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Inventor(s)	MATSUMOTO; Hiroyuki

SECONDARY BATTERY AND METHOD FOR MANUFACTURING SECONDARY BATTERY

Abstract

A secondary battery includes: a positive electrode layer; a negative electrode layer; a solid electrolyte layer (a first solid electrolyte layer and a second solid electrolyte layer) provided between the positive electrode layer and the negative electrode layer, containing a solid electrolyte through which lithium ions migrate; and a separator that is in contact with the solid electrolyte layer between the positive electrode layer and the negative electrode layer. A plurality of holes for supplying the electrolytic solution contained within the separator to the solid electrolyte layer are formed in the surface of the separator.

Inventors: **MATSUMOTO; Hiroyuki (Fujisawa-shi, JP)**

Applicant: **ISUZU MOTORS LIMITED** (Yokohama-shi, JP)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS
[0001] The present application claims priority to Japanese Patent Applications number 2024-20039, filed on Feb. 14, 2024 contents of which are incorporated herein by reference in their entirety.
BACKGROUND OF THE INVENTION
[0002] The present disclosure relates to a secondary battery and a method for manufacturing the secondary battery. In recent years, an all-solid-state battery using a solid electrolyte has been developed as a lithium ion secondary battery from the viewpoint of safety or the like (see Japanese Unexamined Patent Application Publication No. 2023-165328). In the all-solid-state battery, a solid electrolyte layer through which lithium ions can migrate is provided between a positive electrode layer and a negative electrode layer.
[0003] In the all-solid-state battery, lithium may be precipitated on the negative electrode layer side during charging. In particular, in cases of abnormalities such as deterioration of the all-solid-state battery, lithium is not taken into the negative electrode layer and precipitates from the surface of the negative electrode layer in the form of dendrites (acicular crystals). Then, when the precipitation of lithium within the solid electrolyte layer further progresses and reaches the positive electrode layer, an internal short circuit may occur.
BRIEF SUMMARY OF THE INVENTION
[0004] The present disclosure has been made in view of these points, and its object is to suppress precipitation of lithium in a solid electrolyte layer.
[0005] A first aspect of the present disclosure provides a secondary battery including: a positive electrode layer; a negative electrode layer; a solid electrolyte layer provided between the positive electrode layer and the negative electrode layer, containing a solid electrolyte through which lithium ions migrate; and a separator in contact with the solid electrolyte layer between the positive electrode layer and the negative electrode layer, wherein a plurality of holes for supplying an electrolytic solution contained within the separator to the solid electrolyte layer are formed in the surface of the separator.
[0006] A second aspect of the present disclosure provides a method for manufacturing a secondary battery including: preparing a positive electrode layer, a negative electrode layer, a solid electrolyte layer containing a solid electrolyte through which lithium ions migrate, and a separator containing an electrolytic solution therein; sandwiching the solid electrolyte layer and the separator between the positive electrode layer and the negative electrode layer so that solid electrolyte layer is in contact with the separator; and pressurizing the separator having a plurality of holes for supplying the electrolyte solution to the solid electrolyte layer by fastening the positive electrode layer and the negative electrode layer.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0007] FIG. **1** is a schematic diagram illustrating a configuration of a secondary battery **1** according to an embodiment.
[0008] FIG. **2** is a schematic view for explaining an internal short circuit in a secondary battery **100** according to a comparative example.
[0009] FIG. **3** is a schematic view for explaining a configuration of a separator **50**.
[0010] FIG. **4** is a schematic view showing a hole **53** included in an upper surface **51***a* of the separator **50**.
[0011] FIG. **5** is a schematic view showing a state in which precipitation of lithium is suppressed.

[0012] FIG. **6** is a flowchart illustrating a manufacturing process of the secondary battery **1**.
[0013] FIG. **7** is a schematic diagram illustrating a secondary battery **1** according to a modification example.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Hereinafter, the present disclosure will be described through exemplary embodiments, but the following exemplary embodiments do not limit the disclosure according to the claims, and not all of the combinations of features described in the exemplary embodiments are necessarily essential to the solution means of the disclosure.

<Configuration of a Secondary Battery>

[0015] FIG. **1** is a schematic diagram illustrating a configuration of a secondary battery **1** according to one embodiment. The secondary battery **1** is a lithium ion secondary battery in which carrier ions are lithium ions. Specifically, the secondary battery **1** is an all-solid-state battery with a laminated structure, integrating a positive electrode layer, a negative electrode layer, and a solid electrolyte layer to realize high energy density of the battery.
[0016] As shown in FIG. **1**, the secondary battery **1** includes a positive electrode layer **10**, a negative electrode layer **20**, a first solid electrolyte layer **30**, a second solid electrolyte layer **40**, a separator **50**, and fastening members **60**.
[0017] The positive electrode layer **10** contains a positive electrode active material. As the positive electrode active material, sulfur, lithium nickel oxide, lithium cobalt oxide, an oxide in which a transition metal is combined with lithium in a fixed ratio, lithium manganate oxide, lithium iron phosphate oxide, or the like can be used. The transition metal is nickel, cobalt, manganese, or the like. The positive electrode layer **10** may contain a solid electrolyte in addition to the positive electrode active material.
[0018] The negative electrode layer **20** contains a negative electrode active material. Specifically, the negative electrode active material is an alloy-based negative electrode such as hard carbon, graphite, or silicon, or metallic lithium. Similar to the positive electrode layer **10**, the negative electrode layer **20** may contain a solid electrolyte in addition to the negative electrode active material. The negative electrode layer **20** and the positive electrode layer **10** have the same shape and are specifically formed in a rectangular plate-like shape.
[0019] The first solid electrolyte layer **30** and the second solid electrolyte layer **40** are provided between the positive electrode layer **10** and the negative electrode layer **20**. As shown in FIG. **1**, the first solid electrolyte layer **30** faces the positive electrode layer **10**, and the second solid electrolyte layer **40** faces the negative electrode layer **20**. Specifically, the first solid electrolyte layer **30** is in contact with the positive electrode layer **10**, and the second solid electrolyte layer **40** is in contact with the negative electrode layer **20**.
[0020] The first solid electrolyte layer **30** and the second solid electrolyte layer **40** have lithium ion conductivity. The first solid electrolyte layer **30** and the second solid electrolyte layer **40** each include a solid electrolyte through which lithium ions can migrate within each respective layer. The solid electrolyte is, for example, a known oxide-based solid electrolyte or sulfide-based solid electrolyte.
[0021] A first solid electrolyte included in the first solid electrolyte layer **30** facing the positive electrode layer **10** may be different from a second solid electrolyte included in the second solid electrolyte layer **40** facing the negative electrode layer **20**. For example, the first solid electrolyte is an electrolyte with oxidation resistance, and the second solid electrolyte is an electrolyte with reduction resistance. The first solid electrolyte may be the same as the second solid electrolyte.
[0022] The separator **50** is provided between the positive electrode layer **10** and the negative electrode layer **20**. Specifically, the separator **50** is sandwiched between the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. Here, the separator **50** is in contact with both the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. For example, the thickness of the separator **50** may be less than the thicknesses of the positive electrode layer **10**, the negative

electrode layer **20**, the first solid electrolyte layer **30**, and the second solid electrolyte layer **40**. In this case, the rigidity of the separator **50** is lower than the rigidity of the positive electrode layer **10**, the negative electrode layer **20**, the first solid electrolyte layer **30**, and the second solid electrolyte layer **40**. The thickness and rigidity of the separator **50** are not limited to those described above.

[0023] Although details will be described later, the separator **50** is made of a porous base material and contains an electrolytic solution therein. Therefore, the electrolytic solution inside the separator **50** is easily supplied to (penetrates into) the first solid electrolyte layer **30** and the second solid electrolyte layer **40**.

[0024] The fastening members **60** fasten the positive electrode layer **10** and the negative electrode layer **20**. Specifically, the fastening members **60** fasten the positive electrode layer **10** and the negative electrode layer **20** with the first solid electrolyte layer **30**, the second solid electrolyte layer **40**, and the separator **50** sandwiched therebetween. Here, the fastening members **60** each include a bolt and a nut, and sandwich the positive electrode layer **10** and the negative electrode layer **20** with the bolt and the nut. The fastening members **60** are provided, for example, at the four corners of the rectangular positive electrode layer **10** and the rectangular negative electrode layer **20**.

[0025] By having the fastening members **60** fasten the positive electrode layer **10** and the negative electrode layer **20**, the separator **50** sandwiched between the positive electrode layer **10** and the negative electrode layer **20** is pressurized by the fastening members **60** via the positive electrode layer **10** and the negative electrode layer **20**. The separator **50** with low rigidity is easily deformed by being pressurized by a fastening force of the fastening members **60**. As the separator **50** is deformed, the electrolytic solution therein easily seeps out, and the seeped-out electrolytic solution is easily supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40**.

<Detailed Configuration of a Separator>

[0026] Before describing the detailed configuration of the separator **50** in the present embodiment, precipitation of lithium that occurs in a secondary battery **100** according to a comparative example in which the separator **50** is not provided will be described with reference to FIG. **2**.

[0027] FIG. **2** is a schematic view for explaining an internal short circuit in the secondary battery **100** according to the comparative example. The secondary battery **100** has a laminated structure including a positive electrode layer **110**, a negative electrode layer **120**, and a solid electrolyte layer **130**.

[0028] In FIG. **2**, an area where lithium precipitation has occurred is shown as an enlarged view. Here, an uneven part exists in the negative electrode layer **120**, causing current to concentrate at this part, which in turn leads to the occurrence of lithium precipitation from said area. As shown in the enlarged view of FIG. **2**, lithium precipitates in the form of dendrites (acicular crystals) within the solid electrolyte layer **130**. The lithium precipitated from the negative electrode layer **120** progresses through the gaps between particles **132**, which are solid electrolytes within the solid electrolyte layer **130**, and reaches the positive electrode layer **110**, as indicated by a bold line in the enlarged view. When the precipitated lithium reaches the positive electrode layer **110**, an internal short circuit would occur between the negative electrode layer **20** and the positive electrode layer **110**.

[0029] A detailed configuration of the separator **50** according to the present embodiment for suppressing the occurrence of the internal short circuit described above will be explained with reference to FIGS. **3** to **5**. FIG. **3** is a schematic view for explaining the configuration of the separator **50**. FIG. **4** is a schematic view showing a hole **53** included in an upper surface **51***a* of the separator **50**.

[0030] The separator **50** contains an electrolytic solution therein. The electrolytic solution within the separator **50** is, for example, 1 mol/L LiPF6 EC/DMC. LiPF6 is lithium hexafluorophosphate, EC is ethylene carbonate, and DMC is dimethyl carbonate. Moreover, it is desirable that the electrolytic solution within the separator **50** has low volatility characteristics and is, for example, a high concentration electrolytic solution or an electrolytic solution using a low boiling point solvent. Furthermore, it is desirable that the electrolytic solution within the separator **50** reacts with the precipitated lithium stably and does not generate gas during the reaction.

[0031] Since the separator **50** is made of the porous base material, the electrolytic solution within the separator **50** is supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40**, as indicated by arrows in FIG. **3**. The electrolytic solution contained within the separator **50** is supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40** during the manufacturing of the secondary battery **1**, for example.

[0032] More specifically, during the manufacturing of the secondary battery **1**, when the fastening members **60** fasten the positive electrode layer **10** and the negative electrode layer **20** while the positive electrode layer **10**, the first solid electrolyte layer **30**, the separator **50**, the second solid electrolyte layer **40**, and the negative electrode layer **20** are laminated, as shown in FIG. **1**, the electrolytic solution within the separator **50** is supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. When the positive electrode layer **10** and the negative electrode layer **20** are fastened by the fastening members **60**, the separator **50** deforms, making it easier for the electrolytic solution within the separator **50** to flow out to the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. In particular, reducing the thickness of the separator **50** increases its deformability, which can promote the supply of the electrolytic solution within the separator **50** to the first solid electrolyte layer **30** and the second solid electrolyte layer **40**.

[0033] The electrolytic solution supplied into the first solid electrolyte layer **30** disperses so as to fill the gaps between particles **32**, which are solid electrolytes within the first solid electrolyte layer **30**. Similarly, the electrolytic solution supplied into the second solid electrolyte layer **40** disperses so as to fill the gaps between particles **42**, which are solid electrolytes within the second solid electrolyte layer **40**.

[0034] A plurality of holes **53** for supplying the electrolytic solution contained within the separator **50** to the solid electrolyte layer are formed in the surface of the separator **50**. The plurality of holes **53** are formed at predetermined intervals across the entire surface of the separator **50**. This arrangement facilitates an even distribution of the electrolytic solution within the solid electrolyte layer through the holes **53**.

[0035] The plurality of holes **53** are formed on both the upper surface **51***a* and a lower surface **51***b* of the separator **50**. The upper surface **51***a* of the separator **50** is a surface facing the first solid electrolyte layer **30**, and the lower surface **51***b* is a surface facing the second solid electrolyte layer **40**. Therefore, in the present embodiment, the upper surface **51***a* corresponds to a first surface of the separator **50**, and the lower surface **51***b* corresponds to a second surface.

[0036] As shown in the enlarged view of FIG. **4**, a plurality of holes **53** are formed at predetermined intervals across the upper surface **51***a*. Although FIG. **4** shows the holes **53** only in the enlarged view for descriptive convenience, the holes **53** are actually formed across the entire upper surface **51***a*. In addition, in FIG. **4**, the shapes of the holes **53** are circular, but this is not a limitation, and the holes **53** may be rectangular or other shapes. The electrolytic solution within the separator **50** is supplied to the first solid electrolyte layer **30** through the holes **53** on the upper surface **51***a*. It should be noted that, although the plurality of holes **53** are described as being formed at predetermined intervals, the present embodiment is not limited thereto, and the intervals between the holes **53** may be uneven.

[0037] Similarly to the upper surface **51***a*, a plurality of holes **53** are formed at predetermined intervals across the lower surface **51***b*. The electrolytic solution within the separator **50** is supplied to the second solid electrolyte layer **40** through the holes **53** on the lower surface **51***b*. Although the plurality of holes **53** on the lower surface **51***b* are described as being formed at predetermined intervals, the present embodiment is not limited thereto, and the intervals between the holes **53** may be uneven. In the present embodiment, the holes **53** formed on the upper surface **51***a* correspond to first holes, and the holes **53** formed on the lower surface **51***b* correspond to second holes.

[0038] The electrolytic solution supplied from the separator **50** disperses so as to fill the gaps between the particles **32**, which are the solid electrolytes within the first solid electrolyte layer **30**, and the gaps between the particles **42**, which are the solid electrolytes within the second solid electrolyte layer **40**, whereby precipitation of lithium is suppressed as shown in FIG. **5**.

[0039] FIG. **5** is a schematic view showing a state in which precipitation of lithium is suppressed. In FIG. **5**, the precipitation state of lithium is indicated by a thick line. Here, it is assumed that the electrolytic solution is dispersed in the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. Specifically, the electrolytic solution fills the gaps between the particles **32** and the gaps between the particles **42**. The lithium precipitated from the negative electrode layer **20** is in contact with the electrolytic solution within the second solid electrolyte layer **40**. When lithium comes into contact with the electrolytic solution, the lithium reacts with the electrolytic solution to form a lithium compound having non-electron conductivity, so that precipitation of lithium is suppressed. Thus, the precipitated lithium can be prevented from reaching the positive electrode layer **10**.

[0040] The sizes of the holes **53** in the lower surface **51***b* may be different from the sizes of the holes **53** in the upper surface **51***a*. For example, the sizes of the holes **53** in the lower surface **51***b* are larger than the sizes of the holes **53** in the upper surface **51***a*. In this case, the electrolytic solution is more easily supplied to the second solid electrolyte layer **40** than to the first solid electrolyte layer **30**. As a result, precipitation of lithium in the second solid electrolyte layer **40** is easily suppressed. The sizes of the holes **53** in the upper surface **51***a* may be larger than the sizes of the holes **53** in the lower surface **51***b*.

[0041] The interval between the holes **53** in the lower surface **51***b* may be different from the interval between the holes **53** in the upper surface **51***a*. For example, the interval between the holes **53** in the lower surface **51***b* is smaller than the interval between the holes **53** in the upper surface **51***a*. In this case, many holes **53** are formed in the lower surface **51***b*, and the electrolytic solution is easily supplied to the second solid electrolyte layer **40**. As a result, precipitation of lithium in the second solid electrolyte layer **40** is easily suppressed. It should be noted that the present embodiment is not limited to the above, and the interval between the holes **53** in the upper surface **51***a* may be smaller than the interval between the holes **53** in the lower surface **51***b*.

[0042] The capacity of the electrolytic solution contained within the separator **50** is preset. For example, the capacity of the electrolytic solution is equivalent to the total volume of the gaps between the solid electrolytes (particles **32** within the first solid electrolyte layer **30** and particles **42** within second solid electrolyte layer **40**). As a result, the electrolytic solution can fill the entire set of gaps between the solid electrolytes, thereby suppressing lithium precipitation within the first solid electrolyte layer **30** and the second solid electrolyte layer **40**.

[0043] However, the present embodiment is not limited to this arrangement, and the capacity of the electrolytic solution may be less than the total volume of the gaps between the solid electrolytes (particles **32** within the first solid electrolyte layer **30** and particles **42** within the second solid electrolyte layer **40**) by a predetermined amount. For example, the capacity of the electrolytic solution may alternatively be equivalent only to the volume of the gaps between the solid electrolytes within the second solid electrolyte layer **40**. Even in such a case, the electrolytic solution still disperses over a wide area within the first solid electrolyte layer **30** and the second solid electrolyte layer **40**, thereby suppressing lithium precipitation.

<Manufacturing Method for the Secondary Battery>

[0044] FIG. **6** is a flowchart illustrating a manufacturing process of the secondary battery **1**.

[0045] First, an operator prepares the positive electrode layer **10**, the negative electrode layer **20**, the first solid electrolyte layer **30**, the second solid electrolyte layer **40**, and the separator **50** (step S**102**). Here, an electrolytic solution is contained within the separator **50**.

[0046] Next, the operator stacks the prepared positive electrode layer **10**, negative electrode layer **20**, first solid electrolyte layer **30**, second solid electrolyte layer **40**, and separator **50** (step S**104**).

Specifically, the operator sandwiches the first solid electrolyte layer **30** and the second solid electrolyte layer **40**, with the separator **50** positioned between them so that each is in contact with the separator **50**, between the positive electrode layer **10** and the negative electrode layer **20**.

[0047] Next, the operator fastens the positive electrode layer **10** and the negative electrode layer **20** together using the fastening members **60**, which pressurizes the separator **50** (step S**106**). The electrolytic solution inside the separator **50**, deformed as a result of the applied pressure, is supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40** through the holes **53** in the surfaces of the separator **50**. The supply amount of electrolytic solution is proportional to the fastening force applied by the fastening members **60**. Specifically, the greater the fastening force of the fastening members **60**, the greater the amount of deformation of the separator **50**, thereby increasing the supply amount of the electrolyte. Therefore, the operator can adjust the fastening force of the fastening members **60** so that the electrolytic solution inside the separator **50** is supplied to the first solid electrolyte layer **30** and the second solid electrolyte layer **40** in a desired amount.

Modification Example

[0048] In the embodiment described above, the secondary battery **1** includes the first solid electrolyte layer **30** and the second solid electrolyte layer **40**. However, it is not limited to this configuration and may include one of the first solid electrolyte layer **30** and the second solid electrolyte layer **40**.

[0049] FIG. **7** is a schematic diagram illustrating a secondary battery **1** according to a modification example. The secondary battery **1** according to the modification example includes the positive electrode layer **10**, the negative electrode layer **20**, the second solid electrolyte layer **40**, the separator **50**, and the fastening members **60**, but does not include the first solid electrolyte layer **30**. The separator **50** is sandwiched between the positive electrode layer **10** and the second solid electrolyte layer **40**. The separator **50** according to the modification example has the same configuration as the separator **50** illustrated in FIG. **1** described above. Specifically, the separator **50** contains the electrolytic solution therein, and the plurality of holes **53** (FIG. **4**) for supplying the electrolytic solution to the second solid electrolyte layer **40** are formed in the surface of the separator **50**.

[0050] Also in the modification example, the electrolytic solution within the separator **50** is supplied to the second solid electrolyte layer **40** through the holes **53**, dispersing into the first solid electrolyte layer **30**. In this way, even if lithium is precipitated from the negative electrode layer **20**, the lithium reacts with the electrolytic solution within the second solid electrolyte layer **40** upon contact, thereby suppressing further lithium precipitation in the second solid electrolyte layer **40**. As a result, the deposited lithium can be prevented from coming into contact with the positive electrode layer **10**.

Effects of the Embodiment

[0051] The secondary battery **1** of the present embodiment described above includes the separator **50** in contact with the solid electrolyte layer (specifically, both the first solid electrolyte layer **30** and the second solid electrolyte layer **40**) disposed between the positive electrode layer **10** and the negative electrode layer **20**. The plurality of holes **53** for supplying the electrolytic solution contained within the separator **50** to the solid electrolyte layer are formed in the surface of the separator **50**. In this configuration, the electrolytic solution supplied from the separator **50** disperses into the solid electrolyte layer. Specifically, the electrolytic solution disperses between the particles, which are the solid electrolytes within the solid electrolyte layer. Consequently, even if lithium precipitates from the negative electrode layer **20**, the lithium will react with the electrolytic solution within the solid electrolyte layer to form a lithium compound, which suppresses the progression of lithium precipitation in the solid electrolyte layer. As a result, it is possible to prevent the precipitated lithium from contacting the positive electrode layer **10**, thereby preventing the occurrence of an internal short circuit.

[0052] The present disclosure is explained on the basis of the exemplary embodiments. The technical scope of the present disclosure is not limited to the scope explained in the above embodiments and it is possible to make various changes and modifications within the scope of the disclosure. For example, all or part of the apparatus can be configured with any unit which is functionally or physically dispersed or integrated. Further, new exemplary embodiments generated by arbitrary combinations of them are included in the exemplary embodiments. Further, effects of the new exemplary embodiments brought by the combinations also have the effects of the original exemplary embodiments.

Claims

1. A secondary battery comprising: a positive electrode layer; a negative electrode layer; a solid electrolyte layer provided between the positive electrode layer and the negative electrode layer, containing a solid electrolyte through which lithium ions migrate; and a separator in contact with the solid electrolyte layer between the positive electrode layer and the negative electrode layer, wherein a plurality of holes for supplying an electrolytic solution contained within the separator to the solid electrolyte layer are formed in the surface of the separator.
2. The secondary battery according to claim 1, wherein the solid electrolyte layer comprises a first solid electrolyte layer facing the positive electrode layer and a second solid electrolyte layer facing the negative electrode layer, and the separator is sandwiched between the first solid electrolyte layer and the second solid electrolyte layer.
3. The secondary battery according to claim 2, wherein a plurality of first holes for supplying the electrolytic solution to the first solid electrolyte layer are formed in a first surface of the separator facing the first solid electrolyte layer, a plurality of second holes for supplying the electrolytic solution to the second solid electrolyte layer are formed in a second surface of the separator facing the second solid electrolyte layer, and the sizes of the second holes are different from the sizes of the first holes.
4. The secondary battery according to claim 2, wherein a plurality of first holes for supplying the electrolytic solution to the first solid electrolyte layer are formed in a first surface of the separator facing the first solid electrolyte layer, a plurality of second holes for supplying the electrolytic solution to the second solid electrolyte layer are formed in a second surface of the separator facing the second solid electrolyte layer, and an interval between the second holes is different from an interval between the first holes.
5. The secondary battery according to claim 2, wherein a first solid electrolyte included in the first solid electrolyte layer is different from a second solid electrolyte included in the second solid electrolyte layer.
6. The secondary battery according to claim 1, further comprising: fastening members that fasten the positive electrode layer and the negative electrode layer with the solid electrolyte layer and the separator sandwiched therebetween, wherein the separator is pressurized by the fastening members via the positive electrode layer and the negative electrode layer.
7. The secondary battery according to claim 1, wherein the capacity of the electrolyte solution is equivalent to the total volume of gaps between the solid electrolytes in the solid electrolyte layer.
8. The secondary battery according to claim 1, wherein the capacity of the electrolytic solution is less than the total volume of gaps between the solid electrolytes in the solid electrolyte layer by a predetermined amount.
9. The secondary battery according to claim 1, wherein the plurality of holes are formed at predetermined intervals across the entire surface of the separator.
10. A method for manufacturing a secondary battery, the method comprising: preparing a positive electrode layer, a negative electrode layer, a solid electrolyte layer containing a solid electrolyte through which lithium ions migrate, and a separator containing an electrolytic solution therein;

sandwiching the solid electrolyte layer and the separator between the positive electrode layer and the negative electrode layer so that solid electrolyte layer is in contact with the separator; and pressurizing the separator having a plurality of holes for supplying the electrolyte solution to the solid electrolyte layer, by fastening the positive electrode layer and the negative electrode layer.

11. The method of manufacturing the secondary battery according to claim 10, wherein the pressurizing includes adjusting a fastening force between the positive electrode layer and the negative electrode layer applied by fastening members so that the separator to be pressurized deforms.