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(54) Benævnelse: **BATTERIELEKTRODE OG FREMGANGSMÅDE TIL FREMSTILLING AF SAMME**

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BATTERY ELECTRODE AND METHOD FOR PRODUCING THE SAME

Technical subject area

The invention relates to a battery electrode and a method for producing the same.

Background of the invention

In general a battery refers both to non-rechargeable primary cells as well as rechargeable secondary cells (also known as rechargeable batteries). Batteries are classified on the basis of the underlying chemical redox reaction, the materials used, the electrical values (e.g. voltage or capacitance) or the geometric or physical design. For example, there are alkali-manganese batteries, zinc-carbon batteries or lithium batteries. In accordance with their internal structure, batteries are additionally divided into wound cells and stacked batteries. In the case of a wound cell, the electrode and separator layers arranged on top of one another are wrapped in a spiral arrangement and installed, for example, in a round battery with a cylindrical housing. In the case of a stacked battery on the other hand, a plurality of electrode and separator layers are alternately stacked on top of each other.

An example of a stacked battery is shown in Fig. 1. As illustrated in Figure 1, in the battery an anode 10 and a cathode 20 are arranged alternately, wherein between each anode 10 and cathode 20, a separator 30 is arranged, in order to isolate the two electrodes spatially and electrically. The separator 30 must, however, be permeable for ions that cause the conversion of the stored chemical energy into electrical energy. Most commonly, microporous plastics or fabrics made from fibreglass or polyethylene are used for separators 30. The anodes 10 and the cathodes 20 are connected to each other in their conductor regions 40, so that all electrodes of the same type are interconnected in a battery. In each of the conductor regions 40 a connection lug 50 (see Fig. 2B) for the cathodes 20 and the anodes 10 is attached, which is connected to a corresponding external voltage terminal of the battery.

Fig. 2A shows a plan view of a cathode 20 with a conductor region 40. In the conductor regions 40 of the cathodes 20 arranged on top of each other, the cathodes 20 are connected to each other. As shown in Figure 2B, the connecting lug 50 is fixed to the interconnected conductor regions 40, which is in contact with the negative terminal of the battery after the assembly of the battery.

The battery electrodes are commonly pre-fabricated as bulk or rolled material, from which a desired electrode shape is cut out during the manufacture of a battery. As shown in Figure 3, the electrode material comprises a collector substrate 60, which is provided with a coating film 70. In this regard, the electrode material has one or more uncoated conductor regions 40, which are necessary later in the assembled condition in order to conduct voltage or current to the outside. At the conductor regions 40 a plurality of identically named electrodes are connected to each other and a metallic connection lug 50 is connected. If the collector substrate 60 is coated on both sides, conductor regions 40 are therefore also formed on both sides. The conductor regions in this case do not necessarily have to be formed opposite one another, but can be offset relative to each other, as shown in Figure 3.

Figures 4A and 4B show methods for producing an electrode material by means of a slotted nozzle system 300. On the strip-shaped collector substrate 60, an ink-like coating film 70 is applied and an uncoated conductor region 40 is formed. This can be done either by discontinuous, intermittent coating, wherein as shown in Fig. 4A, by regular or occasional interruption of the coating an uncoated conductor region 40 is formed, or this can be carried out by continuous coating, as shown in Fig. 4b. However, the construction of more complex conductor regions using these methods is very complex. Therefore, masking steps are occasionally used. Alternatively, conductor regions 40 can be exposed by brushing or similar methods on a collector substrate 60.

After the coating the electrode material is calendered, to compact the coating film and remove cavities which are produced when drying the coating film 70. The finished electrode material can then be rolled up again and stored up for further processing. For the manufacture of a battery, a desired shape is cut or punched out of the electrode material, the shape being different depending on the type of battery or shape of battery. When cutting out the battery electrode it is necessary to additionally ensure that a conductor region 40 must be present. An example of a rectangular electrode shape with conductor region 40 is shown in Fig. 2A.

Fig. 5 shows a flow diagram, on the basis of which the manufacturing process of a battery, for example, a wound cell or a battery stack, is illustrated. Firstly, the collector substrate 60 is coated (S10) with the coating film 70, for example in an intermittent procedure, wherein by interrupting or suspending the process of applying the ink-like coating, a plurality of uncoated conductor regions 40 is formed. The electrode material is then calendered (S20). From the electrode material a desired electrode shape can then be cut or punched out (S30), wherein the blank punched-out shape must have a conductor region 40. These steps are carried out both for producing the anode 10 and for producing the cathode 20. Next, the cut-out electrodes are arranged on top of each other (S40), such that an anode 10 and a cathode 20 are alternate in sequence, with a separator 30 in between (see Fig. 1). In this case, the conductor regions 40 of the cathodes 20 and the conductor regions 40 of the anodes 10 are each arranged on top of one another and connected to one another. A connection lug 50 is then attached to them (S50). The number of anodes 10 and cathodes 20 arranged on top of one another can vary depending on the type and characteristics of the battery. After completion of the electrode arrangement, the electrode arrangement is inserted into a housing and the connection lugs 50 are connected to the outer voltage terminals of the housing (S60). In the case of a wound cell, the electrode arrangement is wound in a spiral and inserted into the housing in this form. After adding the electrolyte (S70), the cell is then sealed (S80), and finally deployed (S90).

In the conventional methods for manufacturing battery electrodes, however, the following problems arise. The production of uncoated conductor regions by masking steps or by brushing off the coating is very time-consuming and expensive. On the other hand, in the alternative production method using intermittent or continuous coating with the aid of a slotted nozzle system, the possible forms and arrangements of the conductor regions on the electrode material are severely restricted. In view of the wide range of application areas of batteries, particularly in design products such as mobile phones, laptops or cars, however, a degree of flexibility in the design of the battery electrodes is increasingly in demand. The trend towards smaller devices represents a particular challenge in battery manufacturing. On the one hand, batteries must therefore be developed with smaller dimensions, while on the other hand complex shapes are often required in order to utilize the space inside a device as efficiently as possible. In addition, in an intermittent coating process it is difficult to produce regular and clean edge regions between the coating region and conductor region.

In addition, with the conventional methods it is difficult and expensive to implement a diversity of shapes of electrodes. For cost reasons, a rolled material is usually used as the electrode material, in which possible positions of the uncoated conductor region 40 with respect to the coating film 70 are permanently defined. As a result, however, the design freedom for the shape of the electrodes is severely restricted, because each electrode must have a conductor region 40. In addition, when cutting out the desired electrode shape along with the conductor region 40, much excess electrode material is produced, which must be discarded. For example, if small electrodes are cut out such that they contain a conductor region 40, if there is a large distance between successive conductor regions 40, regions of the intervening coated substrate can no longer be used. This increases the amount of material consumed and makes the manufacturing process more expensive. Furthermore, for each desired electrode shape a separate punch template must be procured for punching out the desired shape. But due to the high demands on cutting quality, these punch templates are very expensive.

In the conventional production methods, the conductor region 40 is formed such that it protrudes from a coated electrode region, in order to attach the connection lug 50 thereto and connect electrodes of the same type to each other. However, this leads to wasted space in the battery, which is not filled with active electrode material. As a result, the size of the battery is increased unnecessarily, or an external shape of the battery is defined.

In addition, in the conventional production methods or else during storage, the conductor regions 40 can easily become contaminated. In particular during a calendering process, impurities can occur on the conductor regions 40. This degrades the quality of an electrical contact between the electrodes of the same type among themselves and between the electrodes and an associated connection lug 50. In addition, since the conductor regions 40 are formed before the calendering process during the manufacture of the electrode material, due to the uneven thickness of the structure the calendering process is more difficult. In addition, the conductor region 40 that is formed by conventional methods can be poorly defined, wherein particularly edge regions of the conductor region 40 can be inaccurately and non-uniformly implemented.

WO 2009/055529 describes a method for producing a thin-film battery, TFB, which uses a process of CVD or PVD. A cathode current layer is deposited on a non-conductive substrate. A cathode layer is applied on the cathode current layer. An electrolyte layer is applied on the cathode layer. On this, an anode layer is applied. In order to cut out the battery a mask-free laser cutting process is used. To protect the edges the layer structure can be coated with a dielectric and/or metallic material, for example, by means of printing or a vacuum deposition process. If a vacuum deposition process has been applied - the contacts are exposed by laser ablation.

EP 1 596 459 describes an electrochemical device and a method for its manufacture. A plastic substrate is coated on both sides with a metal, which is then removed.

JP 2000149911 describes a method for producing a battery electrode, in which an active material is removed on a protruding connection lug by means of a laser.

Summary of the invention

The object of the present invention, therefore, is to specify a battery electrode and a manufacturing method for the same, which allows the maximum possible design freedom in the shape of a conductor region and a battery electrode with low production costs.

The object is achieved by means of the features of the independent claims.

The invention is based on the idea of removing a coating film formed on a collector substrate in a conductor region by laser ablation. In this way, the coating film can be produced on the collector substrate continuously and extensively, without the need to cut out a conductor region. Because of the uniform thickness of the surface coated collector substrate, in addition a calendering process is simplified and can be performed with better quality. In addition, any desired electrode shape can be cut from the coated collector substrate, without being constrained by a predefined location of the conductor region. Consequently, the electrode material can be used more efficiently, resulting in less waste material. By the use of a laser to expose the conductor regions, the conductor regions can also be produced on the coated collector substrate in any form and at any point with clean and regular edges. This results in absolute design freedom and the facility to produce surface-optimized conductor structures. For example, inactive regions on the electrode, i.e., the surfaces of the conductor regions, can be reduced. This also allows an inactive volume in the battery to be reduced, for example by uncoated conductor regions protruding into a coated region of the electrode or being formed within the coated region. Alternatively, a periphery of the conductor region can be surrounded by up to at least half of the coated region.

For the material removal by means of laser ablation any suitable laser system can be used, such as a cutting or engraving laser system. Due to the high edge quality and cutting precision in terms of cutting path and penetration depth, conductor regions of high quality can be produced. By the use of ultra-short laser pulses the energy input can also be reduced, so that a thermal loading of the electrode material is kept to a minimum. As suitable laser systems are comparable in cost to slit nozzle systems, there are no high procurement costs involved.

According to an aspect of the present invention a method for producing a battery electrode is specified. In this method, a coating film is first applied on a first collector substrate. Then, in at least one conductor region the coating film is removed with a laser. This can be carried out by pulsed laser radiation or continuous laser radiation. It may be the case that the coating film is formed on both sides of the collector substrate, in order to enlarge an active surface of the electrode. At least one conductor region can then be formed on both sides of the collector substrate. In addition, the coating film can be designed such that it essentially completely covers at least one of the two surfaces of the collector substrate, without leaving free edges or free areas uncoated. The coating is preferably performed using a continuous coating procedure, such as a doctor blade, a Comma-bar or kiss-coating. This ensures a greater process reliability at low production cost and thus improves the quality of the electrode material.

In a further exemplary embodiment, not only is the coating film in a conductor region removed with a laser, but also a thin layer on the surface of the collector substrate, so that a fresh clean surface is produced. This allows impurities and oxidized layers in the conductor region to be removed, which reduces a contact resistance between the electrodes and a connection lug. Preferably, the connection lug is fixed to the conductor region immediately after the production of the conductor region, wherein the production of the conductor region can comprise either only the removal of the coating film or both the removal of the coating film and a surface layer of the collector substrate. Therefore, by using a laser for removal of the coating film and/or of a surface layer of the collector substrate, the occurrence of impurities can be avoided, which can represent a serious danger for a finished battery and can cause dendrite formation with resulting short-circuits, for example, while brushing off any abrasive particles or coating residues.

In a preferred embodiment of the method according to the invention, the battery electrode is cut out in a predefined form by means of the laser either before or after the production of the at least one conductor region. In this way, any desired shape of electrode can be selected without special tools such as special punching dies having to be purchased. As a result, the design freedom in the manufacture of the battery electrode is further increased and the process workflow is optimized. The construction of the conductor region and the cutting out of the battery electrode by means of a laser can save work time and additional tooling, since conversion of the electrode material to be processed or of the tool is no longer necessary. Therefore, the conductor region or even the battery electrode can be produced in any desired shape, e.g. round, semi-circular, annular, rectangular or triangular. In addition, the conductor region can be arranged on the coated electrode surface as desired. Preferably, the conductor region protrudes into the coated electrode surface such that it is surrounded by the coated electrode surface over a major part of its circumference, or over at least half of it. At the same time, with the remainder of the circumference it can adjoin an outer edge of the battery electrode. Alternatively, the conductor region can be arranged completely within the coated electrode surface. In this way, an inactive or dead volume can be reduced during assembly of the battery, so that for a given battery size the capacity or volumetric energy density is increased.

Furthermore, at least one recess can be formed in the battery electrode. Preferably, the recess of an electrode corresponds to a conductor region formed on an electrode of the opposite type, so that the conductor regions of the electrodes of similar type stacked on top of one another in an alternating electrode arrangement can be connected to each other through the other electrodes. This can be advantageous, for example, if the conductor region of an electrode protrudes into a coated electrode region or is completely surrounded thereby. If the battery electrode is cut out by means of laser cutting, the recess can also be cut out using the laser, in order to optimize a process workflow.

In a further preferred embodiment of the present invention, a process gas is blown onto the substrate during the laser ablation of the coating film and/or during the laser ablation of the surface layer of the collector substrate and/or during the laser cutting. This enables any residues produced by the laser machining to be removed during the actual process itself. In addition, a process gas can be used which suppresses oxidation or other unwanted chemical surface reactions. The process gas is preferably cold, in order to cool the electrode material during the laser processing.

In a further aspect of the present invention a battery electrode is specified, which contains a collector substrate, a coating film formed on the collector substrate and a conductor region, wherein the conductor region is formed by removal of the coating film using a laser. Thus, the conductor region is formed by an uncoated region of the collector substrate. The battery electrode can be produced in accordance with any of the above-described exemplary embodiments of the method according to the invention.

As a further aspect of the present invention a battery is specified, which contains a battery electrode produced according to any of the above-described exemplary embodiments of the method according to the invention.

Brief description of the drawings

The drawings show:

Fig. 1 a schematic cross-sectional view of an electrode arrangement in a conventional battery;

Figures 2A and 2B a plan view of a conventional battery electrode;

Fig. 3 a cross-sectional view of a conventional electrode material;

Figures 4A and 4B methods for producing a conventional electrode material;

Fig. 5 a flow diagram of a conventional production method of a battery;

Fig. 6 battery electrodes in accordance with a first exemplary embodiment of the present invention;

Fig. 7 battery electrodes in accordance with a further exemplary embodiment of the present invention;

Fig. 8 battery electrodes in accordance with another exemplary embodiment of the present invention;

Figs. 9A-9C sectional views through an electrode material during a production process according to the present invention; and

Fig. 10 a flow diagram of a production method according to an exemplary embodiment of the present invention.

Detailed description of the invention

The invention is described in the following using the example of the lithium-ion battery, which is characterized by a high energy density and thermal stability. The present invention is not intended to be limited to lithium-ion batteries, however, but can be applied to any type of battery.

In a lithium-ion battery a collector substrate 60 of an anode 10 consists, for example, of copper which is coated with a coating film 70 made of graphite, binding agent, carbon black and solvent. According to the present invention, the coating film 70 in a conductor region 40 is removed, so that the collector substrate 60 is exposed in the conductor region 40. A connection lug 50 made of nickel can be attached to the conductor region 40 of the anode 10. In the cathode 20 a collector substrate 60 consists, for example, of aluminium and is coated with a coating film 70 made from an active material that supports a redox reaction, binding agent, carbon black, graphite and solvent. The connection lug of the cathode preferably also consists of aluminium.

Fig. 6 shows battery electrodes according to the present invention, in which a conductor region 40 adjoins the coating film 70 on the collector substrate 60 over the majority of its circumference. Both the anodes 10 and the cathodes have an internally situated conductor region 40 and a recess 80. The recess 80 is formed at a point that corresponds to the conductor region 40 of the respective opposite type of electrode in the assembled condition. The recesses 80 of the anodes 10 are thus arranged in such a way that in the assembled condition of the electrodes they are located above or below the conductor regions 40 of the cathodes 10. The arrows in Figure 6 indicate an electrode arrangement in the assembled condition, wherein an anode 10 and a cathode 20 are arranged alternately on top of each other. In this arrangement a separator 30 (not shown) is arranged between the anodes 10 and cathodes 20, which consists of micro-porous films or non-woven fabrics. In the conductor regions 40, before assembling the electrodes connection lugs 50 are attached to at least one of the anodes 10 and at least one of the cathodes 20. Preferably however, the connection lugs 50 are attached to the conductor regions 40 after the assembly of the electrodes, for example by ultrasonic welding. Because in this exemplary embodiment a conductor region 40 of one electrode is located opposite a recess 80 of an electrode of the opposite type, in this case the cathodes 20 or anodes 10 can be electrically connected to each other at their conductor regions 40.

It is also possible to design only the cathodes or the anodes with an internally located or internally protruding conductor region, wherein the other of the two electrodes is produced with a protruding conductor region according to the conventional method.

Fig. 7 shows a further exemplary embodiment of battery electrodes according to the present invention. The anodes 10 shown in Fig. 7 have a round recess 80 at their centre, while the cathodes 20 have a corresponding conductor region 40 at their centre. The conductor region 40 of the anodes 10 is formed on their circumferential border, so that the cathodes 20 have a recess 80 at this point. As previously described, the conductor regions 40 of the electrodes of the same type are connected to each other and connection lugs 50 are attached in each of the conductor regions 40 of the anodes 10 and cathodes 20.

Fig. 8 shows another example of battery electrodes according to the present invention. In this exemplary embodiment, the conductor regions 40 are completely surrounded by the coating film 70. Here, the anode 10 has two conductor regions 40a and 40b and the cathode 20 has two corresponding recesses 80a and 80b. In this case, one connection lug 50 is attached to each of the two conductor regions 40a and 40b of the anode

10. The formation of a plurality of conductor regions 40 on an electrode can lead to an improved voltage collection and resistance.

In the following the manufacture of the battery electrodes will be described. According to the present invention, firstly, as shown in Fig. 9A, a collector substrate 60 is coated extensively on both sides with a coating film 70. The collector substrate 60 may, however, also be coated extensively or substantially completely only on one surface. The coating film 70 is applied in a liquid state to the collector substrate 60. This can be performed using simple, continuous coating technologies, such as doctor blade, Comma-bar or kiss coating. Subsequently, the coating film 70 is dried or cured, wherein a thickness of the coating film 70 in the dry state is approximately 25µm, for example. After the drying or curing of the coating film 70, the coated collector substrate 60 is calendered in order to compact the coating film 70. The uniform thickness of the collector substrate 60 simplifies the calendering process so that it can be carried out more efficiently, so that the quality of the electrode material is improved. In addition, the coated collector substrate 60 can be stored as rolls of material and is available as electrode material for subsequent further processing.

As shown in Fig. 9B, at least one conductor region 40 is then formed on the coated collector substrate 60, by the coating film 70 in the conductor region 40 being removed by laser ablation and exposing the underlying collector substrate 60. During a laser ablation process, material is removed from the surface by bombarding it with laser radiation. For this purpose, a technique such as pulsed laser radiation with high power density is used. Since the heat conduction enables only a very slow energy transport into the volume, the irradiated energy is concentrated onto a very thin layer at the surface. As a result, the surface is heated strongly and results in an abrupt evaporation or melting of the material. In order to ensure a sufficient absorption of the laser light, a wavelength of the laser radiation is chosen according to the material to be removed. Preferably, an engraving or cutting laser system is used, for example with an ytterbium laser at a wavelength of 1070 nm. However, other gas, solid-state or fibre lasers can also be used. In addition, during the processing operation a process gas or blown gas can also be directed onto the surface, in order to drive the removed material from the kerf or to prevent unwanted chemical reactions on the surface. The evaporation or melting of the material does not generate any harmful impurities.

Because the conductor regions 40 are produced by laser ablation, any desired shapes and arrangements of the conductor region can be formed. In particular, the conductor regions 40 can be arranged on the electrode surface such that they do not protrude from the battery electrode. This allows an energy density/volume ratio to be increased and the size of a battery to be reduced while maintaining the same electrical properties. The formation of the conductor region 40 is preferably carried out immediately before connecting the identical electrodes or the attachment of a connection lug 50 in the conductor regions 40. For example, stacked identical electrodes can be connected to each other by means of a welded contact in the conductor regions 40. At the same time a connection lug 50 can be attached to one of the conductor regions 40. Since the conductor regions 40 are only formed shortly before the further processing of the electrode material, a fresh, clean surface is available for the contacting of the identical electrodes to one another or for the attachment of the connection lug 50. This means that passivation layers, such as oxidized surfaces and other impurities, can be avoided in the conductor region 40.

It is possible that not only is the coating film 70 in the conductor region 40 removed using lasers, but also, as shown in Fig. 9C, a thin layer of the collector substrate 60. By the use of laser systems with high cutting precision, the penetration depth of the laser can be precisely controlled, so that the depth of the material removal can be chosen as desired. Therefore, a collector substrate 60 can be selectively thinned in the conductor region 40 to reduce an electrical contact resistance. It can also result in an improved surface composition for electrical contacting.

Fig. 10 is a flowchart of a manufacturing process of a battery according to the present invention. First of all, an ink-like coating film 70 is applied extensively or substantially completely (S100) on a collector substrate 60, which consists of a metal strip approximately 8-20 µm thick. After drying or curing of the coating film 70, which in the dry state is approximately 25 µm thick, the uniformly coated collector substrate 60 is calendered (S200), in order to remove any cavities and irregularities from the coating film 70 resulting from the drying. The calendered and coated collector substrate 60 can then be stored in the form of rolls of material until further processing. In order to manufacture the battery electrode, the coating film 70 is removed in a predetermined conductor region 40 on the coated substrate 60 by laser ablation (S300). Possibly, a thin layer of the collector substrate 60 may additionally be removed in the conductor region 40, to improve the surface quality for electrical contacting. In the next step S400 the electrode and, if applicable, the recesses 80 are then cut out from the coated collector substrate 60 in a desired shape. Preferably, the electrode or the recess 80 is cut out with a laser, but a stamping device can also be used as an alternative. The sequence of steps S400 and S300 can also be reversed. Thereafter, anodes 10 and cathodes 20 are arranged alternately on top of one another in such a way that the conductor regions 40 of the same type are facing each other, wherein the recesses 80 of the cathodes 20 are arranged between the conductor regions 40 of the anodes 10 and vice versa. Then, each of the conductor regions 40 of electrodes of the same type are connected to each other, for example by ultrasonic welding, wherein in each case a connection lug 50 is attached thereto (S500). Alternatively, the connection lug 50 can also be attached to one of the cathodes 20 or anodes 10 before the assembly of the electrodes.

The remaining steps are the same as those of the conventional method for producing a battery. The electrode arrangement is inserted into a container and the connection lugs 50 are connected to the outer voltage terminals of the battery (S60). Then the unit is filled with an electrolyte (S70) and the cell is sealed (S80). Finally, a deployment is carried out (S90).

According to the present invention battery electrodes can be produced cost-effectively and with high quality by producing the conductor region on the coated collector substrate by laser ablation. Due to the high cutting precision with regard to cutting path and penetration depth of lasers, even complex outlines can be quickly and precisely cut out or removed. In addition, maximum design freedom is possible, since a conductor region can be formed with a laser system at any desired position and in any shape, designed on a computer. In particular, the conductor regions can be formed such that they do not protrude from an outer circumference of the battery electrode, but instead penetrate into a coated region of the battery electrode. This allows a higher capacity and energy density to be achieved for the same battery size. In addition, a space-optimized conductor region can be formed, so that only an absolutely essential region is exposed by laser ablation. This saves further processing steps for removing excess uncoated electrode surfaces, as well as material. Furthermore, the manufacture of battery electrodes is economic even at low minimum quantities, so that even individually designed batteries can be produced with little effort and low costs. In addition, flexibility in manufacture and material utilization is increased. In addition, by the use of a laser for forming the conductor regions, simple continuous coating technologies can be used for producing the coated collector substrate, making a manufacturing process less expensive. A collector substrate coated over its entire surface can also be more easily calendered and better stored. Since the conductor region can be produced immediately before contacting, using a production method according to the invention impurities or passivation layers in the contact region can be prevented and a contact resistance can be reduced.

KRAV

1. Fremgangsmåde til fremstilling af en batterielektrode, omfattende:

dannelse (S100) af en belægningsfilm (70) på et kollektorsubstrat (60) ved at belægge et stort område af kollektorsubstratet (60) med en blækagtig belægningsfilm;
tørring eller hærdning af den påførte belægningsfilm;
kalandrering af det belagte kollektorsubstrat (60);
fremstilling (S200) af mindst ét aflederområde (40) ved fjernelse af belægningsfilmen (70) med laserablation,

kendetegnet ved, at der ved fremstilling af aflederområdet (40) fjernes et lag af kollektorsubstratet (60) i aflederområdet (40) vha. laserablation ved styring af laserens indtrængningsdybde i kollektorsubstratet (60).

2. Fremgangsmåde ifølge krav 1, hvor belægningsfilmen (70) påføres begge sider af kollektorsubstratet (60) og/eller en samlet overflade af kollektorsubstratet (60) og/eller i en kontinuerlig belægningsproces.

3. Fremgangsmåde ifølge krav 1 eller 2, hvor der på mindst én side af kollektorsubstratet (60) dannes mindst ét aflederområde (40) ved laserablation.

4. Fremgangsmåde ifølge et af ovenstående krav, hvor der sker en kollektorsubstratskontaktering (S500) i aflederområdet (40) med en tilslutningsfane (50) umiddelbart efter dannelsen af aflederområdet (40).

5. Fremgangsmåde ifølge et af ovenstående krav, hvor fremgangsmåden til fremstilling af en batterielektrode endvidere omfatter:
udskæring af batterielektroden og/eller af udsparinger af det belagte kollektorsubstrat vha. laserskæring (S400).

6. Fremgangsmåde ifølge et af ovenstående krav, hvor aflederområdet (40) og/eller batterielektroden fremstilles i en rund, ringformet, firkantet, trekantet eller anden mulig form eller som et udsnit heraf.

7. Fremgangsmåde ifølge et af ovenstående krav, hvor der under laserablationen (S300) og/eller under laserskæringen (S400) blæses en procesgas på kollektorsubstratet (60).

8. Batterielektrode, omfattende:

et kollektorsubstrat (60):

en kalandreret belægningsfilm (70) på kollektorsubstratet (60); og

mindst ét aflederområde (40) dannet ved fjernelse af belægningsfilmen (70) med laserablation, **kendetegnet ved, at** kollektorsubstratet (60) har en mindre tykkelse i aflederområdet (40) end i kollektorsubstratets (60) belagte område, hvorved laserens indtrængningsdybde i kollektorsubstratet (60) til fjernelse af et lag af kollektorsubstratet (60) er styrbar.

9. Batteri, der indeholder en batterielektrode ifølge krav 8.

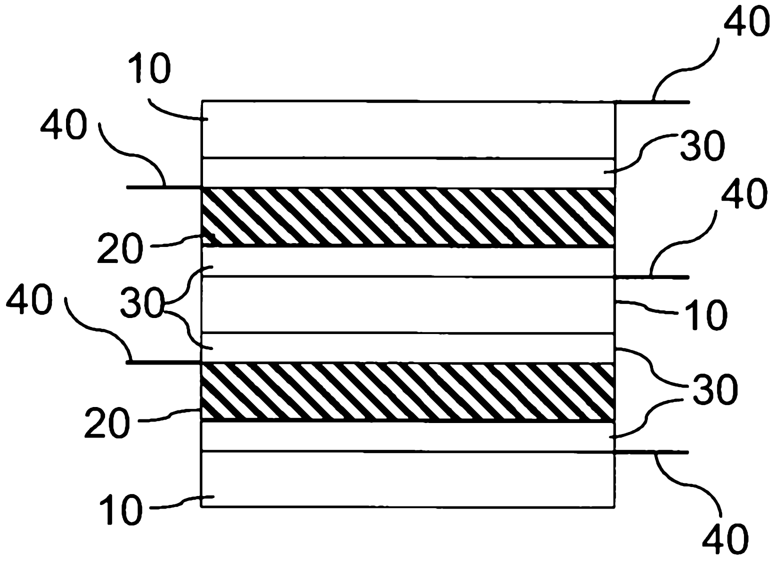

Fig. 1

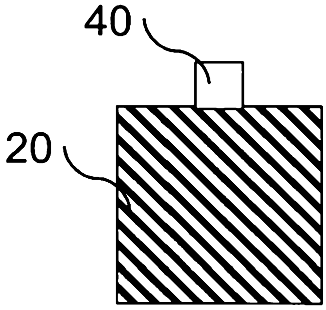

Fig. 2A

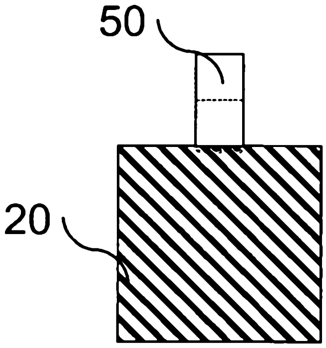

Fig. 2B

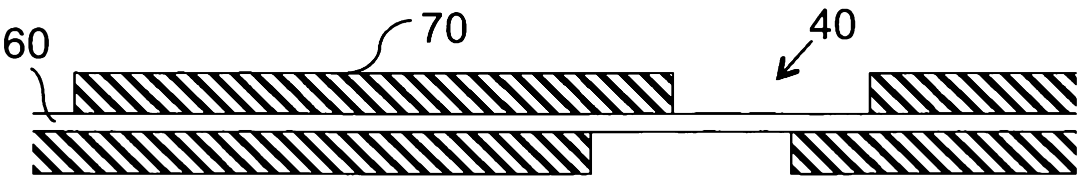

Fig. 3

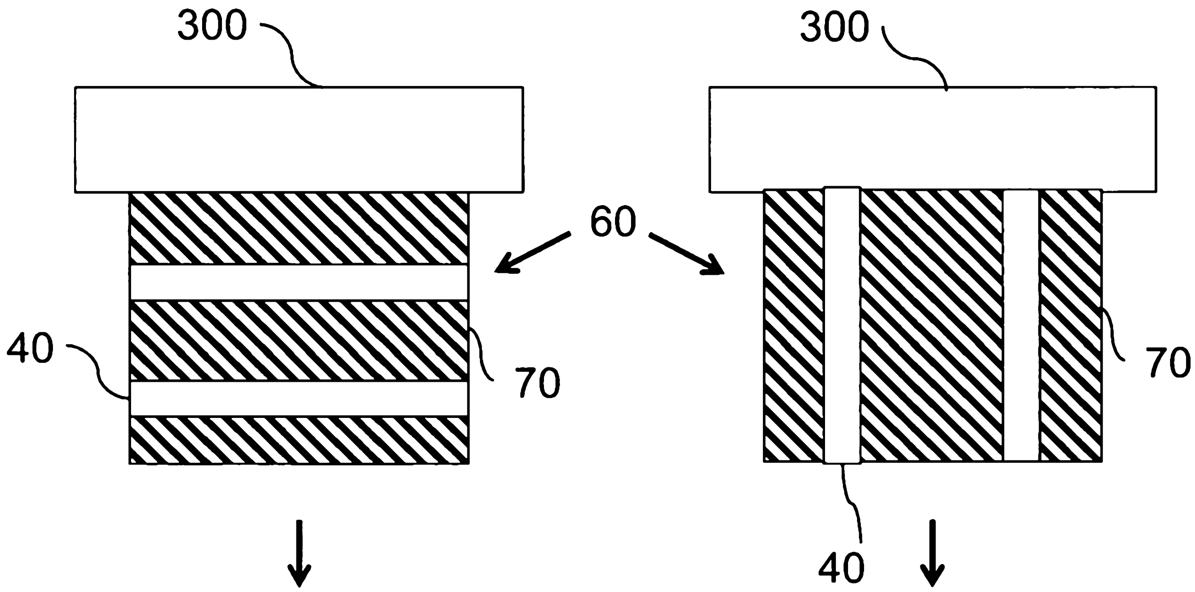

Fig. 4A

Fig. 4B

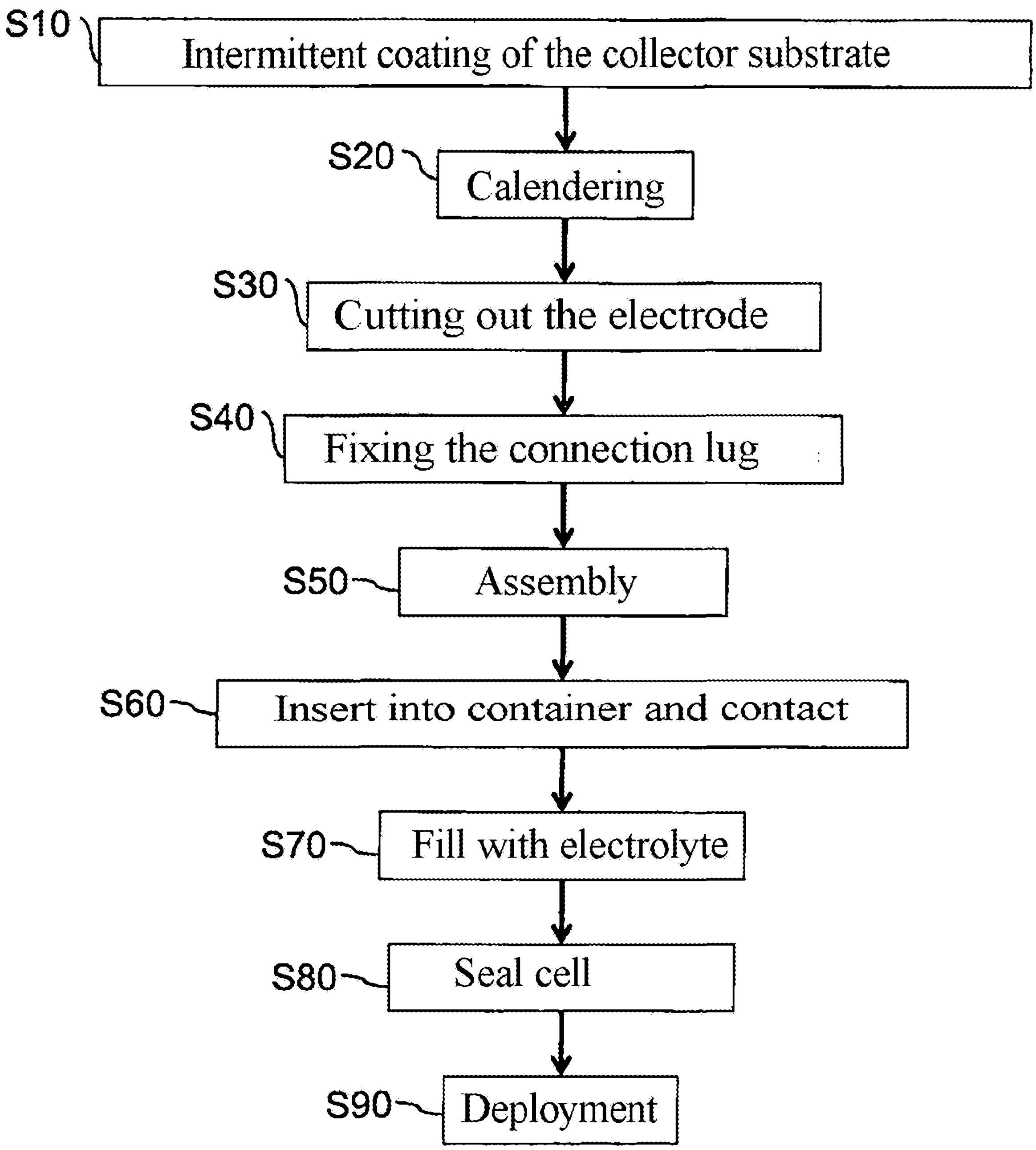
S10
Intermittent coating of the collector substrate
S20
Calendering
S30
Cutting out the electrode
S40
Fixing the connection lug
S50
Assembly
S60
Insert into container and contact
S70
Fill with electrolyte
S80
Seal cell
S90
Deployment

Fig. 5

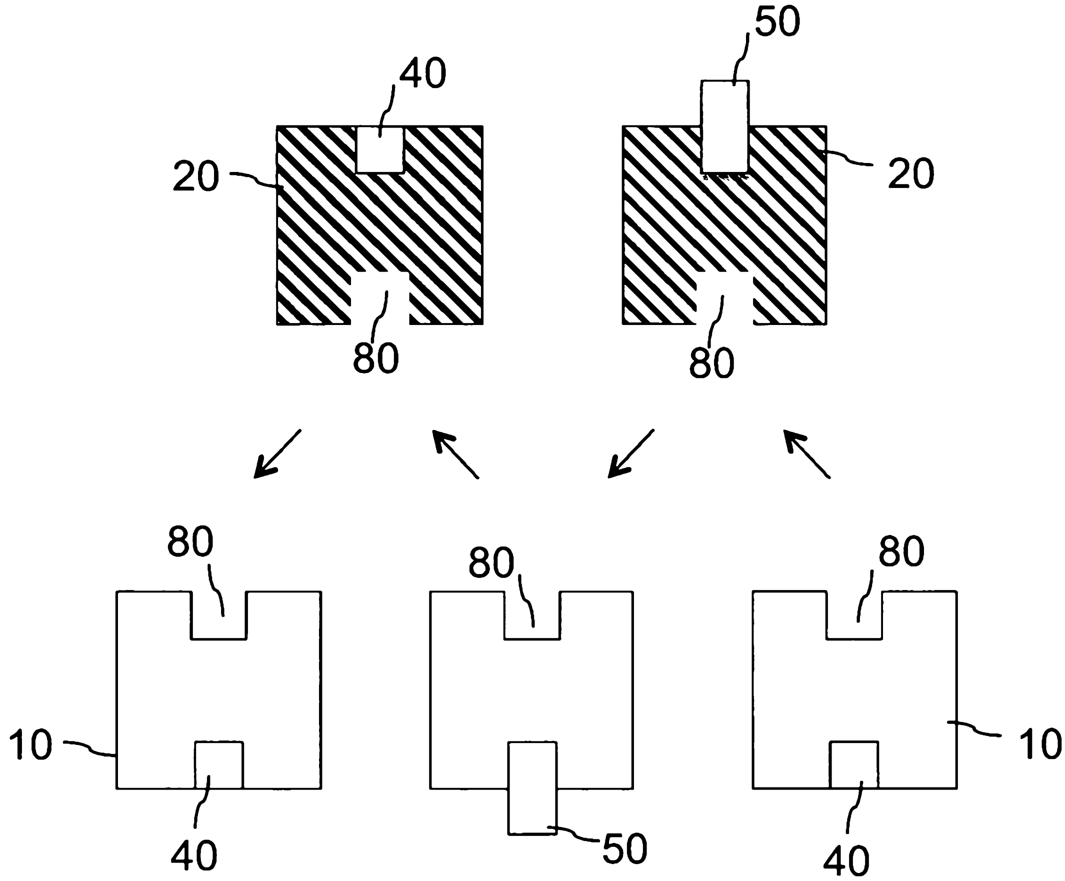

Fig. 6

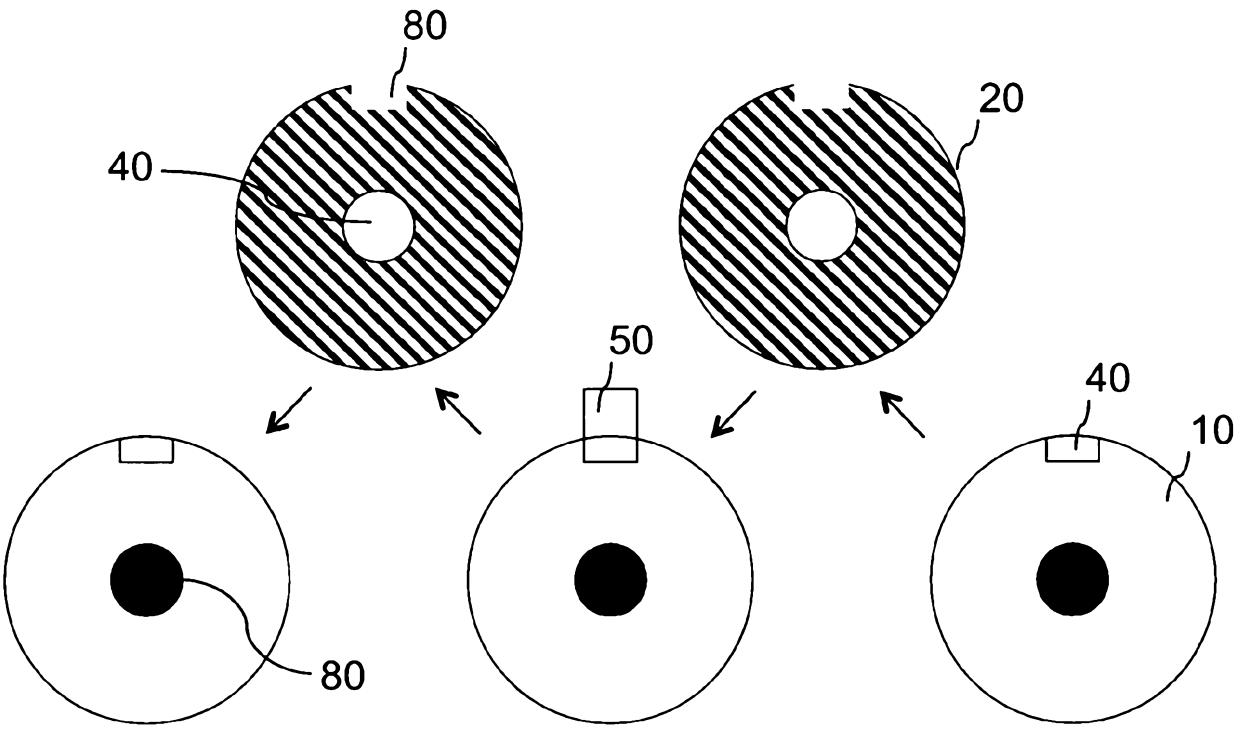

Fig. 7

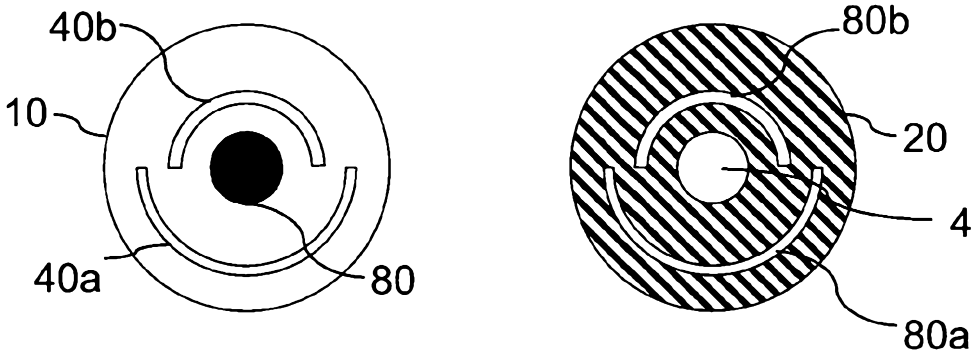

Fig. 8

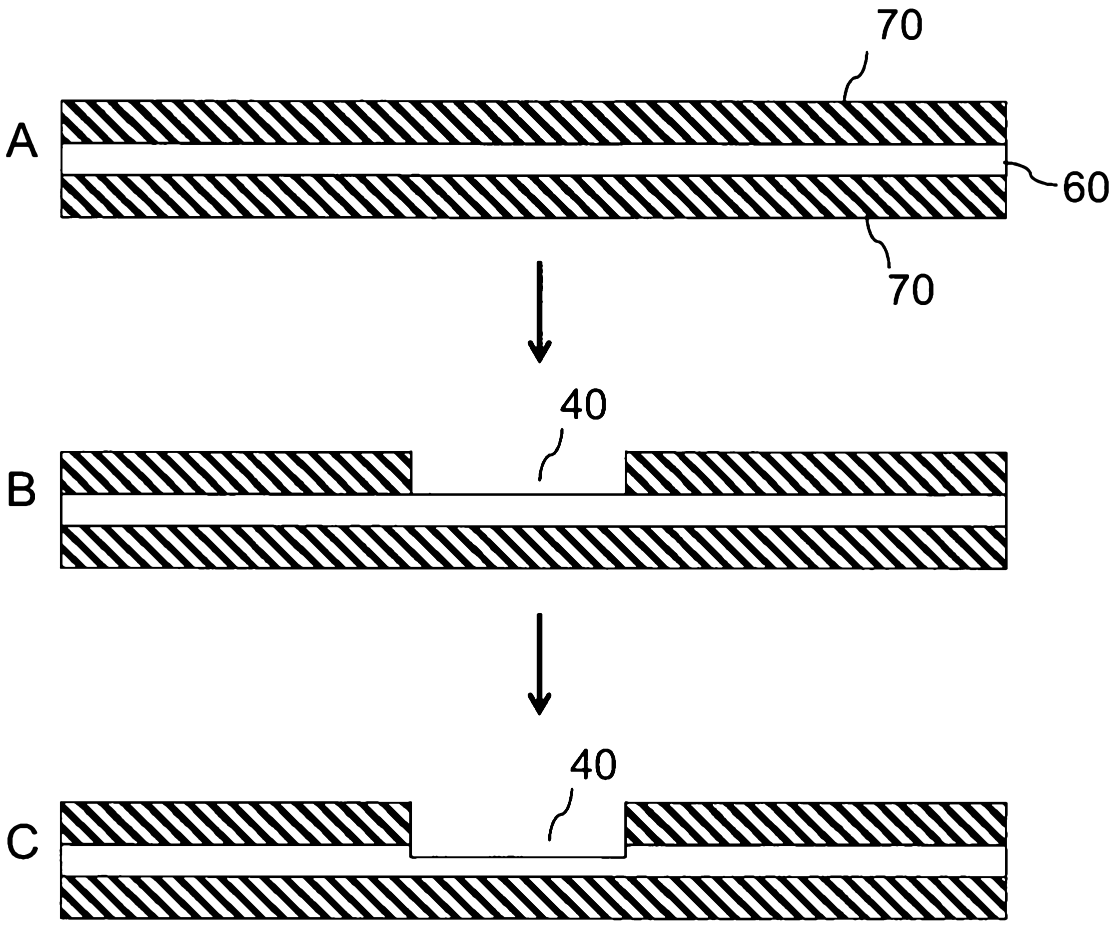

Fig. 9

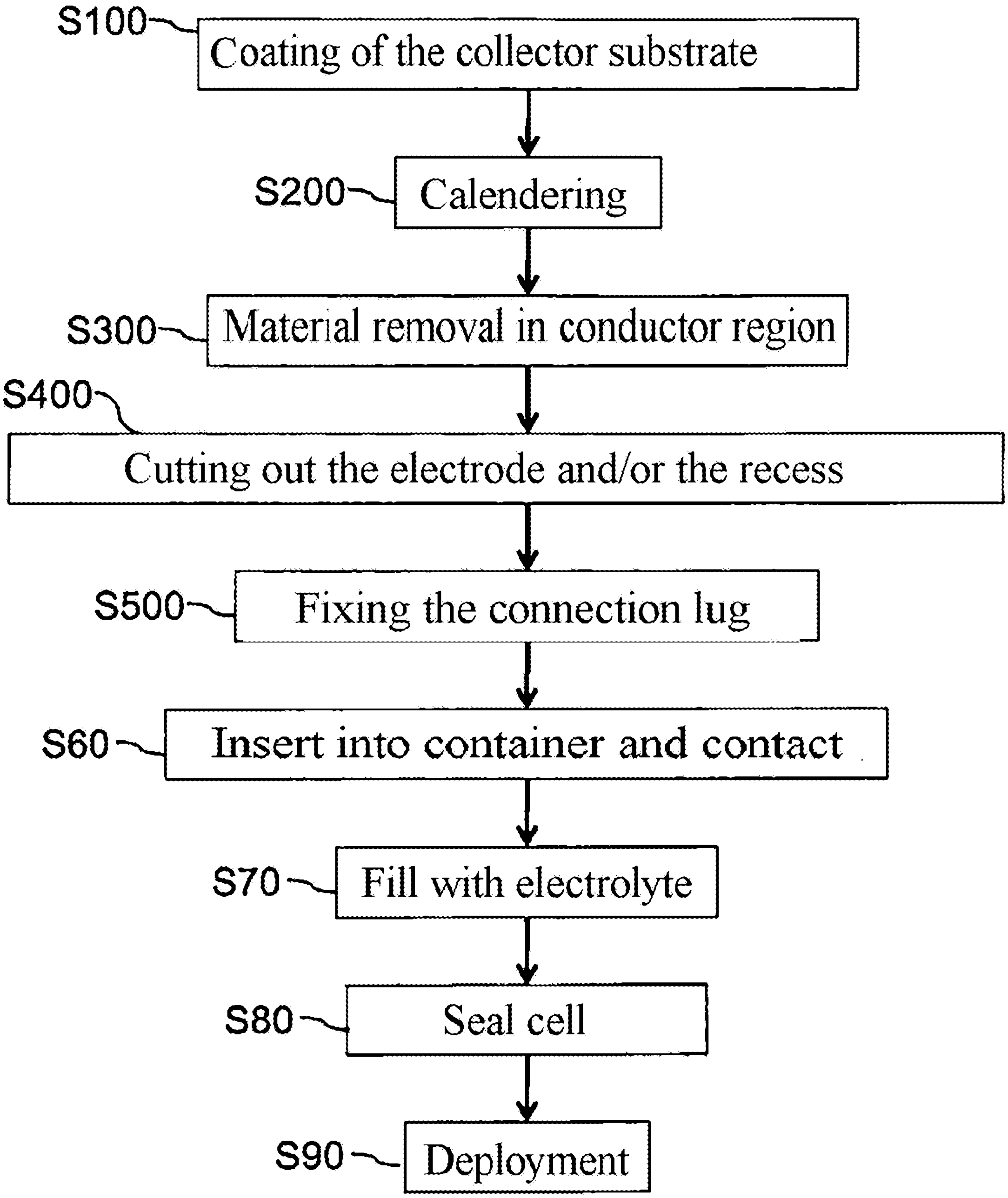
S100
Coating of the collector substrate
S200
Calendering
S300
Material removal in conductor region
S400
Cutting out the electrode and/or the recess
S500
Fixing the connection lug
S60
Insert into container and contact
S70
Fill with electrolyte
S80
Seal cell
S90
Deployment

Fig. 10