

ORIGINAL

SECONDARY BATTERY, ELECTRONIC DEVICE, ELECTRIC POWER TOOL,
ELECTRICAL VEHICLE, AND ELECTRIC POWER STORAGE SYSTEM

ABSTRACT

A secondary battery capable of suppressing resistance rise even after repeated charge and discharge is provided. The secondary battery includes a cathode, an anode, and an electrolytic solution. The anode contains titanium-containing lithium composite as an anode active material, and the electrolytic solution contains cyclic disulfonic acid anhydride.

What is claimed is:

1. A secondary battery comprising:

a cathode;

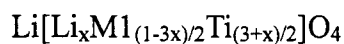
an anode; and

an electrolytic solution,

wherein the anode contains one or more of titanium-containing lithium composite oxides expressed by the following Formula 1 to Formula 3 as an anode active material, and

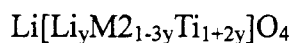
the electrolytic solution contains cyclic disulfonic acid anhydride expressed by the following Formula 4 or cyclic disulfonic acid anhydride expressed by the following Formula 5 or both.

Formula 1



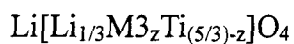
where M1 is one or more of Mg, Ca, Cu, Zn, and Sr, and x satisfies $0 \leq x \leq 1/3$.

Formula 2



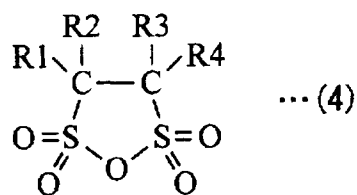
where M2 is one or more of Al, Sc, Cr, Mn, Fe, Ga, and Y, and y satisfies $0 \leq y \leq 1/3$.

Formula 3



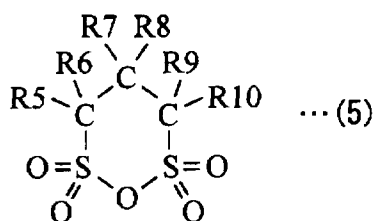
where M3 is one or more of V, Zr, and Nb, and z satisfies $0 \leq z \leq 2/3$.

Formula 4



where R1 to R4 are an alkyl group ($\text{C}_m\text{H}_{2m+1}$: m satisfies $0 \leq m \leq 4$).

Formula 5



where R5 to R10 are an alkyl group ($\text{C}_n\text{H}_{2n+1}$: n satisfies $0 \leq n \leq 4$).

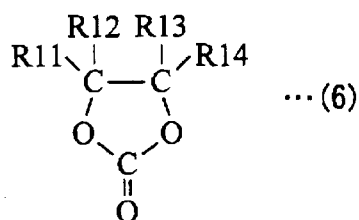
2. The secondary battery according to claim 1, wherein the cyclic disulfonic acid anhydride is 1,2-ethanedisulfonic acid anhydride or 1,3-propanedisulfonic acid anhydride or both.

3. The secondary battery according to claim 1, wherein a content of the cyclic disulfonic acid anhydride in the electrolytic solution is from 0.1 wt% to 5 wt% both inclusive.

4. The secondary battery according to claim 1, wherein the electrolytic solution contains halogenated cyclic ester carbonate expressed by the following Formula 6 or unsaturated carbon bond cyclic ester carbonate expressed by the following Formula 7 or

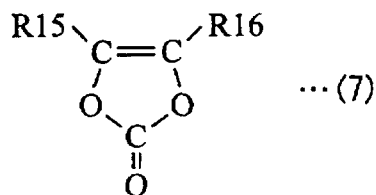
both.

Formula 6



where R11 to R14 are a hydrogen group, a halogen group, an alkyl group (C_pH_{2p+1} : p satisfies $0 \leq p \leq 4$), or a halogenated alkyl group ($C_qH_{2q+1}X_r$: X is a halogen, q satisfies $0 \leq q \leq 4$, and r satisfies $0 \leq r \leq 2q+1$), and one or more of R11 to R14 are a halogen group or a halogenated alkyl group.

Formula 7



where R15 and R16 are an alkyl group (C_sH_{2s+1} : s satisfies $0 \leq s \leq 4$).

5. The secondary battery according to claim 4, wherein the halogenated cyclic ester carbonate is 4-fluoro-1,3-dioxolane-2-one, and the unsaturated carbon bond cyclic ester carbonate is vinylene carbonate.

6. The secondary battery according to claim 1, wherein the electrolytic solution contains propylene carbonate as a cyclic ester carbonate.

7. The secondary battery according to claim 1, wherein the cathode and the anode are layered with a separator in between, and

the separator includes a base material layer as a porous film and a polymer compound layer provided on one or both surfaces of the base material layer.

8. The secondary battery according to claim 7, wherein the polymer compound layer contains polyvinylidene fluoride.

9. The secondary battery according to claim 1, wherein the secondary battery is a lithium ion secondary battery.

10. An electronic device using the secondary battery according to claim 1.

11. An electric power tool using the secondary battery according to claim 1.

12. An electrical vehicle using the secondary battery according to claim 1.

13. An electric power storage system using the secondary battery according to claim 1.

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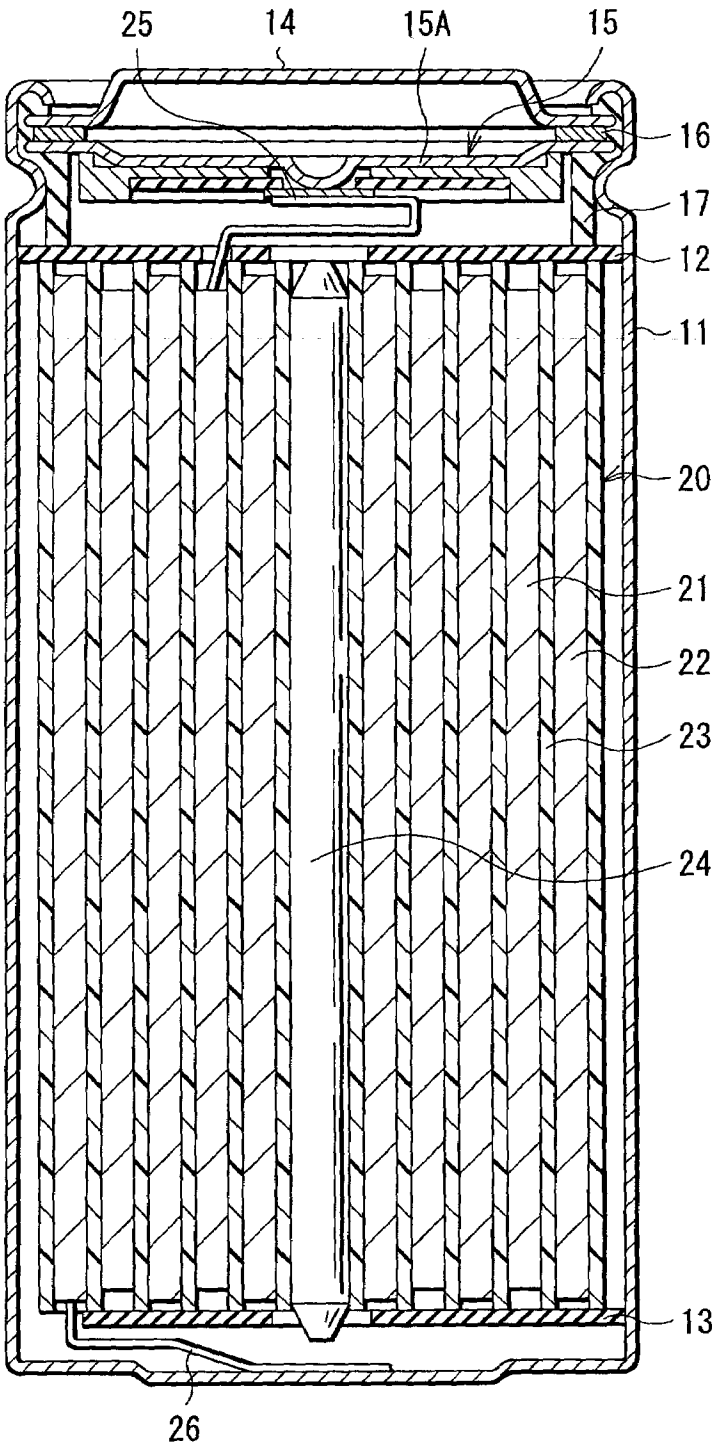


FIG. 1

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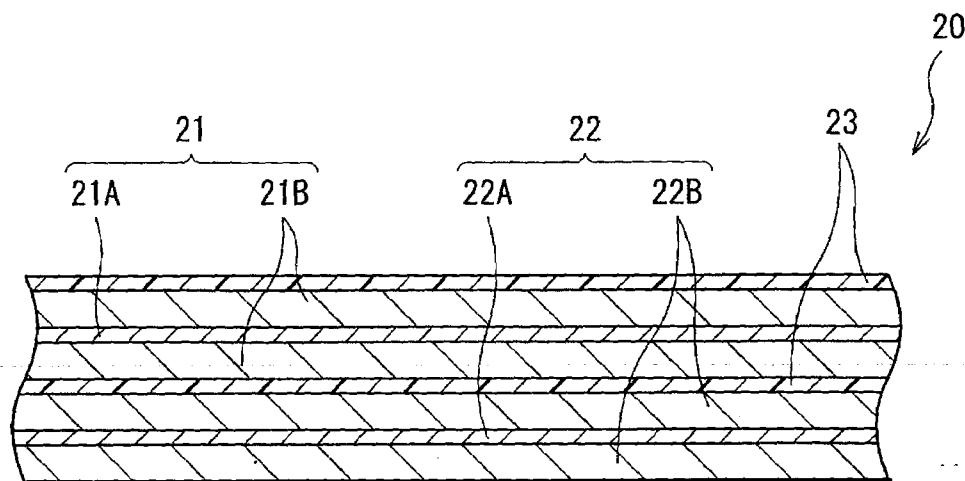


FIG. 2

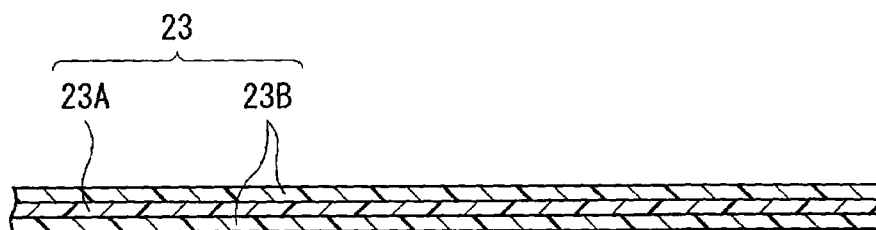


FIG. 3


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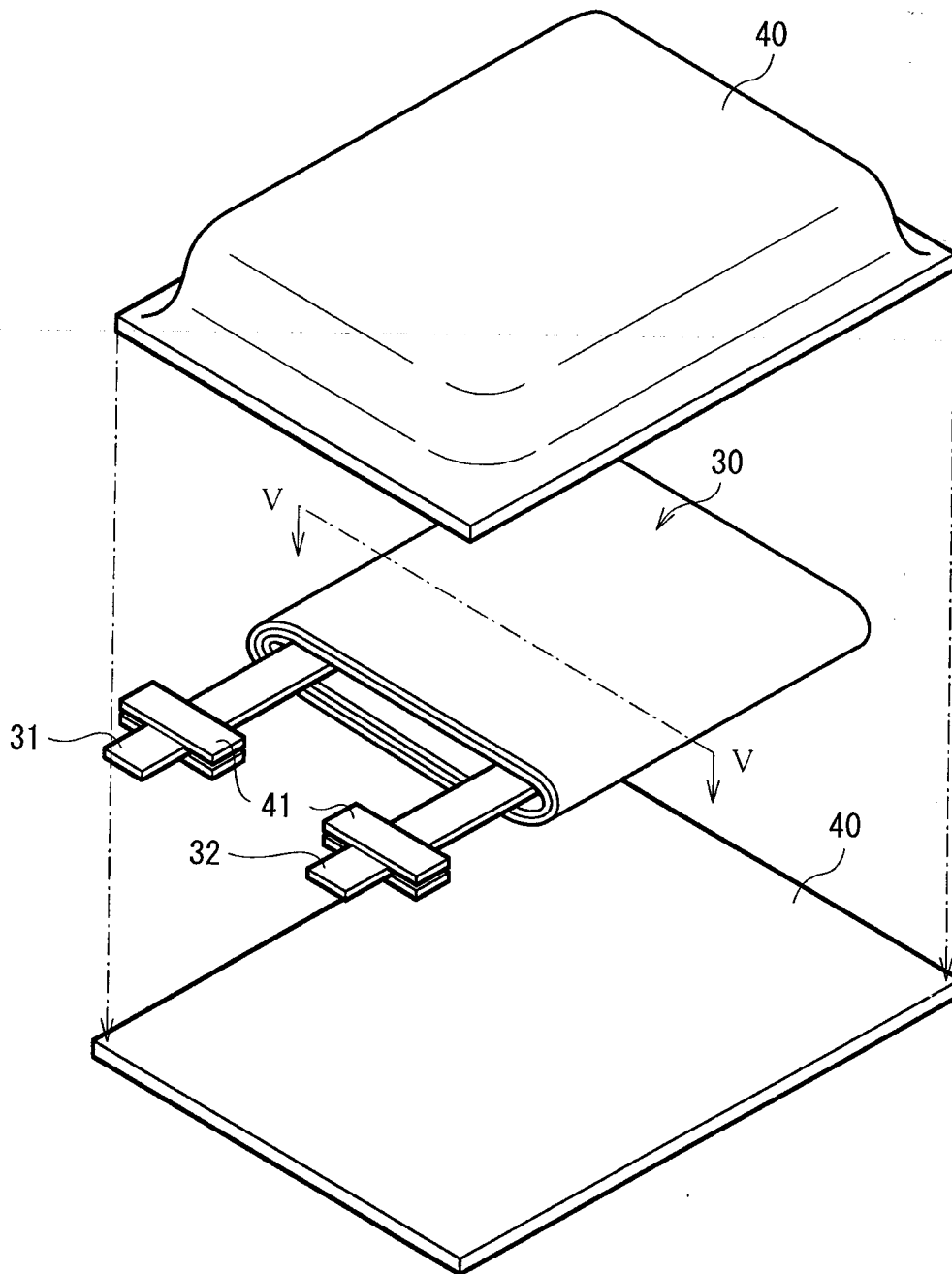


FIG. 4

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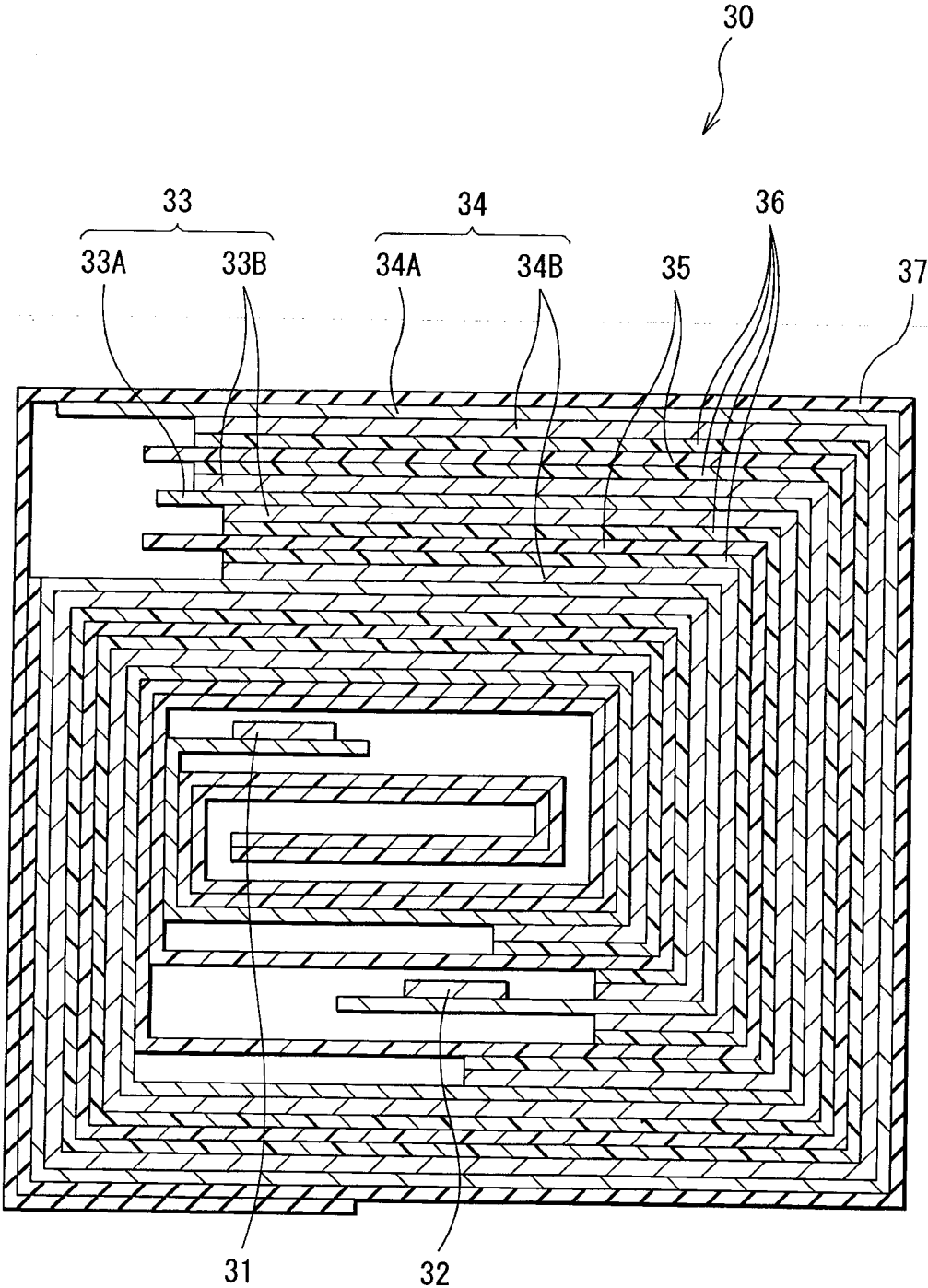


FIG. 5


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BACKGROUND

[0001] The present technology relates to secondary batteries including a cathode, an anode, and an electrolytic solution, electronic devices using the same, electric power tools using the same, electrical vehicles using the same, and electric power storage systems using the same.

[0002] In recent years, electronic devices represented by a mobile phone and a Personal Digital Assistant (PDA) have been widely used, and it has been strongly demanded to further reduce their size and weight and to achieve their long life. Accordingly, as a power source for the electronic devices, a battery, in particular, a small and light-weight secondary battery capable of providing a high energy density has been developed. In recent years, it has been considered to apply such a secondary battery not only to the foregoing electronic devices but also to various applications represented by an electric power tool such as an electrical drill, an electrical vehicle such as an electrical automobile, and an electric power storage system such as a home electrical power server.

[0003] As the secondary batteries, secondary batteries using various charge and discharge principles have been widely proposed. Specially, lithium ion secondary batteries using insertion and extraction of lithium ions are considered promising, since the lithium ion secondary batteries are able to provide a higher energy density than that of lead batteries, nickel cadmium batteries and the like.

[0004] The secondary batteries include a cathode, an anode, and an electrolytic solution. The cathode and the anode respectively contain a cathode active material and