CLAIMS

1. A lithium-ion battery, comprising a case, a cell, and an electrolyte solution, wherein the cell and the electrolyte solution are arranged in the case; the cell comprises a positive electrode plate, a negative electrode plate, and a separator; the separator is arranged between the positive electrode plate and the negative electrode plate; the positive electrode plate comprises a positive electrode current collector and a positive electrode active material layer; the positive electrode active material layer is electrically connected to the positive electrode current collector; the negative electrode plate comprises a negative electrode current collector and a negative electrode active material layer; the negative electrode active material layer is electrically connected to the negative electrode current collector;

at least one surface of the negative electrode current collector is provided with the negative electrode active material layer, and a thickness of the active material layer on one surface of the negative electrode plate is 50-95 μm; the negative electrode active material layer comprises a negative electrode active material, and the negative electrode active material comprises graphite; Dv50 of the graphite is 10-30 μm, and a graphitization degree of the graphite is greater than or equal to 90%;

at least one surface of the positive electrode current collector is provided with the positive electrode active material layer, and the thickness of the active material layer on one surface of the positive electrode plate is 60-105 μm; the positive electrode active material layer comprises a positive electrode active material, and the positive electrode active material comprises lithium-containing phosphate and a carbon layer located on a surface of the lithium-containing phosphate; and

a capacity L of the lithium-ion battery is shown as $500Ah<L\leq700Ah$, and an actual gas storage space v of the lithium-ion battery is $>190cm^3$.

2. The lithium-ion battery according to claim 1, wherein

the capacity L of the lithium-ion battery is shown as 500Ah<L≤600Ah, and the theoretical gas storage space of the lithium-ion battery is V0, and V0=0.38cm^3/Ah·L; or,

the capacity L of the lithium-ion battery is shown as 600Ah<L≤700Ah, and the theoretical gas storage space of the lithium-ion battery is V0, and V0=0.44cm^3/Ah·L; and

the actual gas storage space v of the lithium-ion battery is greater than or equal to the theoretical gas storage space V0.

3. The lithium-ion battery according to claim 1, wherein

the capacity L of the lithium-ion battery is shown as 500Ah<L≤600Ah, and the theoretical gas storage space of the lithium-ion battery is V0, and V0=0.54cm^3/Ah·L; or,

the capacity L of the lithium-ion battery is shown as 600Ah<L≤700Ah, and the theoretical gas storage space of the lithium-ion battery is V0, and V0=0.65cm^3/Ah·L; and

the actual gas storage space v of the lithium-ion battery is greater than or equal to the theoretical gas storage space V0.

4. The lithium-ion battery according to claim 2, wherein

the capacity L of the lithium-ion battery is shown as 500Ah<L≤600Ah, and the theoretical gas storage space of the lithium-ion battery is V0max, and V0max=0.54cm^3/Ah·L; or,

the capacity L of the lithium-ion battery is shown as 600Ah<L≤700Ah, and the theoretical gas storage space of the lithium-ion battery is V0max, and V0max=0.65cm^3/Ah·L; and

the actual gas storage space v of the lithium-ion battery is greater than or equal to the theoretical gas storage spaces V0max.

5. The lithium-ion battery according to any one of claims 1 to 4, wherein at least part of the surface of graphite is coated with a carbon layer, the Dv90 of the graphite is ≤40μm, the Dv10 of the graphite is ≥3μm, and the Dv99 of the graphite is ≤49μm; and/or,

an OI value of the graphite is 3-30; and/or,

the graphitization degree of the graphite is 90%-95%.

6. The lithium-ion battery according to claim 5, wherein the graphitization degree of the graphite is 91%-95%; and/or,

the OI value of the graphite is 15-30.

7. The lithium-ion battery according to any one of claims 1 to 4, wherein a surface density of the active material layer on one surface of the negative electrode plate is 0.07mg/mm^2-0.13mg/mm^2; and/or

a compaction density of the active material layer on one surface of the negative electrode plate is 1.3g/cc-1.7g/cc; and/or

a surface density of the active material layer on one surface of the positive electrode plate is 0.16mg/mm^2-0.26mg/mm^2; and/or

a compaction density of the active material layer on one surface of the positive electrode plate is 2.3g/cc-2.7g/cc.

8. The lithium-ion battery according to any one of claims 1 to 4, wherein the separator comprises a base film and a coating, the coating is adhered to a surface of the base film and partially located in the base film, and a porosity of the separator is 30%-50%.

9. The lithium-ion battery according to claim 5, wherein a thickness of the carbon layer on the surface of the graphite is 0.5-2 μm.

10. The lithium-ion battery according to any one of claims 1 to 4, wherein the negative electrode active material layer further comprises a carbon tube; and/or,

the negative electrode active material layer further comprises silicon, and a mass content of the silicon in the negative electrode active material layer is 1%-8%.

11. The lithium-ion battery according to any one of claims 1 to 4, wherein the lithium-containing phosphate comprises lithium iron phosphate that is doped with a metal element, and the metal element is selected from at least one of titanium and vanadium;

the doped metal element accounts for not greater than 0.4% of the mass of the positive electrode active material; and

the doped metal elements comprise titanium, and the titanium accounts for 0.2%-0.4% of the mass of the positive electrode active material.

12. The lithium-ion battery according to any one of claims 1 to 4, wherein the positive electrode active material layer comprises the carbon tube, and the carbon tube comprises at least one of the oligowalled carbon tube and the single-walled carbon tube.

13. The lithium-ion battery according to any one of claims 1 to 4, wherein the electrolyte solution comprises a lithium salt and a solvent, a molar content by volume of the lithium salt is 0.8mol/L-1.5mol/L, and the lithium salt comprises lithium hexafluorophosphate;

the lithium salt also comprises lithium bis(fluorosulfonyl)imide;

the molar content by volume of lithium hexafluorophosphate is higher than that of lithium bis(fluorosulfonyl)imide; and/or

the lithium bis(fluorosulfonyl)imide accounts for 3%-9% of the mass of the electrolyte solution.

14. The lithium-ion battery according to claim 13, wherein the solvent comprises EC, DMC, EMC, and DEC; the content of EC is 30%-40%, and a sum of the mass of DMC and the mass of EMC is greater than the mass of EC; and the content of EC is a quotient of the mass of EC/ (difference value between the mass of the electrolyte solution and the mass of the lithium salt).

15. The lithium-ion battery according to claim 14, wherein the total content of EMC and DMC is 50%-60%; and the total content of EMC and DMC is the quotient of the total mass of EMC and DMC/ (difference value between the mass of the electrolyte solution and the mass of the lithium salt); and

the content of DMC is 10%-15%; and the content of DMC is the quotient of the mass of the DMC/(difference value between the mass of the electrolyte solution and the mass of the lithium salt).

16. The lithium-ion battery according to claim 13, wherein the electrolyte solution also comprises carboxylic ester, with the content not greater than 10%; and the content of the carboxylic ester is the quotient of the mass of the carboxylic ester/ (difference value between the mass of the electrolyte solution and the mass of the lithium salt).

17. The lithium-ion battery according to any one of claims 13 to 16, wherein the negative electrode plate is of a square structure, a width of the negative electrode plate is 200-250 mm, and the porosity of the separator is 35%-50%.

18. The lithium-ion battery according to any one of claims 13 to 17, wherein the length-width ratio of the cell is 6-8 or 2.8-4.

19. The lithium-ion battery according to any one of claims 1 to 4, wherein the negative electrode plate comprises negative electrode tabs which are electrically connected to the negative electrode current collector; the positive electrode plate comprises positive electrode tabs which are electrically connected to the positive electrode current collector;

the case comprises a positive electrode terminal post, a negative electrode terminal post, and an explosion-proof valve; the positive electrode terminal post is electrically connected to the positive electrode tabs; the negative electrode terminal post is electrically connected to the negative electrode tab; the explosion-proof valve is arranged at a first end of the case; at least one of the positive electrode terminal post and the negative electrode terminal post is also arranged at the first end of the case; a gas pressure for opening the explosion-proof valve is 0.55-0.65 Mpa; and a ratio of an area of the explosion-proof valve to the capacity of the lithium-ion battery is $0.5mm^2/Ah$-$1.5mm^2/Ah$.

20. The lithium-ion battery according to claim 19, wherein the positive electrode terminal post is arranged at the first end of the case; the positive electrode tabs are arranged on a short edge of the positive electrode current collector; a first upper exhaust channel is formed between upper ends of the positive electrode tabs and the case; and in an airflow direction of the first upper exhaust channel, a projection area of the explosion-proof valve is at least partially overlapped with the projection area of the first upper exhaust channel.

21. The lithium-ion battery according to claim 20, wherein in the airflow direction of the first upper exhaust channel, an overlap ratio of the projection area of the explosion-proof valve and the projection area of the first upper exhaust channel exceeds 80%; the overlap ratio of the projection area of the explosion-proof valve and the projection area of the first upper exhaust channel is a ratio of an area of the overlapping area of the projection area of the explosion-proof valve and the projection area of the first upper exhaust channel to an area of the projection area of the first upper exhaust channel.

22. The lithium-ion battery according to claim 20 or 21, wherein the positive electrode tabs are asymmetrically distributed on the short edge of the positive electrode current collector; and

in a width direction of the cell, a vertical distance from upper ends of the positive electrode tabs to an upper end of the positive electrode plate is a first distance, the vertical distance from lower ends of the positive electrode tabs to a lower end of the positive electrode plate is a second distance, and the first distance is greater than the second distance.

23. The lithium-ion battery according to claim 19, wherein the negative electrode terminal post is arranged at a first end of the case, the negative electrode tabs are arranged on the short edge of the negative electrode current collector, a second upper exhaust channel is formed between upper ends of the negative electrode tabs and the case; and in the airflow direction of the second upper exhaust channel, the projection area of the explosion-proof valve and the projection area of the second upper exhaust channel are at least partially overlapped.

24. The lithium-ion battery according to claim 23, wherein in the airflow direction of the second upper exhaust channel, the overlap ratio of the projection area of the explosion-proof valve and the projection area of the second upper exhaust channel exceeds 80%; and the overlap ratio of the projection area of the explosion-proof valve and the projection area of the second upper exhaust channel is the ratio of the area of the overlapping area of the projection area of the explosion-proof valve and the projection area of the second upper exhaust channel to the area of the projection area of the second upper exhaust channel.

25. The lithium-ion battery according to claim 23 or 24, wherein the ratio of widths of the negative electrode tabs to a width of the short edge of the negative electrode current collector is 0.5-0.8.

26. The lithium-ion battery according to claim 23 or 24, wherein the negative electrode tabs are asymmetrically distributed on the short edge of the negative electrode current collector; and

in the width direction of the cell, a vertical distance from the upper ends of the negative electrode tabs to the upper end of the negative electrode plate is a third distance, the vertical distance from the lower ends of the negative electrode tabs to the lower end of the negative electrode plate is a fourth distance, and the third distance is greater than the fourth distance.

27. The lithium-ion battery according to any one of claims 1 to 4, wherein a difference value of Dv50 and Dv10 of graphite is ≤10μm, and the difference value of Dv90 and Dv50 of graphite is ≤15μm.

28. The lithium-ion battery according to any one of claims 1 to 4, wherein the negative electrode active material layer further comprises silicon; the thickness of the active material layer on one surface of the negative electrode plate is 50-70 μm, and a mass content of silicon in the negative electrode active material layer is 1%-10%; or

the negative electrode active material layer further comprises silicon; the thickness of the active material layer on one surface of the negative electrode plate is 70-80 μm, and a mass content of silicon in the negative electrode active material layer is 1%-8%; or

the negative electrode active material layer further comprises silicon; the thickness of the active material layer on one surface of the negative electrode plate is 80-95 μm, and a mass content of silicon in the negative electrode active material layer is 1%-5%.

29. The lithium-ion battery according to claim 16, wherein the content of the carboxylic ester is 5%-10%, and lithium bis(fluorosulfonyl)imide accounts for 2%-7% of the mass of the electrolyte solution.

30. The lithium-ion battery according to claim 5, wherein the negative electrode active material comprises primary particles consisting of graphite and a carbon layer on a surface of the graphite, and the Dv50 of the primary particles is 10-20 μm.

31. A charging method, being used for charging the lithium-ion battery according to any one of claims 1 to 30, and comprising a first charging section and a second charging section, wherein a voltage in the first charging section is less than that in the second charging section, the voltage of the first charging section increases as the charging time increases, and the voltage of the second charging section is unchanged; the first charging section comprises the following charging processes:

charging the lithium-ion battery with a first current within a first time;

charging the lithium-ion battery with a second current within a second time;

charging the lithium-ion battery with a third current within a third time; and

charging the lithium-ion battery with a fourth current within a fourth time;

the first current is greater than the second current, the first time is greater than the second time, the third current is not greater than the first current, the third time is greater than the

second time, the fourth current is less than the third current, and the fourth time is less than the third current.

32. The charging method according to claim 31, wherein the second current is equal to the fourth current.

33. A lithium-ion battery system, comprising a management module and the lithium-ion battery according to any one of claims 1 to 30, wherein the management module comprises a charging program for the lithium-ion battery, and the charging program implements the charging method according to claim 31 or 32.