は負電極箔４２から正電極箔４１へ、電解液を通して流れ、正極リード４１ａを伝わって外部の電気回路に流れる。

【００４５】

図１１に、この発明を適用して作製したリチウムイオン電池の電極箔を展開した様子を示す。参照符号５１で示すのは正電極箔であり、参照符号５２で示すのは負電極箔である。図９に示す既存のリチウムイオン電池と異なり、正電極箔５１および負電極箔５２から接続される正極リード５１ａおよび負極リード５２ａの引き出し位置の距離をできるだけ小さくするように構成されている。

【００４６】

この場合の電流の流れを、図１２に模式的に示す。なお、正電極箔５１および負電極箔５２２間に配置されるセパレータは省略し、また正電極箔５１および負電極箔５２の周囲には電解液が満たされているものとする。

【００４７】

この発明を適用した場合、負極リード５２ａから正極リード５１ａまで電流が流れるためには、大まかに経路Ａ、経路Ｂ、経路Ｃの３経路に分けることができる。この場合、経路ＢおよびＣは、負電極箔５２側を流れる電流と正電極箔５１側を流れる電流が逆方向となり、インダクタンス成分が抑制される。したがって、経路Ａにおける電流によるインダクタンス成分のみが発生する。

【００４８】

したがって、正電極箔５１および負電極箔５２から接続される正極リード５１ａおよび負極リード５２ａの引き出し位置の距離を極小にすることにより、インダクタンス成分を抑えることが可能である。

【００４９】

また、第３の実施形態として，図１３に示すように、正電極箔５１および負電極箔５２から引き出す正極リード５１ａおよび負極リード５２ａを複数本設置することにより，インダクタンス成分を抑制するような構成も可能である。

【００５０】

以上、この発明の一実施形態について具体的に説明したが、この発明は、上述の一実施形態に限定されるものではなく、この発明の技術的思想に基づく各種の変形が可能である。

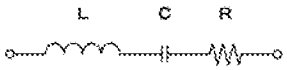
【００５１】

例えば、第３の実施例において、一方の電極リードを複数本とし、他方の電極リードを１本とするだけでなく、正極リード、負極リードの両方が複数本導出されるような構成を用いてもよい。

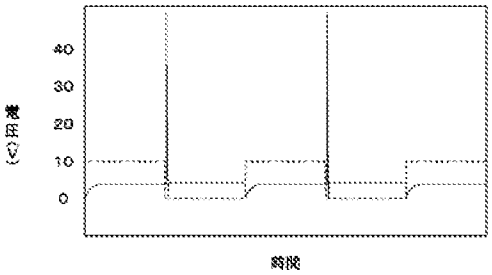
【図面の簡単な説明】

【００５２】
【図１】リチウムイオン電池内の概念的な等価回路の一例を示す略線図である。
【図２】電気回路に断続的に電流を流した場合に電池端子に生じる電圧の計算例を示す略線図である。
【図３】円筒型のリチウムイオン二次電池のインピーダンス特性を示す略線図である
【図４】負荷電流を１０Ａから０Ａへ切り替えた場合の電圧特性を示す略線図である。
【図５】この発明を適用することが可能であるリチウムイオン電池の構成の一例を示す断面図である。
【図６】既存のリチウムイオン電池における電極の巻回構造を示す模式図である。
【図７】この発明の第１の実施形態による電池における電極の巻回構造を示す模式図である。
【図８】図７に示す巻回電極体を用いて作製したリチウムイオン電池において、負荷電流を１０Ａから０Ａへ切り替えた場合の電圧特性を示す略線図である。
【図９】既存のリチウムイオン電池の電極箔を展開した様子を示す略線図である。
【図１０】既存のリチウムイオン電池の電流の流れを示す模式図である。
【図１１】この発明の第２の実施形態による電池の電極箔を展開した様子を示す略線図である。
【図１２】この発明を適用して作製したリチウムイオン電池の電流の流れを示す模式図である。
【図１３】この発明の第３の実施形態による電池における、正極リードを複数設置した場合の電極箔を展開した様子を示す略線図である。
【図１４】正極リードを２本設置して作製したリチウムイオン電池の電流の流れを示す模式図である。
【符号の説明】
【００５３】
２１・・・正電極箔
２２・・・負電極箔
３１・・・正電極箔
３２・・・負電極箔
４１・・・正電極箔
４１ａ・・・正極リード
４２・・・負電極箔
４２ａ・・・負極リード
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５２ａ・・・負極リード

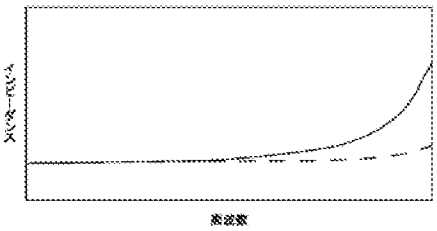
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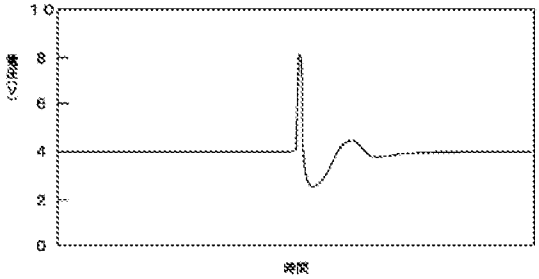
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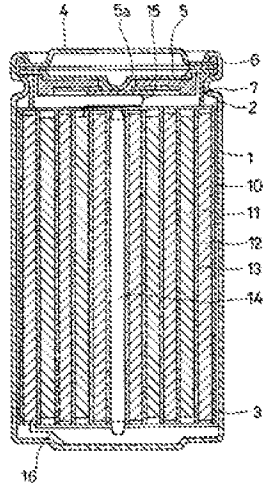
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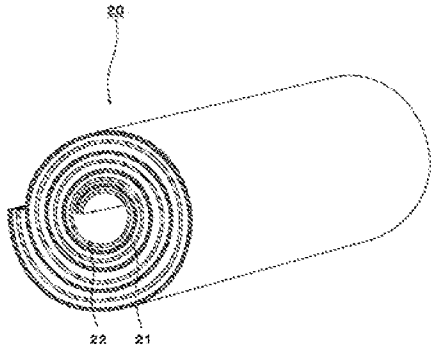
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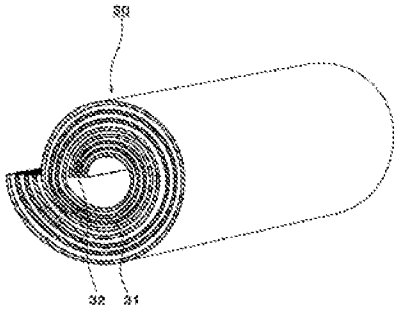
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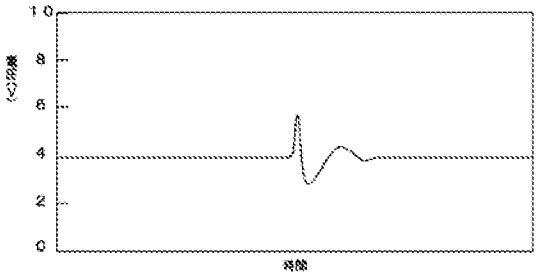
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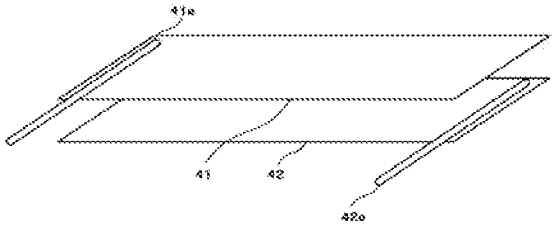
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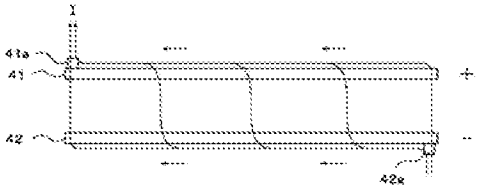
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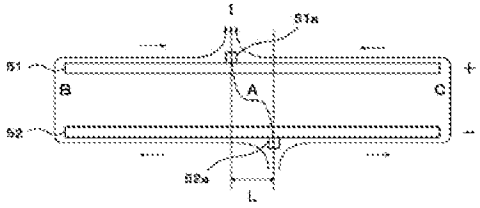
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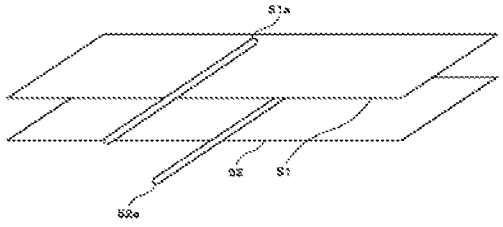
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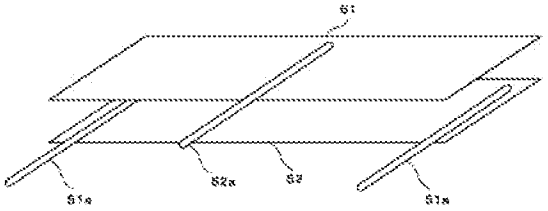
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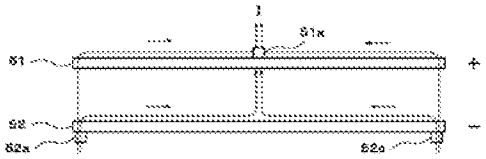
【図１１】



【図１３】



【図１４】



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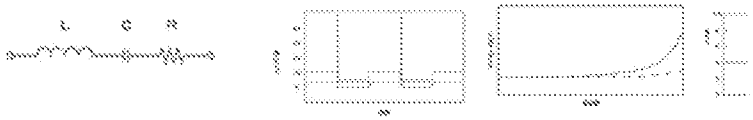
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Battery device

Abstract

<P>PROBLEM TO BE SOLVED: To provide battery structure preventing the generation of overvoltage in sudden current shut off by decreasing inductance components in a battery. <P>SOLUTION: A wound electrode body is prepared by piling a positive electrode foil and a negative electrode foil through a separator, winding them from the central part in the length direction of each electrode foil, and positioning the electrode foil end parts of a positive electrode and a negative electrode in the winding end. Alternatively, the electrode winding body is prepared by spirally winding from the the end part of the electrode foil as usual, and when a positive electrode lead and a negative electrode lead are installed in the positive electrode foil and the negative electrode foil, the leads are arranged in the positions as near as possible. <P>COPYRIGHT: (C)2006,JPO&NCIPI

Images (14)



Classifications

- H02J50/10 Energy storage using batteries

View 1 more classifications

JP2006032052A

Japan

Prioritized PTE Filed Prior Art Similar

Other languages: Japanese

Inventor: Keiji Tsuchiya, 啓司 土屋

Current Assignee : Sony Corp

Worldwide applications

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2004-07-14 Application filed by Sony Corp

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2006-02-02 Publication of JP2006032052A

Status Pending

Info: Cited by (2), Legal events, Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Claims (4)

Hide Dependent

translated from Japanese

A positive electrode prepared by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil, and a negative electrode made by applying a negative electrode active material to a negative electrode current collector made of a sheet-like metal foil in a battery device in which a cylindrical wound electrode body produced by stacking and winding this through a separator is housed in an exterior body.

The cylindrical wound electrode body is manufactured by winding the positive electrode and the negative electrode from a longitudinal central portion so that the electrode foil end portions of the positive electrode and the negative electrode come to the end of winding. A positive electrode prepared by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil, and a negative electrode made by applying a negative electrode active material to a negative electrode current collector made of a sheet-like metal foil in a battery device in which a cylindrical wound electrode body produced by stacking and winding this through a separator is housed in an exterior body.

A battery device, wherein a distance between a positive electrode lead connected to the positive electrode current collector and a negative electrode lead connected to the negative electrode current collector is minimized. The battery device according to claim 2,

A battery device, wherein the positive electrode lead and the negative electrode lead are led out from substantially the same position of each of the positive electrode current collector and the negative electrode current collector. A positive electrode prepared by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil, and a negative electrode made by applying a negative electrode active material to a negative electrode current collector made of a sheet-like metal foil in a battery device in which a cylindrical wound electrode body produced by stacking and winding this through a separator is housed in an exterior body,

A battery device, wherein a positive electrode lead is led out from the positive electrode current collector, a negative electrode lead is led out from the negative electrode current collector, and at least one of the positive electrode lead and the negative electrode lead is plural.

Description

translated from Japanese

The present invention relates to a battery device for a primary battery and a secondary battery.

In recent years, with the development of portable electronic devices such as notebook personal computers and mobile phones, the demand for batteries has been rapidly increasing, and the use of batteries has been expanded. Under such circumstances, battery design is moving toward smaller size and higher capacity, and at the same time, higher safety is required when the battery is used.

Currently, primary and secondary batteries (hereinafter, appropriately referred to as lithium ion batteries) using lithium and lithium ions as a constituent material are attracting attention as batteries that meet the demand for miniaturization and high capacity.

A lithium ion battery uses carbon or graphite as a negative electrode and combines various ceramic positive electrode agents, and is produced using a non-aqueous solvent as an electrolyte.

The lithium ion secondary battery is a non-aqueous electrolyte battery using lithium ion doping / dedoping. A lithium ion secondary battery mainly includes a positive electrode and a negative electrode that can be doped / undoped with lithium ions, a non-aqueous electrolyte (a solution obtained by dissolving a lithium salt in an aprotic organic solvent), a positive electrode, and a negative electrode. And a separator interposed therebetween. The electrode includes a current collector and an active

material layer formed on the current collector. The active material layer includes an active material, a conductive agent, and a binder that binds these materials to a current collector.

Lithium ion batteries are advantageous in that they are small and lightweight, have high energy density, and can withstand long-term storage. Taking advantage of this, cylindrical shapes, square shapes, coin shapes, and the like are now manufactured and used in various electronic devices.

Conventionally, a protection circuit has been provided as a safety measure against overcharge of a battery, external short circuit, and the like. As an example of a battery protection circuit, there is a thermal resistance element (hereinafter referred to as a PTC element as appropriate). The PTC element is usually an element having an extremely small resistance, but has a characteristic that the resistance value increases when an excessive current flows or when the temperature becomes high, and the current flowing through the battery is limited. By providing the battery with a PTC element, for example, even when an external short circuit occurs, the PTC element works when the temperature reaches a certain temperature and stops the battery current, thereby preventing an overcurrent from flowing through the battery.

Patent Document 1 below proposes a protection circuit capable of reducing the current value before the battery is deteriorated or damaged even when the value of the current flowing through the battery is increased.

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The internal structure of a conventional lithium ion battery is a wound electrode body in which strip-shaped electrodes are stacked and wound spirally. Therefore, as shown in FIG. 1, the conceptual equivalent circuit is considered to be a series circuit of C (battery capacity), R (internal resistance component), and L (internal inductance component), and corresponds to both ends of the battery. To do. For this reason, it has an inductance component depending on the position of the lead drawn from the electrode. When the usage method is such that a large current is intermittently taken out from the battery, a counter electromotive force due to di / dt is generated by the inductance component, and a large voltage is generated between the output terminals of the battery. In particular, in the use of an electric circuit such as a power tool or a toy having a structure in which the output terminal of the battery is opened when the current is reduced, the occurrence of overvoltage is remarkable.

For example, FIG. 2 shows a calculation example of the voltage generated at the battery terminal when a current is intermittently passed through the electric circuit. In FIG. 2, the waveform indicated by the solid line indicates the voltage generated at the battery terminal, and the waveform indicated by the dotted line indicates the voltage applied to the load circuit.

When a current starts to flow, a voltage is gradually applied to the battery terminal, and then becomes a constant voltage. However, when the current is set to 0, a large voltage is suddenly generated at the battery terminal due to the energy stored in the inductance component.

In particular, when the impedance increases due to the inductance component of the battery in a high frequency range and the load current changes abruptly, the battery voltage becomes unstable. For example, FIG. 3 is a graph showing impedance characteristics of a cylindrical lithium ion secondary battery. The waveform indicated by the solid line is the impedance characteristic of the battery, and the waveform indicated by the dotted line is the background during measurement. The actual impedance can be obtained by the difference between the value indicated by the solid line and the value indicated by the dotted line. The impedance increases as the frequency becomes higher.

FIG. 4 is a graph showing voltage characteristics of a cylindrical lithium ion secondary battery, and shows voltage characteristics when the load current is switched from 10 A to 0 A as an example. When the load current is suddenly switched from 10 A to 0 A, the battery voltage, which was 4 V, rises to 8 V. Depending on the degree of overvoltage, the voltage resistance of the FET (Field Effect Transistor) for protecting the battery, the control circuit on the side of the device used, etc. may be exceeded, which may destroy the FET, the control circuit, and the like. For this reason, it is dangerous to generate overvoltage, and there is an increasing demand for overvoltage prevention.

Conventionally, since the number of cells connected to the device is small and the usage method is such that the fluctuation of the load current is small, the problem of overvoltage as described above is relatively small. However, in recent years, the need for countermeasures against overvoltage has increased as the use of batteries has expanded and the number of connected cells has increased. Although it is possible to take measures against overvoltage by improving the withstand voltage of the control circuit on the equipment side, a control circuit with an extremely high withstand voltage value is required and the cost increases. It is necessary to take measures against overvoltage on the battery side.

Therefore, an object of the present invention is to provide a battery device that prevents the occurrence of an overvoltage at the time of a sudden current interruption by reducing the inductance component in the battery.

In order to solve the above-mentioned problems, a first aspect of the present invention is a positive electrode produced by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil, and a negative electrode made of a sheet-like metal foil in a battery device in which a negative electrode produced by applying a negative electrode active material to a current collector is overlapped with a separator and a cylindrical wound electrode body produced by winding this is housed in an exterior body. The cylindrical wound electrode body is a battery device characterized in that it is wound from the center part in the longitudinal direction of the positive electrode and the negative electrode so that the electrode foil end portions of the positive electrode and the negative electrode come to the end of winding.

A second aspect of the present invention is a negative electrode active material formed on a positive electrode current collector made of a sheet-like metal foil and a positive electrode produced by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil. Connected to a positive electrode current collector in a battery device in which a cylindrical wound electrode body produced by stacking a negative electrode produced by applying a substance on a negative electrode is wound through a separator and wound around the separator. The battery device is characterized in that the distance between the positive electrode lead and the negative electrode lead connected to the negative electrode current collector is minimized.

The third aspect of the present invention is a negative electrode active material manufactured by applying a positive electrode active material to a positive electrode current collector made of a sheet-like metal foil and a negative electrode current collector made of a sheet-like metal foil. In a battery device in which a cylindrical wound electrode body produced by stacking a negative electrode produced by applying a substance on a negative electrode via a separator and winding the same is housed in an exterior body, the positive electrode current collector to the positive electrode The battery device is characterized in that the lead is led out, the negative electrode lead is led out from the negative electrode current collector, and at least one of the positive electrode lead and the negative electrode lead is plural.

According to the present invention, it is possible to prevent the occurrence of an overvoltage due to a sudden current interruption, particularly in an application in which a large current is intermittently passed, such as an electric tool or an electric toy. In addition, it is possible to prevent malfunction, destruction, etc. due to overvoltage when installing a load circuit such as charge control in the secondary battery.

Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

FIG. 5 is a cross-sectional view showing an example of the configuration of a lithium ion battery according to an embodiment of the present invention. This lithium ion battery is called a so-called cylindrical type, and a wound electrode body 10 in which a strip-like positive electrode 11 and a negative electrode 12 are wound through a

separator 13 inside a substantially hollow cylindrical battery can 1, have. The battery can 1 is made of, for example, iron (Fe) plated with nickel, and has one end closed and the other end open. Inside the battery can 1, a pair of insulating plates 2 and 3 are respectively disposed perpendicular to the winding peripheral surface so as to sandwich the winding electrode body 10.

A battery lid 4 and a safety valve mechanism 5 and a PTC element 6 provided inside the battery lid 4 are attached to an open portion of the battery can 1 by caulking through a gasket 7. The inside of 1 is sealed. The battery lid 4 is made of, for example, the same material as the battery can 1. The safety valve mechanism 5 is electrically connected to the battery lid 4 via the heat sensitive resistance element 6, and the disk plate 5a is reversed when the internal pressure of the battery exceeds a certain level due to an internal short circuit or external heating. Thus, the electrical connection between the battery lid 4 and the wound electrode body 10 is cut off. When the temperature rises, the heat-sensitive resistance element 6 limits the current by increasing the resistance value and prevents abnormal generation due to a large current. For example, the gasket 7 made of barium titanate semiconductor ceramics is used, is made of, for example, an insulating material, and the surface is coated with asphalt.

For example, the wound electrode body 10 is wound around a center pin 14. A positive electrode lead 15 made of aluminum (Al) or the like is connected to the positive electrode 11 of the wound electrode body 10. The positive electrode lead 15 is electrically connected to the battery lid 4 by being welded to the safety valve mechanism 5. The negative electrode lead 16 is welded and electrically connected to the battery can 1.

<Positive electrode 11>
The positive electrode 11 includes, for example, a positive electrode current collector having a band shape and a positive electrode mixture layer formed on one or both surfaces of the positive electrode current collector. The positive electrode current collector is made of, for example, a metal foil such as an aluminum foil, a nickel foil, or a stainless steel foil.

The positive electrode mixture layer is composed of a positive electrode active material and a binder. Specific examples of the positive electrode mixture layer include $LiCoO_2$ and $LiNiO_2$. Moreover, as a binder contained in this positive mix layer layer, the well-known binder normally used for this kind of battery can be used. Examples of the binder include fluorine resins such as polyvinyl fluoride, polyvinylidene fluoride, and polytetrafluoroethylene.

Moreover, you may make it contain a conductive material, the additive which expresses various functions, etc. in a positive mix layer as needed. The conductive material is not particularly limited as long as it can be mixed with an appropriate amount of the active material to impart conductivity, and examples thereof include carbon powders such as graphite and carbon black.

As a method for forming the positive electrode active material layer, for example, a powdery positive electrode active material is mixed with a solvent together with a binder (binder), and if necessary, a dispersion paint is formed by a ball mill, a sand mill, a twin-screw kneader or the like. Thereafter, a method of applying and drying on the positive electrode current collector is suitably used. In this case, the type of the solvent used is not particularly limited as long as it is inactive to the positive electrode current collector and can dissolve the binder. For example, N-methyl-2-pyrrolidone or the like is generally used. Any organic solvent can be used. The coating apparatus is not particularly limited, and examples thereof include slide coating, extrusion type die coating, reverse roll, gravure, knife coater, kiss coater, micro gravure, rod coater, blade coater and the like. The drying method is not particularly limited, and examples thereof include standing drying, a blast dryer, a hot air dryer, an infrared heater, and a far infrared heater.

<Negative electrode 12>
The negative electrode 12 includes, for example, a negative electrode current collector having a band shape and a negative electrode mixture layer formed on one or both surfaces of the negative electrode current collector. The negative electrode current collector is made of, for example, a metal foil such as a copper foil, a nickel foil, or a stainless steel foil.

The negative electrode mixture layer is composed of a negative electrode active material and a binder. Specific examples of the negative electrode mixture layer include carbonaceous materials such as pyrolytic carbons, cokes, graphites, glassy carbons, organic polymer compound fired bodies, carbon fibers, and activated carbon.

As the binder contained in the positive electrode mixture layer, known binders usually used in this type of battery can be used. Examples of the binder include fluorine resins such as polyvinyl fluoride, polyvinylidene fluoride, and polytetrafluoroethylene.

As a method for forming the negative electrode active material layer, the same method as that for the positive electrode active material layer described above can be used.

<Separator 13>
The separator 13 separates the positive electrode mixture layer 11b and the negative electrode mixture layer 12b. The separator 13 is, for example, a porous film made of a polyolefin-based material such as polypropylene or polyethylene, or a porous film made of an inorganic material such as a nonwoven fabric made of a ceramic material, and these two or more kinds of porous films It is good also as a structure which laminated | stacked.

In the lithium ion battery having such a structure, the following configuration is used to prevent overvoltage.

As an overvoltage prevention measure according to the first embodiment of the present invention, an electrode winding structure capable of preventing the occurrence of overvoltage will be described.

FIG. 6 schematically shows an electrode winding structure in an existing lithium ion battery. FIG. 7 schematically shows an electrode winding structure in a battery manufactured by applying the present invention. In addition, in order to show the winding structure of positive electrode foil and negative electrode foil in an easy-to-understand manner, illustration of separators and the like disposed between the positive electrode foil and the negative electrode foil is omitted in FIGS.

The electrode winding structure in the existing lithium ion battery shown in FIG. 6 is such that a positive electrode foil indicated by reference numeral 21 and a negative electrode foil indicated by reference numeral 22 are overlapped, and spirally wound from an end portion of the electrode foil. It is made by turning.

An example of a wound electrode body produced by applying the present invention is shown in FIG. In this wound electrode body, a positive electrode foil indicated by reference numeral 31 and a negative electrode foil indicated by reference numeral 32 are overlapped via a separator, and then wound from the center in the longitudinal direction of each electrode foil. Each electrode foil end portion of the negative electrode is prepared so as to come to the end of winding.

By adopting this configuration, the direction of the current generated in the electrode foil can be reversed in the portion where the inductance component has been generated conventionally. Thereby, the direction of the magnetic flux generated by the inductance component is reversed, and the inductance component can be substantially reduced.

FIG. 8 shows voltage characteristics when the load current is switched from 10 A to 0 A in the lithium ion battery manufactured using the spirally wound electrode body shown in FIG. When the load current is suddenly switched from 10 A to 0 A, the voltage of the battery, which was 4 V in the conventional lithium ion battery, rises to 8 V. However, in the case of the lithium ion battery manufactured using the present invention, 5.6 V It can be suppressed by a voltage increase of a certain degree.

Next, a method for preventing the occurrence of overvoltage by changing the lead-out position of the electrode lead will be described as an overvoltage prevention measure according to the second embodiment of the present invention.

FIG. 9 schematically shows a state in which an electrode foil of an existing lithium ion battery is developed. Reference numeral 41 indicates a positive electrode foil, and reference numeral 42 indicates a negative electrode foil. A positive electrode lead 41 a and a negative electrode lead 42 a for connecting the electrode foil and the battery outer package are provided on each of the positive electrode foil 41 and the negative electrode foil 42. In an existing lithium ion battery, a wound electrode body is manufactured by installing a positive electrode lead 41a and a negative electrode lead 42a at opposite ends of each electrode foil.

FIG. 10 schematically shows a current flow when the positive electrode lead 41a and the negative electrode lead 42a are installed. The illustration of the separator disposed between the positive electrode foil 41 and the negative electrode foil 42 is omitted, and it is assumed that the positive electrode foil 41 and the negative electrode foil 42 are filled with an electrolytic solution.

In this case, the current introduced from the negative electrode lead 42a flows through the electrolyte from the negative electrode foil 42 to the positive electrode foil 41, and then flows through the positive electrode lead 41a to the external electric circuit.

FIG. 11 shows a state in which an electrode foil of a lithium ion battery manufactured by applying the present invention is developed. Reference numeral 51 indicates a positive electrode foil, and reference numeral 52 indicates a negative electrode foil. Unlike the existing lithium ion battery shown in FIG. 9, the distance between the lead positions of the positive electrode lead 51a and the negative electrode lead 52a connected from the positive electrode foil 51 and the negative electrode foil 52 is made as small as possible.

The current flow in this case is schematically shown in FIG. In addition, the separator arrange | positioned between the positive electrode foil 51 and the negative electrode foil 522 is abbreviate | omitted, and the electrolyte solution shall be filled in the circumference | surroundings of the positive electrode foil 51 and the negative electrode foil 52. FIG.

When the present invention is applied, in order for the current to flow from the negative electrode lead 52a to the positive electrode lead 51a, it can be roughly divided into three paths: a path A, a path B, and a path C. In this case, in the path B and the path C, the current flowing on the negative electrode foil 52 side and the current flowing on the positive electrode foil 51 side are in opposite directions, and the inductance component is suppressed. Therefore, only the inductance component due to the current in the path A is generated.

Therefore, the inductance component can be suppressed by minimizing the distance between the lead positions of the positive electrode lead 51 a and the negative electrode lead 52 a connected from the positive electrode foil 51 and the negative electrode foil 52.

Further, as a third embodiment, as shown in FIG. 13, a configuration in which an inductance component is suppressed by installing a plurality of positive electrode leads 51 a and negative electrode leads 52 a drawn from the positive electrode foil 51 and the negative electrode foil 52. Is also possible

The embodiment of the present invention has been specifically described above, but the present invention is not limited to the above-described embodiment, and various modifications based on the technical idea of the present invention are possible.

For example, in the third embodiment, not only the one electrode lead is plural and the other electrode lead is one, but a configuration in which plural positive leads and plural negative leads are derived is used. Also good.

It is a basic diagram which shows an example of the conceptual equivalent circuit in a lithium ion battery. It is a basic diagram which shows the example of calculation of the voltage which arises in a battery terminal when an electric current is sent through an electric circuit intermittently. It is a basic diagram which shows the impedance characteristic of a cylindrical lithium ion secondary battery. It is a basic diagram which shows the voltage characteristic at the time of switching load current from 10A to 0A. It is sectional drawing which shows an example of a structure of the lithium ion battery which can apply this invention. It is a schematic diagram which shows the winding structure of the electrode in the existing lithium ion battery. It is a schematic diagram which shows the winding structure of the electrode in the battery by 1st Embodiment of this invention. FIG. 8 is a schematic diagram showing voltage characteristics when the load current is switched from 10 A to 0 A in the lithium ion battery manufactured using the wound electrode body shown in FIG. 7. It is a basic diagram which shows a mode that the electrode foil of the existing lithium ion battery was expand | deployed. It is a schematic diagram which shows the flow of the electric current of the existing lithium ion battery. It is a basic diagram which shows a mode that the electrode foil of the battery by 2nd Embodiment of this invention was expand | deployed. It is a schematic diagram which shows the flow of the electric current of the lithium ion battery produced by applying this invention. It is a basic diagram which shows a mode that the electrode foil at the time of installing the positive electrode lead in the battery by the 3rd Embodiment of this invention was expand | deployed. It is a schematic diagram which shows the electric current flow of the lithium ion battery produced by installing two positive electrode leads.

Explanation of symbols

21 ... Positive electrode foil 22 ... Negative electrode foil 31 ... Positive electrode foil 32 ... Negative electrode foil 41 ... Positive electrode foil 41a ... Positive electrode lead 42 ... Negative electrode foil 42a ... Negative electrode lead 51 ... Positive electrode foil 51a ... Positive electrode lead 52 ... Negative electrode foil 52a ... Negative electrode lead

Cited By (2)

Publication number	Priority date	Publication date	Assignee	Title
JP2008027858A *	2006-07-25	2008-02-07	Sony Corp	Wound cell
CN102270638A *	2010-12-29	2011-08-28	[illegible]	Battery cell having reduced cell inductance
Family To Family Citations				

* Cited by examiner, † Cited by third party, ‡ Family to family citation

Similar Documents

Publication	Publication Date	Title

JP7177786B2	2022-11-15	power generation unit
US8420248B2	2013-04-16	Electrode assembly and secondary battery using the same
JP4382557B2	2009-12-16	Non-aqueous secondary battery
US9887404B2	2018-02-06	Secondary battery
KR100305101B1	2001-09-25	Explosion-proof secondary battery
KR100869803B1	2008-11-21	Battery module
US8974944B2	2015-03-10	Electrode assembly and rechargeable battery using the same
JP6754768B2	2020-09-16	Non-aqueous electrolyte secondary battery
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JP2000277176A	2000-10-06	Lithium secondary battery and method for using the same
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JP2006032092A	2006-02-02	Battery device
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JP2010073847A	2010-04-02	Ptc thermistor element and method of manufacturing the same, and secondary battery cell and method of manufacturing the same
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JP2005100899A	2005-04-14	Nonaqueous electrolyte secondary battery
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JP2006032219A	2006-02-02	Battery pack
JP7139928B2	2022-09-06	Non-aqueous electrolyte secondary battery, method for designing non-aqueous electrolyte secondary battery, and method for manufacturing non-aqueous electrolyte secondary battery
KR20080095464A	2008-10-29	Rechargeable battery
JP2016062787A	2016-04-25	Lithium ion secondary battery

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
JP2004207148A	2004-07-14	2004-07-14	Battery device

Applications Claiming Priority (1)

Application	Filing date	Title
JP2004207148A	2004-07-14	Battery device

Legal Events

Date	Code	Title	Description
2006-02-10	A064	Notification of resignation of power of attorney	**Free format text:** JAPANESE INTERMEDIATE CODE: A7424 **Effective date:** 20060209

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
foil		claims,abstract,description	79	0.000
winding		claims,abstract,description	22	0.000
metal		claims,description	14	0.000
metal		claims,description	14	0.000
positive electrode material		claims,description	10	0.000
negative electrode material		claims,description	8	0.000
decreasing		abstract	1	0.000

Show all concepts from the description section

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US 20190044124A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0044124 A1**

KAWATE (43) **Pub. Date: Feb. 7, 2019**

(54) **ELECTROCHEMICAL ENERGY STORAGE DEVICE**

(71) Applicant: **Lithium Energy and Power GmbH & Co. KG**, Stuttgart (DE)

(72) Inventor: **Kenji KAWATE**, (US)

(21) Appl. No.: **15/760,595**

(22) PCT Filed: **Jul. 26, 2016**

(86) PCT No.: **PCT/EP2016/067708**

§ 371 (c)(1),
(2) Date: **Mar. 15, 2018**

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H01M 10/04	(2006.01)
H01G 11/78	(2006.01)
H01G 11/58	(2006.01)
H01G 11/66	(2006.01)
H01G 11/26	(2006.01)

(52) **U.S. Cl.**

CPC ***H01M 2/36*** (2013.01); ***H01M 10/0431*** (2013.01); ***H01G 11/26*** (2013.01); ***H01G 11/58*** (2013.01); ***H01G 11/66*** (2013.01); ***H01G 11/78*** (2013.01)

(57) **ABSTRACT**

An energy storage device includes: an electrode assembly; and a container for housing the electrode assembly, wherein an electrolyte solution filling opening from which electrolyte solution is to be filled into the container is formed in a position of a wall portion of the container and facing a tab portion of the electrode assembly.

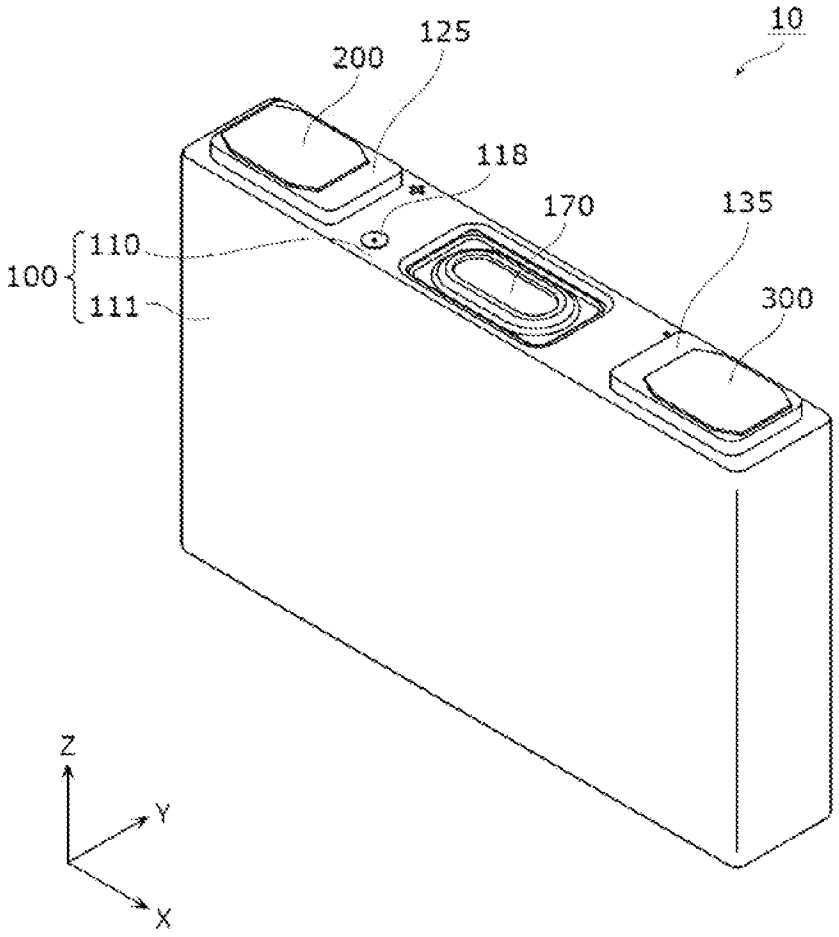


Fig. 1

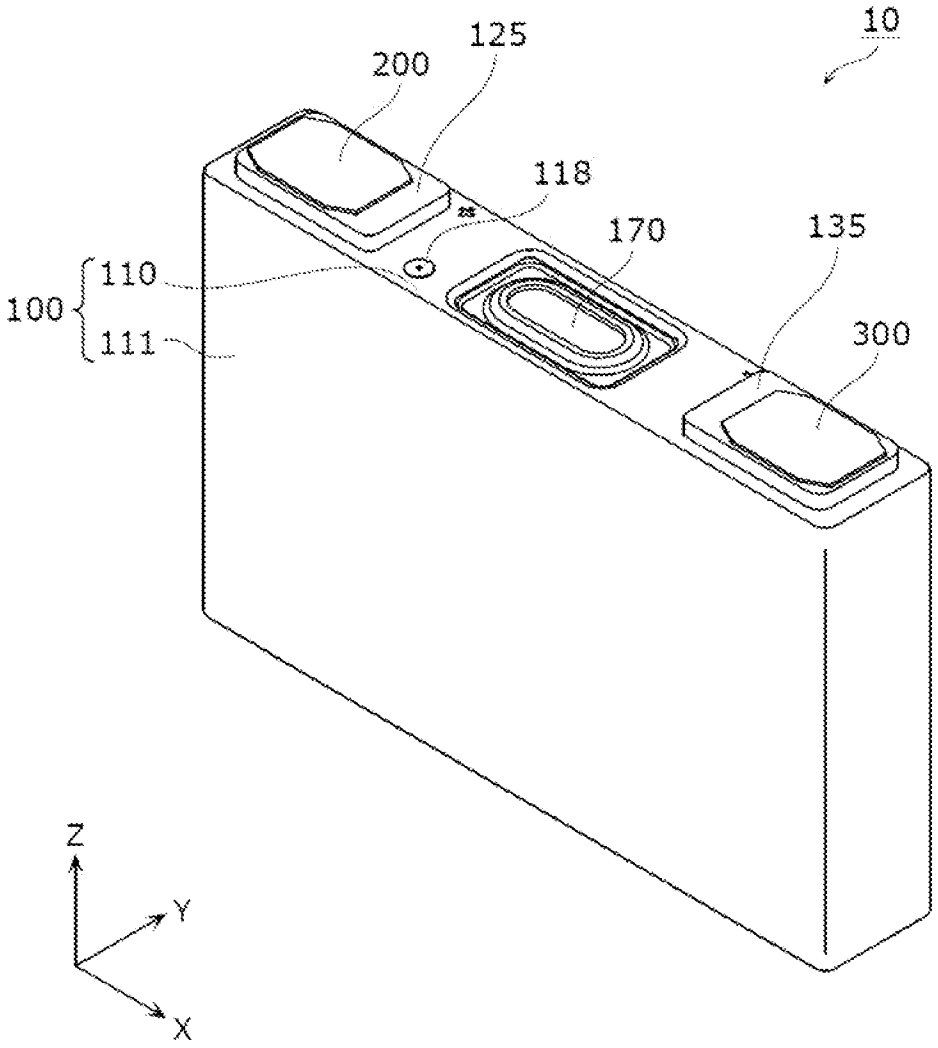


Fig. 2

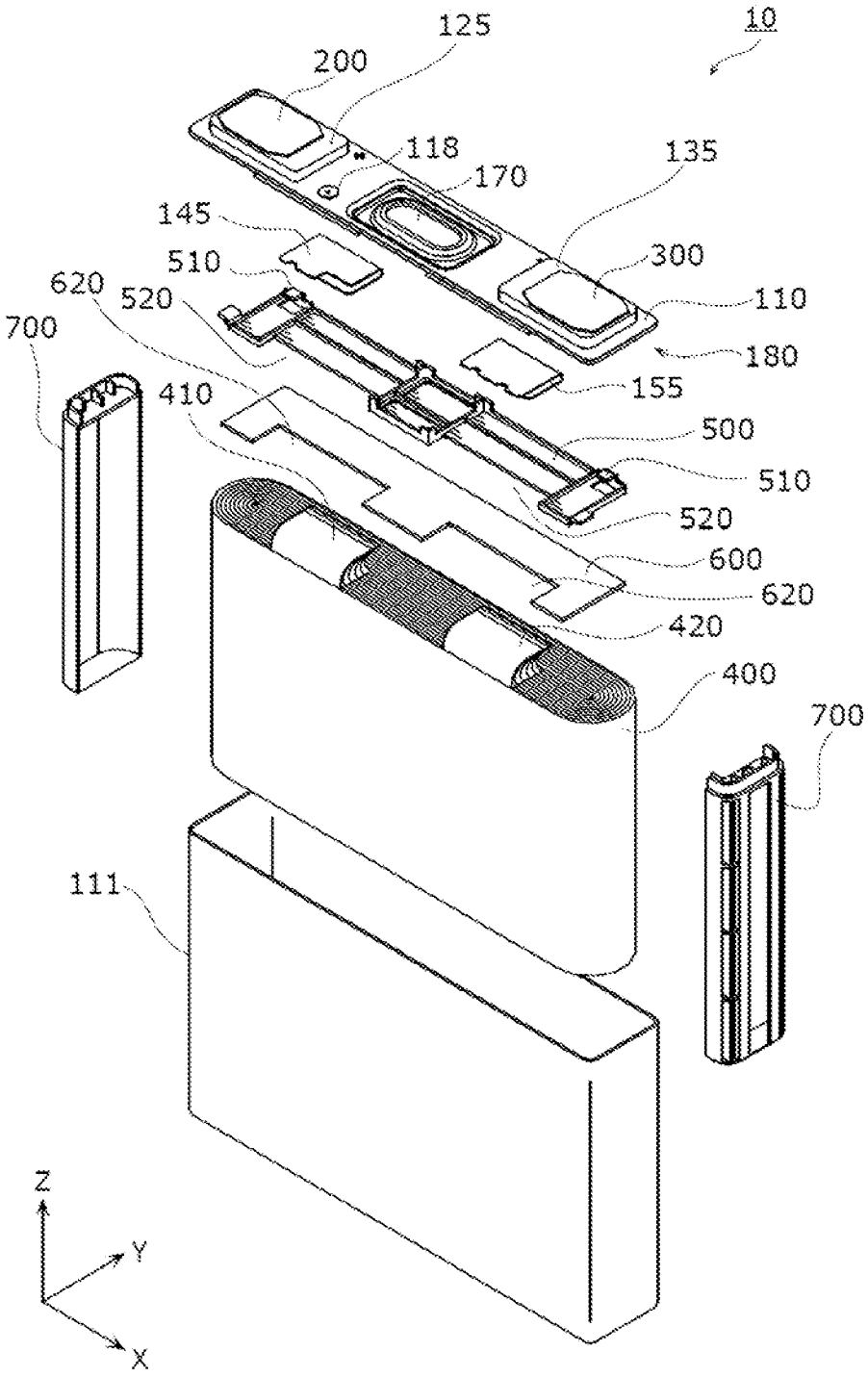
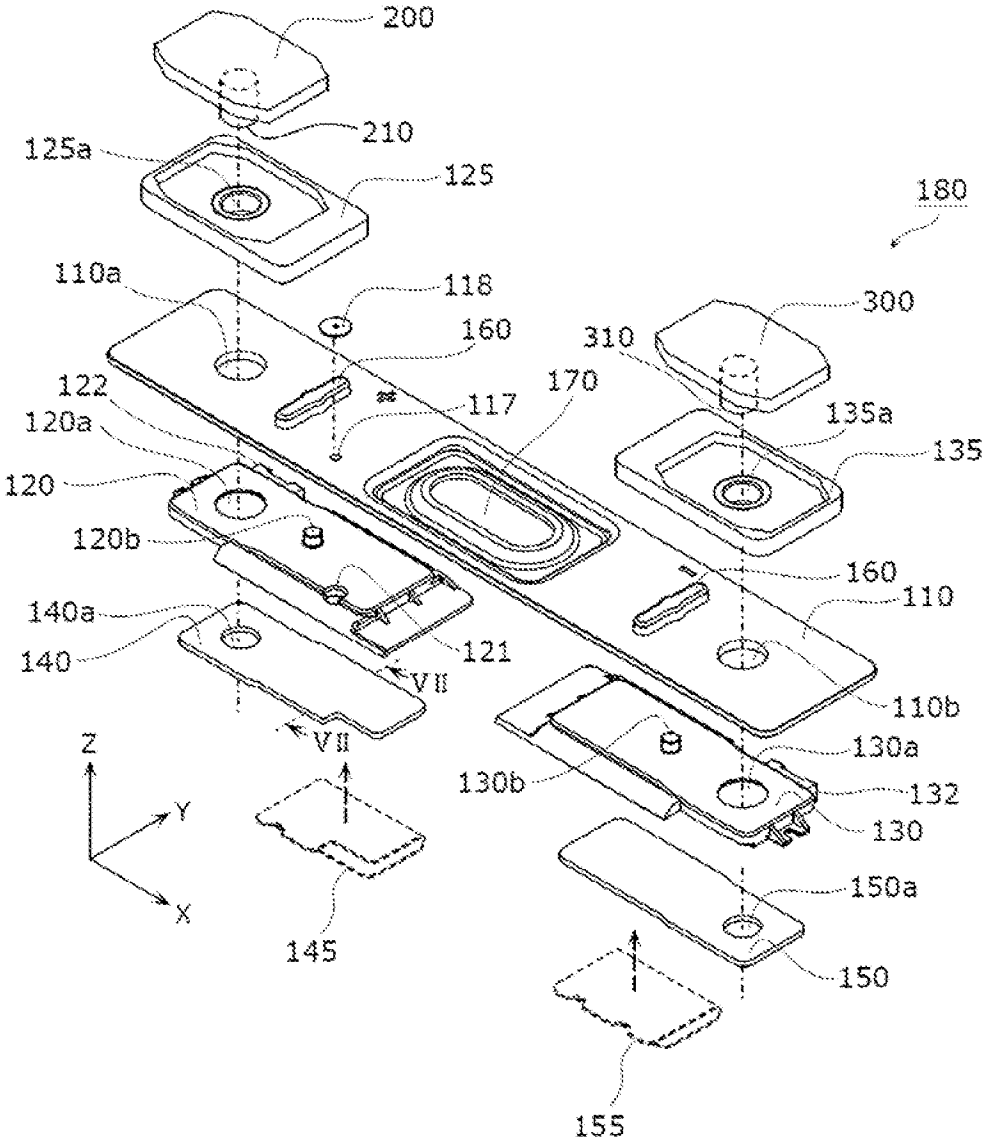

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155
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X

Fig. 3


200
210
125a
125
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110a
118
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310
122
117
170
135a
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120b
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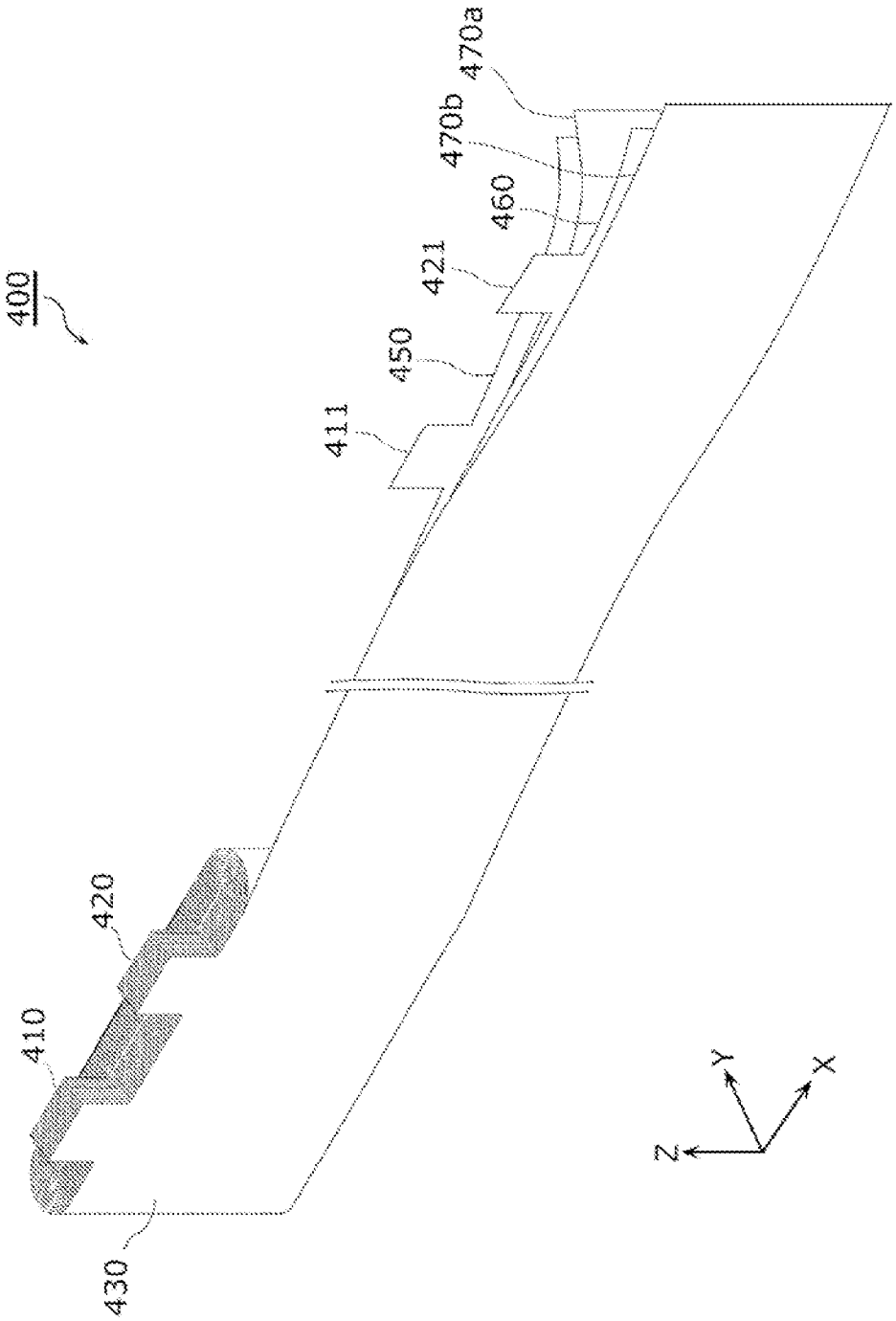


Fig. 4

Fig. 5

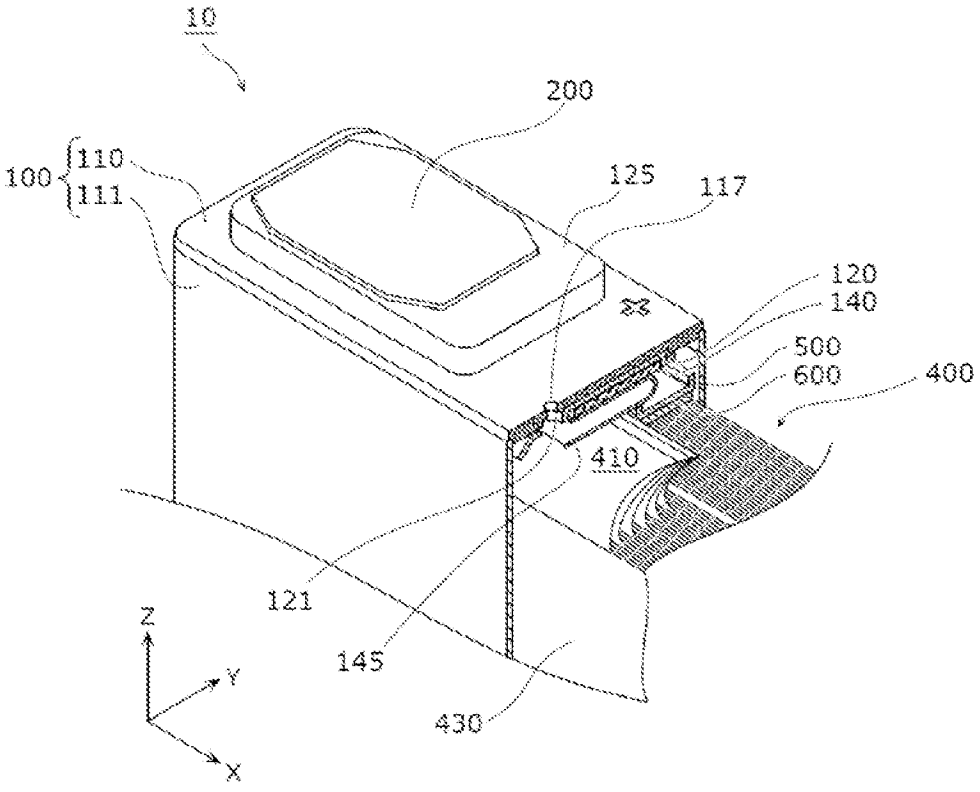

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Fig. 6

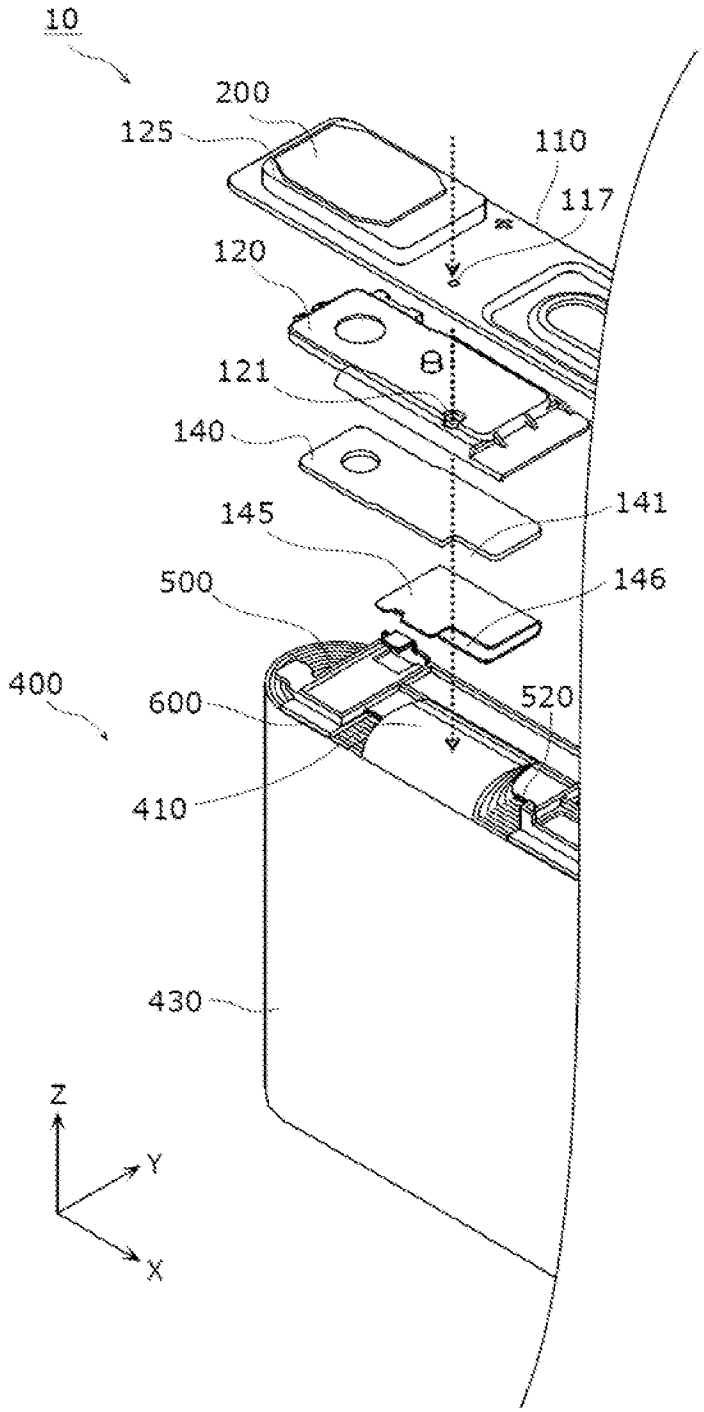
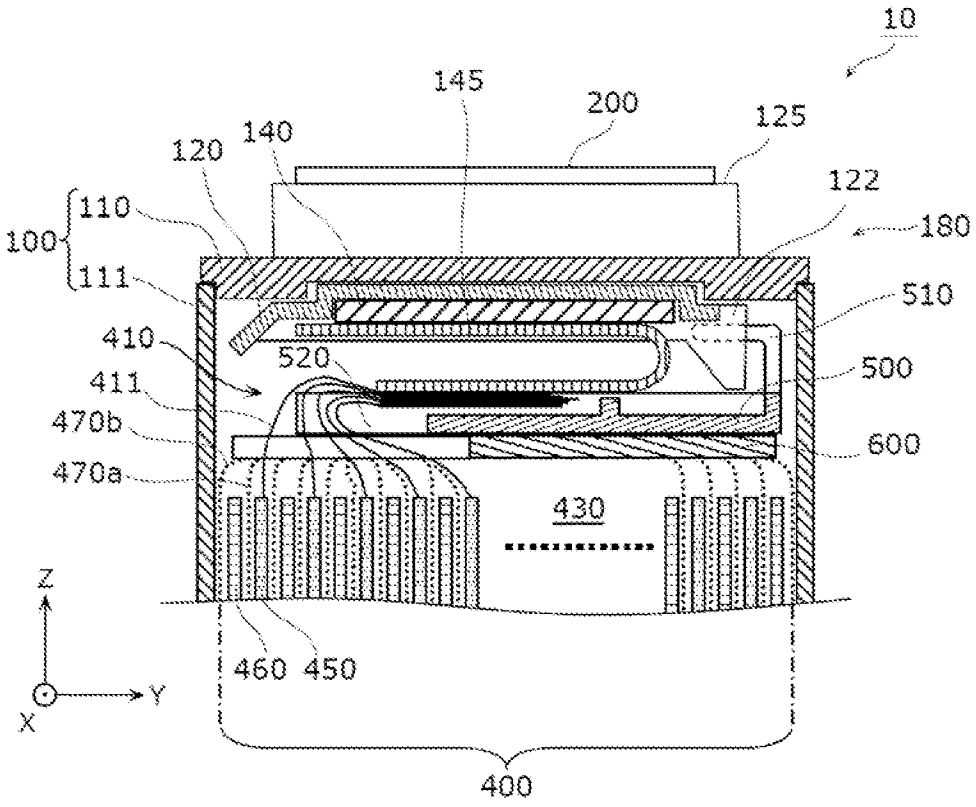

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Fig. 7


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140
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520
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411
470b
600
470a
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Z
Y
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ELECTROCHEMICAL ENERGY STORAGE DEVICE

TECHNICAL FIELD

[0001] The present invention relates to an energy storage device including an electrode assembly and a container for housing the electrode assembly.

BACKGROUND ART

[0002] Conventionally, there is a known structure in which an electrolyte solution filling opening from which electrolyte solution is to be filled into a container is provided to a container in an energy storage device including an electrode assembly and the container for housing the electrode assembly. For example, Patent Document 1 discloses a battery including a battery container for housing a power generating element, a lid body for sealing an opening portion of the battery container, and an electrolyte solution filling opening which is formed in the lid body and from which electrolyte solution is to be filled. In this battery, a positive electrode lead of the power generating element is welded to the container and the electrolyte solution filling opening provided to the container is sealed with a positive electrode terminal. In other words, the positive electrode terminal also performs a function of sealing the electrolyte solution filling opening.

PRIOR ART DOCUMENT

Patent Document

[0003] Patent Document 1: JP-A-2003-317703

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

[0004] An electrode assembly of an energy storage device has a structure formed by layering positive electrodes and negative electrodes with separators sandwiched therebetween, for example. From a viewpoint of preventing entry of foreign matters such as metal pieces into the electrode assembly, an end portion of the electrode assembly is preferably closed as fully as possible. On the other hand, however, it is necessary to cause the electrolyte solution filled into the container from the electrolyte solution filling opening to efficiently penetrate active material layers of the positive electrodes, active material layers of the negative electrode, and the separators in the electrode assembly, respectively.

[0005] In view of the above conventional problem, it is an object of the present invention to provide an energy storage device which includes an electrode assembly and a container for housing the electrode assembly and in which electrolyte solution filled from an electrolyte solution filling opening formed in the container can efficiently penetrate the electrode assembly.

Means for Solving the Problems

[0006] To achieve the above object, according to an aspect of the present invention, there is provided an energy storage device including an electrode assembly and a container for housing the electrode assembly, wherein an electrolyte solution filling opening from which electrolyte solution is to be filled into the container is formed in a position of a wall portion of the container and facing a tab portion of the electrode assembly.

[0007] With this structure, because the tab portion exists in the position facing the electrolyte solution filling opening, the electrolyte solution which has been filled from the electrolyte solution filling opening immediately reaches the tab portion. The tab portion is a portion formed by layering portions of a substrate of an electrode (a positive electrode or a negative electrode) and not coated with active material (active material uncoated portions) and a portion of the tab portion is joined to a conductive member such as a current collector. Therefore, the electrolyte solution filled from the electrolyte solution filling opening arranged at the position facing the tab portion goes down the tab portion and efficiently penetrates the electrode assembly (more specifically, active material layers of the positive electrode and the negative electrode and separators in the electrode assembly).

[0008] Moreover, at an end portion of the electrode assembly other than the tab portion, end edges of the separators may be bent, or a structure may be disposed, for example, to take measures against entry of foreign matters. In other words, in the energy storage device according to the aspect, the electrolyte solution can efficiently penetrate the electrode assembly and the entry of the foreign matters into the electrode assembly can be suppressed.

[0009] The energy storage device according to an aspect of the present invention may further include the current collector disposed in the container and electrically connected to the tab portion and an insulating member disposed between the current collector and the wall portion of the container, wherein a through hole may be formed in a position of the insulating member and between the electrolyte solution filling opening and the tab portion.

[0010] With this structure, the insulating member for electrically insulating the current collector and the wall portion formed with the electrolyte solution filling opening from each other can be disposed in such a manner as not to obstruct a flow of the electrolyte solution filled from the electrolyte solution filling opening. In other words, the electrolyte solution filling opening is disposed in the position facing the tab portion and therefore the insulating member for insulating the current collector electrically connected to the tab portion and the wall portion from each other may be disposed in such a position as to overlap the electrolyte solution filling opening when seen in a direction in which the electrolyte solution is filled in some cases. In this case, by forming the through hole in the position of the insulating member between the electrolyte solution filling opening and the tab portion, it is possible to cause the electrolyte solution filled from the electrolyte solution filling opening to reach the tab portion through the through hole.

[0011] Moreover, the energy storage device according to an aspect of the present invention may further include a spacer disposed between an end portion of the electrode assembly provided with the tab portion and the wall portion of the container, wherein the spacer may have an opening portion through which the tab portion is inserted.

[0012] With this structure, while disposing the spacer having functions of restricting a position of the electrode assembly, preventing a short circuit between the electrode assembly and the conductive member, and suppressing the entry of the foreign matters into the electrode assembly between the end portion of the electrode assembly provided