

方形 110Ah 纳米钛酸锂电池规格书

SPECIFICATION of PRISMATIC 110Ah-LITHIUM TITANATE CELL

(产品型号: LTO51130205 /110Ah)

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Revision history

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1. 适用范围 Scope

本规格书描述纳米钛酸锂电池的基本参数、电化学特性、可靠性及其试验和判定标准、使用说明、安全规程、质量评定及包装、贮存和运输等，适用于格力钛新能源股份有限公司制造的 LTO51130205/110Ah 纳米钛酸锂电池。

This specification describes the nano lithium titanate cell's basic parameters, electrochemical characteristics, reliability and its test method, decision criteria, instructions, safety procedures, quality evaluation, packaging, storage, and transportation, etc. The specification is applied to the LTO51130205/110Ah lithium ion cell manufactured by GREE Altairnano New Energy Inc.

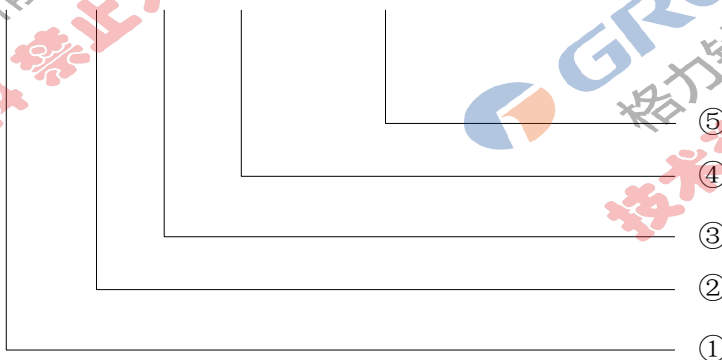
2. 概述 Description

产品型号：LTO51130205/110Ah 纳米钛酸锂电池。

Product model: LTO51130205/110Ah Lithium Titanate Cell.

2.1 命名规则 Naming Rules

LTO 51 130 205 / 110Ah



① 代表电芯采用的负极材料为钛酸锂。

Indicates the anode material of the cell, the letter "LTO" defines Lithium Titanate.

② 代表电池厚度 (mm)。

Indicates the thickness of the cell (mm).

③ 代表电池宽度 (mm)。

Indicates the width of the cell (mm).

④ 代表电池高度(mm)，用三位数字表示。

Indicates the overall height of the cell (mm) in three digits.

⑤ 代表电池容量。

Indicates the capacity of the cell.

2.2 电池构成 Cell Component

电池由正极、负极（钛酸锂）、隔离膜、电解液和铝制金属外壳等组成。电池壳体不带电。

The cell is composed of positive electrode and negative (lithium titanate), separator, electrolyte and aluminum metal shell etc. The case of the cell is neutral.

2.3 引用标准 Adopted Standard

GB/T 31484-2015 电动汽车用动力蓄电池循环寿命要求及试验方法

GB/T 31484-2015 Cycle life requirements and test methods for traction battery of electric vehicle

GB/T 31486-2015 电动汽车用动力蓄电池电性能要求及试验方法

GB/T 31486-2015 Electrical performance requirements and test methods for traction battery of electric vehicle

GB 38031-2020 电动汽车用动力蓄电池安全要求

GB 38031-2020 Electric vehicles traction battery safety requirements

Q/GRT 1.02.001—2022 纳米钛酸锂电池

Q/GRT 1.02.001—2022 Nano lithium titanate Secondary cell

联合国危险物品运输试验和标准手册 38.3 节

UN Manual of Tests and Criteria Subsection 38.3

IEC 62619:2022 含碱性或其他非酸性电解质的二次电池和电池组-用于工业应用二次锂电池和电池组的安全要求

IEC 62619:2022 Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications

3. 电池性能测试条件 Test Conditions of Cell Properties

3.1 标准测试条件 Standard Testing Conditions

3.1.1 标准测试环境 Standard Testing Environment

除非有其他特殊说明，本规格书中所有测试都在以下环境条件进行：

Unless otherwise specified, all tests in this Product Specification are conducted at flowing environment conditions:

温度：25℃ ±2℃；

Temperature: 25℃ ±2℃；

相对湿度：15%~90%；

Humidity: 15%~90%；

大气压力：86kPa~106kPa；

Atmospheric pressure: 86kPa~106kPa.

海拔：≤4000m。

Height above sea level: ≤4000m.

本规格书所提到的室温是指 25℃ ±2℃。

The room temperature mentioned in this product specification is 25℃ ±2℃.

3.1.2 标准充电方式 Standard Charge Method

在标准环境条件下，以 $1I_1(110A)$ 电流恒流充电至充电截止电压，停止充电。

Under standard test environment, the cell is charged to the standard charge cut-off voltage at a constant current of $1I_1$ (110A), then stopped charging.

3.1.3 标准放电方式 Standard Discharge Method

在标准环境条件下，以 $1I_1(110A)$ 电流恒流放电至放电截止电压，停止放电。

Under standard test environment, the cell is discharged to the standard discharge cut-off voltage at a constant current of $1I_1$ (110A), then stopped discharging.

3.1.4 初始容量 Initial Capacity

新出厂的电池，按照 3.1.3 放电，搁置 10min，再按照 3.1.2 充满电，所充的容量为初始充电容量；搁置 10min，再按照 3.1.3 放电，所放的容量为初始放电容量。

The fresh cell is discharged according to 3.1.3, rest 10min, and then charged according to 3.1.2, the charge capacity is defined to be initial charge capacity; rest 10min, discharged according to 3.1.3, the discharge capacity is defined to be initial discharge capacity.

3.2 测量器具及设备 Measuring Instruments or Apparatus

3.2.1 尺寸测量设备 Dimension Measuring Instrument

测量尺寸的仪器精度应不小于 0.01mm。

Dimension measurement shall be implemented by instruments which accuracy should not be less than 0.01 mm.

3.2.2 电压表 Voltmeter

国家标准或更灵敏等级，内阻不小于 10 k Ω /V。

Standard class specified in the national standard or more sensitive class with inner impedance not less than 10 k Ω /V.

3.2.3 电流表 Ammeter

国家标准或更灵敏等级，外部总内阻包括电流表和导线应小于 0.01 Ω 。

Standard class specified in the national standard or more sensitive class. Total external resistance including ammeter and wire is less than 0.01 Ω .

3.2.4 内阻测试仪 Impedance Meter

内阻测试仪测试方法为交流阻抗法(AC 1kHz LCR meter)。

Impedance shall be measured by a sinusoidal alternating current method (AC 1kHz LCR meter).

4. 技术规格 Specification

4.1 单体电池基本参数 Cell Specification

序号 No.	项目 Item	参数 Parameters	备注 Remark
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编制：余佳洛 审核：马美品 标准化：李丽珠 批准：詹世英
日期：2024/05/20 日期：2024/05/20 日期：2024/05/20 日期：2024/05/20

4.1.1	外观 Appearance	符合 GB/T 31486-2015 5.1.1 外观检验标准 Accord with GB/T 31486-2015 5.1.1 appearance inspection standard	电池外观不得有变形及裂纹，表面无毛刺、干燥、 无外伤、无污物，且宜有清晰、正确的标志 The appearance of the cell should not have any deformation or cracks, and the surface should be dry, free of burrs, trauma, dirt, and should have clear and correct marks.
4.1.2	额定容量 Rated Capacity	110Ah	25±2℃
4.1.3	标称电压 Nominal Voltage	2.3V	/
4.1.4	内阻 Internal Impedance	≤0.5mΩ	50%荷电状态下用交流法测量内阻 Internal resistance measured at AC 1kHz after 50% charged.
4.1.5	标准充电截止电压 Standard Charge Cut-off Voltage	2.9V	/
4.1.6	标准放电截止电压 Standard Discharge Cut-off Voltage	1.5V	/
4.1.7	最大持续充电电流 Maximum Continuous Charge Current	330A	25±2℃
4.1.8	最大持续放电电流 Maximum Continuous Discharge Current	330A	25±2℃
4.1.9	最大脉冲充/放电电流 (10s) Maximum Pulse Charge/Discharge Current (10s)	500A	25±2℃
4.1.10	工作温度范围 (充电和放电) Operating Temperature Range (charge and discharge)	温度: -40~55℃ 相对湿度: ≤85% Temperature: -40~55℃ Humidity: ≤85%RH	当电池温度低于 0℃时，建议充/放电电流≤1 I ₁ (110A) Recommended charge/discharge current ≤1 I ₁ (110A), when cell temperature is lower than 0℃.

4.1.11	储存温度范围 Storage Temperature Range	理想存储温度: $25 \pm 2^{\circ}\text{C}$ Ideal storage temperature: $25 \pm 2^{\circ}\text{C}$ 可接受存储温度: $-40^{\circ}\text{C} \sim 55^{\circ}\text{C}$ Acceptable storage temperature : $-40^{\circ}\text{C} \sim 55^{\circ}\text{C}$	$\leq 90\% \text{RH}$ 储存湿度范围。 Storage moisture range: $\leq 90\% \text{RH}$.
4.1.12	尺寸 Dimension	厚度: $51.0^{+1.0}\text{mm}$ 宽度: $130.0^{+1.0}\text{mm}$ 高度: $205.0^{+1.0}\text{mm}$ Thickness: $51.0^{+1.0}\text{mm}$ Width: $130.0^{+1.0}\text{mm}$ Height: $205.0^{+1.0}\text{mm}$	①电池详细尺寸, 请参看本规格书“13.电池结构示意图”。 The detailed dimension can be found in "13. Scheme of the cell structure" of this specification. ②测试厚度时需加压: 压力 2000~2500N。 Using 2000~2500N pressure When test the thickness of the cell.
4.1.13	重量 Weight	$3000 \pm 50\text{g}$	
4.1.14	质量能量密度 Weight-energy density	$\geq 80\text{Wh/kg}$	典型值: 84Wh/kg
4.1.15	体积能量密度 Volume-energy density	$\geq 178\text{Wh/L}$	典型值: 186Wh/L
4.1.16	电池保护温度 Cell protection temperature	55°C	

4.2 单体电池电化学性能参数 Cell Electrochemical Performance

序号 No.	项目 Item	测试方法 Test Method	标准 Criteria
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4.2.1	循环寿命 Cycle Life	在标准测试环境下，电池按 3.1.2 规定充电，搁置 30 分钟，而后按 3.1.3 规定放电，搁置 30 分钟，再进行下一个充放电循环，连续进行充放电循环 16000 次。 Under standard testing environment, the cell is charged in accordance with 3.1.2, rest 30 minutes, discharged in accordance with 3.1.3, rest 30 minutes, and then proceed to next charge-discharge cycle. The cell shall be continuously charged and discharged for 16000 cycles.	16000 次循环后，放电容量 $\geq 80\%$ * 初始放电容量 Discharge Capacity after 16000 cycles $\geq 80\%$ * initial discharge capacity
4.2.2	倍率充电性能 Rate Charge Performance	在标准测试环境下，电池按 3.1.3 规定放电，搁置 10 分钟，而后以 330A 电流充电至标准充电截止电压，计算充电容量 (Ah) 与初始充电容量的比值(%)。 Under standard testing environment, the cell is discharged in accordance with 3.1.3, rest 10 minutes, and then charged to standard cut-off voltage at a constant current of 330A. Calculate the ratio of charge capacity and initial charge capacity (%).	330A 充电容量 $\geq 90\%$ * 初始充电容量 330A Charging capacity $\geq 90\%$ * initial charge capacity
4.2.3	倍率放电性能 Rate Discharge Performance	在标准测试环境下，电池按 3.1.2 规定充电，搁置 10 分钟，而后以 330A 电流放电至标准放电截止电压，计算放电容量 (Ah) 与初始放电容量的比值(%)。 Under standard testing environment, the cell is charged in accordance with 3.1.2, rest 10 minutes, and then discharged to standard cut-off voltage at a constant current of 330A. Calculate the ratio of discharge capacity and initial discharge capacity (%).	330A 放电容量 $\geq 90\%$ * 初始放电容量 330A Discharging capacity $\geq 90\%$ * initial discharge capacity
4.2.4	低温充电性能 Low Temperature Charge	电池按 3.1.3 规定放电结束后： 1.将电池放入 $-20 \pm 2^\circ\text{C}$ 恒温环境中搁置 $24 \pm 0.2\text{h}$，然后以 $1I_1$ (110A) 电流充电至标准充电截止电压，计算充电容量 (Ah) 与初始充电容量的比值 (%)。	-20°C 充电容量 $\geq 80\%$ * 初始充电容量 Charging capacity at $-20^\circ\text{C} \geq 80\%$ * initial charge capacity

	Performance	2. 将电池放入$-40 \pm 2^{\circ}\text{C}$恒温环境中搁置 $24 \pm 0.2\text{h}$, 然后以 $0.5I_1$ (55A)电流充电至标准充电截止电压, 计算充电容量 (Ah) 与初始充电容量的比值(%). 1. The cell is discharged in accordance with 3.1.3, stored in an ambient temperature of $-20 \pm 2^{\circ}\text{C}$ for $24 \pm 0.2\text{h}$, and then charged to standard charge cut-off voltage at a constant current of $1I_1$ (110A). Calculate the ratio of charge capacity and initial charge capacity (%). 2. The cell is discharged in accordance with 3.1.3, stored in an ambient temperature of $-40 \pm 2^{\circ}\text{C}$ for $24 \pm 0.2\text{h}$, and then charged to standard charge cut-off voltage at a constant current of $0.5I_1$(55A). Calculate the ratio of charge capacity and initial charge capacity (%).	-40°C 充电容量 $\geq 60\%*$ 初始充电容量 Charging capacity at $-40^{\circ}\text{C} \geq 60\% * \text{initial charge capacity}$
4.2.5	低温放电性能 Low Temperature Discharge Performance	电池按 3.1.2 规定充电结束后, 将电池放入$-20 \pm 2^{\circ}\text{C}/-40 \pm 2^{\circ}\text{C}$恒温环境中搁置 $24 \pm 0.2\text{h}$, 然后以 $1I_1$ (110A)电流放电至放电截止电压 1.2V, 计算放电容量 (Ah) 与初始放电容量的比值(%). The cell is charged in accordance with 3.1.2, and rest in an ambient temperature of $-20 \pm 2^{\circ}\text{C}/-40 \pm 2^{\circ}\text{C}$ for $24 \pm 0.2\text{h}$, and then discharged to 1.2V at a constant current of $1I_1$ (110A). Calculate the ratio of discharge capacity and initial discharge capacity (%).	-20°C放电容量$\geq 70\%*$ 初始放电容量 Discharging capacity at $-20^{\circ}\text{C} \geq 70\% * \text{initial discharge capacity}$ -40°C 放电容量 $\geq 55\%*$ 初始放电容量 Discharging capacity at $-40^{\circ}\text{C} \geq 55\% * \text{initial discharge capacity}$

4.2.6	常温荷电保持与容量恢复能力 Retention Capability and Capacity recovery at Room Temperature	电池按 3.1.2 规定充电结束后，将电池在室温环境中搁置 30 天，然后按 3.1.3 规定放电，计算放电容量 (Ah) 与初始放电容量的比值(%). 再按 3.1.2 规定充电，搁置 10 分钟，按 3.1.3 规定放电，计算放电容量 (Ah) 与初始放电容量的比值(%). The cell is charged in accordance with 3.1.2, rest 30 days in an ambient temperature of $25\pm2^{\circ}\text{C}$, then discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%). Charged in accordance with 3.1.2, rest 10 minutes, discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%).	常温剩余容量$\geq 85\%$*初始放电容量，恢复容量$\geq 95\%$*初始放电容量 The residual capacity is not less than 85% of the initial discharge capacity, and the recoverable capacity is not less than 95% of the initial discharge capacity at room temperature
4.2.7	55℃荷电保持与容量恢复能力 Retention Capability and Capacity Recovery at 55℃	电池按 3.1.2 规定充电结束后，将电池在 $55\pm2^{\circ}\text{C}$ 环境下储存 7 天，再在 $25\pm2^{\circ}\text{C}$ 环境搁置 5h，按 3.1.3 放电，计算放电容量 (Ah) 与初始放电容量的比值(%). 再按照 3.1.2 规定充电，搁置 10 分钟，按 3.1.3 放电，计算放电容量 (Ah) 与初始放电容量的比值(%). The cell is charged in accordance with 3.1.2, and stored in an ambient temperature of $55\pm2^{\circ}\text{C}$ for 7 days, rest 5h ($25\pm2^{\circ}\text{C}$), then discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%). Charged in accordance with 3.1.2, rest 10 minutes, discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%).	55℃剩余容量$\geq 85\%$*初始放电容量，恢复容量$\geq 95\%$*初始放电容量 The residual capacity is not less than 85% of the initial discharge capacity, and the recoverable capacity is not less than 95% of the initial discharge capacity at 55℃

4.2.8	储存 Storage	电池按 3.1.3 规定放电结束后，然后按 3.1.2 充电 30 分钟，将电池在 $55 \pm 2^{\circ}\text{C}$ 环境下储存 30 天。电池在 $25 \pm 2^{\circ}\text{C}$ 环境搁置 5h，再按照 3.1.2 规定充电，搁置 10 分钟，按 3.1.3 放电，计算放电容量 (Ah) 与初始放电容量的比值(%)。 The cell is discharged in accordance with 3.1.3, then charged in accordance with 3.1.2 for 30 minutes, and stored in an ambient temperature of $55 \pm 2^{\circ}\text{C}$ for 30 days, rest 5h ($25 \pm 2^{\circ}\text{C}$), then charged in accordance with 3.1.2, rest 10 minutes, discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%).	恢复容量 $\geq 95\%$ * 初始放电容量 The recoverable capacity is not less than 95% of the initial discharge capacity
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4.3 单体电池 OCV-SOC 曲线图 Cell OCV-SOC Curve

4.3.1 充电 OCV-SOC 曲线图 Charge OCV-SOC Curve

测试条件:

- ① 25°C 恒温箱中搁置 10min;
- ② $1I_1(110\text{A})$ 恒流充电至 2.9V ;
- ③ 搁置 10min;
- ④ $1I_1(110\text{A})$ 恒流放电至 1.5V ;
- ⑤ 搁置 10min;
- ⑥ 重复②③④⑤步骤 3 次;
- ⑦ 以 $1I_1(110\text{A})$ 恒流充电 3min，搁置 30min，选取此时的终止电压为 5%SOC 对应的开路电压;
- ⑧ 重复步骤⑦，直至终止电压 2.9V 。

Test Conditions:

- ① Rest 10minutes at 25°C ;
- ② $1I_1(110\text{A})$ charge to 2.9V ;
- ③ Rest 10minutes;
- ④ $1I_1(110\text{A})$ discharge to 1.5V ;
- ⑤ Rest 10minutes;
- ⑥ Repeat②③④⑤ for 3 times;
- ⑦ $1I_1(110\text{A})$ charge 3minutes, rest 30min, the OCV of 5%SOC: choose the cut-off voltage;
- ⑧ Repeat ⑦ to 2.9V .

表 1 单体电池常温充电 OCV-SOC

Table 1 Charge OCV-SOC at room temperature

SOC	电压 (V)
0%	2.073
5%	2.115
10%	2.128
15%	2.14
20%	2.151
25%	2.161
30%	2.171
35%	2.181
40%	2.191
45%	2.203
50%	2.215
55%	2.231
60%	2.251
65%	2.276
70%	2.307
75%	2.344
80%	2.385
85%	2.43
90%	2.477
95%	2.528
100%	2.614

4.3.2 放电 OCV-SOC 曲线图 Discharge OCV-SOC Curve

测试条件:

- ① 25℃恒温箱中搁置10min;
- ② $1I_1(110A)$ 恒流放电至 1.5V;
- ③ 搁置10min;
- ④ $1I_1(110A)$ 恒流充电至 2.9V;
- ⑤ 搁置10min;
- ⑥ 重复②③④⑤步骤3次;
- ⑦ 以 $1I_1(110A)$ 恒流放电3min, 搁置30min, 选取此时的终止电压为5%SOC对应的开路电压;
- ⑧ 重复步骤⑦, 直至终止电压 1.5V。

Test Conditions:

- ① Rest 10minutes at 25℃;
- ② $1I_1(110A)$ discharge to 1.5V;
- ③ Rest 10minutes;
- ④ $1I_1(110A)$ charge to 2.9V;
- ⑤ Rest 10minutes;
- ⑥ Repeat ②③④⑤ for 3 times;

- ⑦ $1I_1(110A)$ charge 3minutes, rest 30min, the OCV of 5%SOC: choose the cut-off voltage;
⑧ Repeat ⑦ to 1.5V.

表 2 单体电池常温放电 OCV-SOC

Table 2 Discharge OCV-SOC at room temperature

SOC	电压 (V)
100%	2.732
95%	2.532
90%	2.478
85%	2.429
80%	2.384
75%	2.342
70%	2.304
65%	2.273
60%	2.247
55%	2.227
50%	2.212
45%	2.198
40%	2.187
35%	2.177
30%	2.167
25%	2.157
20%	2.146
15%	2.135
10%	2.123
5%	2.109
0%	2.085

4.4 单体电池充放电性能 Cell Charge-Discharge Curve

4.4.1 常温 1C 充放电性能 1C Charge-Discharge Performance at Room Temperature

测试条件:

- ① 25℃恒温箱中搁置10min;
- ② $1I_1(110A)$ 恒流充电至 2.9V;
- ③ 搁置10min;
- ④ $1I_1(110A)$ 恒流放电至 1.5V;
- ⑤ 搁置10min;
- ⑥ 重复②③④⑤步骤3次;
- ⑦ 取最后一步的充电容量和放电容量作为电池的初始充电容量和初始放电容量。

Test Conditions:

- ① Rest 10minutes at 25℃;
- ② $1I_1(110A)$ charge to 2.9V;
- ③ Rest 10minutes;

- ④ $1I_1(110A)$ discharge to 1.5V;
⑤ Rest 10 minutes;
⑥ Repeat ②③④⑤ for 3 times;
⑦ Initial charge capacity: choose the final charge capacity from ② to ⑥; Initial discharge capacity: choose the final discharge capacity from ② to ⑥.

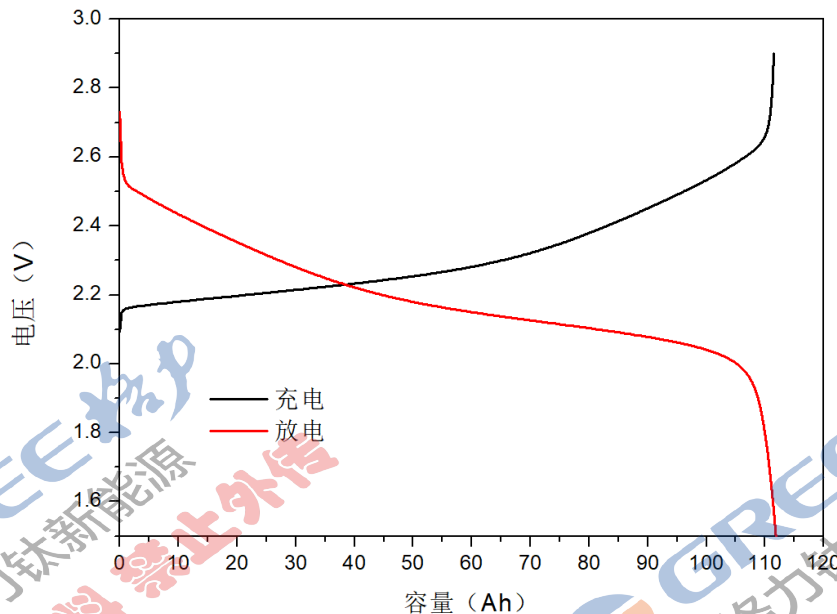


图 1 常温 1C 充放电性能曲线图

Fig. 1 1C charge-discharge performance curve at room temperature

4.4.2 单体电池最大持续充电性能 Cell Maximum Continuous Charge Performance

表 3 单体电池最大持续充电电流限制表

Table 3 Maximum continuous charge current limit table of cell

SOC	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
$T > 55^{\circ}\text{C}$	0	0	0	0	0	0	0	0	0	0	0	0
$50^{\circ}\text{C} < T \leq 55^{\circ}\text{C}$	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.33C	0.1C	0
$45^{\circ}\text{C} < T \leq 50^{\circ}\text{C}$	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.33C	0
$40^{\circ}\text{C} < T \leq 45^{\circ}\text{C}$	2C	2C	2C	2C	2C	2C	2C	2C	2C	1.5C	1C	0
$35^{\circ}\text{C} < T \leq 40^{\circ}\text{C}$	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2C	1C	0
$25^{\circ}\text{C} < T \leq 35^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
$15^{\circ}\text{C} < T \leq 25^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
$5^{\circ}\text{C} < T \leq 15^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
$0^{\circ}\text{C} < T \leq 5^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
$-10^{\circ}\text{C} < T \leq 0^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	0.5C	0
$-20^{\circ}\text{C} < T \leq -10^{\circ}\text{C}$	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	0.5C	0
$-30^{\circ}\text{C} < T \leq -20^{\circ}\text{C}$	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0

-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0
备注：电池使用的上限温度为 55℃。													
Remark: The maximum operating temperature of the cell is 55℃.													

4.4.3 单体电池脉冲充电性能 Cell Pulse Charge Performance

表 4 单体电池脉冲 60s 充电电流限制表

Table 4 Charge current limit table for cell pulse 60s

SOC 温度	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0
45℃<T≤50℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	0
40℃<T≤45℃	3C	3C	3C	3C	3C	3C	3C	3 C	3C	3C	2C	0
35℃<T≤40℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	0
25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	0
5℃<T≤15℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	0
0℃<T≤5℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	1C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
-20℃<T≤-10℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	0.5C	0
-30℃<T≤-20℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0	0
-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0	0
备注：电池使用的上限温度为 55℃。												
Remark: The maximum operating temperature of the cell is 55℃.												

表 5 单体电池脉冲 30s 充电电流限制表

Table 5 Charge current limit table for cell pulse 30s

SOC 温度	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1C	0
45℃<T≤50℃	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	1.5C	0
40℃<T≤45℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	0
35℃<T≤40℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
5℃<T≤15℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
0℃<T≤5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0

-20℃<T≤-10℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	0
-30℃<T≤-20℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0	0
-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0	0
备注：电池使用的上限温度为 55℃。													
Remark: The maximum operating temperature of the cell is 55℃.													

表 6 单体电池脉冲 10s 充电电流限制表

Table 6 Charge current limit table for cell pulse 10s

SOC 温度	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	95%	100%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	0
45℃<T≤50℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	0
40℃<T≤45℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
35℃<T≤40℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
5℃<T≤15℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
0℃<T≤5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
-20℃<T≤-10℃	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	1C	0
-30℃<T≤-20℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0	0
-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0	0
备注：电池使用的上限温度为 55℃。												
Remark: The maximum operating temperature of the cell is 55℃.												

4.4.4 单体电池最大持续放电性能 Cell Maximum Continuous Discharge Performance

表 7 单体电池最大持续放电电流限制表

Table 7 Maximum continuous discharge current limit table of cell

温度 \ SOC	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.33C	0.33C	0
45℃<T≤50℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.33C	0
40℃<T≤45℃	2C	2C	2C	2C	2C	2C	2C	2C	1.5C	1.5C	1C	0
35℃<T≤40℃	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2C	1C	0
25℃<T≤35℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
15℃<T≤25℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0
5℃<T≤15℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0

$0^{\circ}\text{C} < T \leq 5^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	2.5C	2C	2C	2C	1C	0
$-10^{\circ}\text{C} < T \leq 0^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	2.5C	2C	1C	0.5C	0.5C	0
$-20^{\circ}\text{C} < T \leq -10^{\circ}\text{C}$	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	0.5C	0.5C	0
$-30^{\circ}\text{C} < T \leq -20^{\circ}\text{C}$	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0
$-40^{\circ}\text{C} < T \leq -30^{\circ}\text{C}$	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.33C	0.33C	0
备注：电池使用的上限温度为 55°C 。													
Remark: The maximum operating temperature of the cell is 55°C .													

4.4.5 单体电池脉冲放电性能 Cell Pulse Discharge Performance

表 8 单体电池脉冲 60s 放电电流限制表

Table 8 Discharge current limit table for cell pulse 60s

SOC 温度	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0
45℃<T≤50℃	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	0.5C	0
40℃<T≤45℃	3C	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	0
35℃<T≤40℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0
25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1.5C	0
5℃<T≤15℃	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3C	2C	1C	0
0℃<T≤5℃	3C	3C	3C	3C	3C	3C	3C	3C	2.5C	2C	1C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	1C	0
-20℃<T≤-10℃	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	0.5C	0
-30℃<T≤-20℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0
-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.33C	0.33C	0
备注：电池使用的上限温度为 55℃。												
Remark: The maximum operating temperature of the cell is 55℃.												

表 9 单体电池脉冲 30s 放电电流限制表

Table 9 Discharge current limit table for cell pulse 30s

SOC 温度	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
$T > 55^{\circ}\text{C}$	0	0	0	0	0	0	0	0	0	0	0	0
$50^{\circ}\text{C} < T \leq 55^{\circ}\text{C}$	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	1.5C	0.5C	0.5C	0
$45^{\circ}\text{C} < T \leq 50^{\circ}\text{C}$	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2.5C	2C	1C	0.5C	0
$40^{\circ}\text{C} < T \leq 45^{\circ}\text{C}$	3C	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	0
$35^{\circ}\text{C} < T \leq 40^{\circ}\text{C}$	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0

25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1.5C	0
5℃<T≤15℃	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3C	2C	1C	0
0℃<T≤5℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	2.5C	2C	1C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	1C	1C	0
-20℃<T≤-10℃	3C	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	0.5C	0
-30℃<T≤-20℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0
-40℃<T≤-30℃	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C	0.33C	0.33C	0
备注：电池使用的上限温度为 55℃。													
Remark: The maximum operating temperature of the cell is 55℃.													

表 10 单体电池脉冲 10s 放电电流限制表

Table 10 Discharge current limit table for cell pulse 10s

SOC 温度	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	5%	0%
T>55℃	0	0	0	0	0	0	0	0	0	0	0	0
50℃<T≤55℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	0.5C	0
45℃<T≤50℃	3C	3C	3C	3C	3C	3C	3C	3C	2C	1C	0.5C	0
40℃<T≤45℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1.5C	0
35℃<T≤40℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0
25℃<T≤35℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	0
15℃<T≤25℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1.5C	0
5℃<T≤15℃	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3.5C	3C	2C	1C	0
0℃<T≤5℃	3C	3C	3C	3C	3C	3C	3C	3C	2.5C	2C	1C	0
-10℃<T≤0℃	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	1C	1C	0
-20℃<T≤-10℃	3C	3C	3C	3C	3C	3C	3C	2C	1.5C	1C	0.5C	0
-30℃<T≤-20℃	2C	2C	2C	2C	2C	2C	1C	1C	1C	1C	0.5C	0
-40℃<T≤-30℃	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0.5C	0.33C	0.33C	0
备注：电池使用的上限温度为 55℃。												
Remark: The maximum operating temperature of the cell is 55℃.												

5. 单体电池可靠性测试 Cell Reliability Test

序号 No.	项目 Items	测试方法及条件 Test Method and Conditions	标准 Criteria
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5.1	过放电 Over Discharge	电池按 3.1.2 规定充电结束后，对电池以 $1 I_1(110A)$ 电流放电 90min，观察 1h。 The cell is charged in accordance with 3.1.2, then discharged at a constant current of $1 I_1(110A)$ for 90 minutes, observed for 1h.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.1，不起火、不爆炸 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.1, no fire, no explosion
5.2	过充电 Over Charge	电池按 3.1.2 规定充电结束后，对电池以 $1 I_1(110A)$ 恒流充电，至电压达到 4.35V 或充电时间达到 1h，观察 1h。 The cell is charged in accordance with 3.1.2, then charged to 4.35V or charge time is over 1h at a constant current of $1 I_1(110A)$, observed for 1h.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.2，不爆炸、不起火 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.2, no explosion, no fire
5.3	短路 Short Circuit	电池按 3.1.2 规定充电结束后，将电池正、负极经外部短路 10min，外部线路电阻应小于 $5m\Omega$，观察 1h。 The cell is charged in accordance with 3.1.2, then short-circuited by connecting the positive and negative terminals for 10 min with an external line having a maximum resistance of $5m\Omega$, then observed for 1h.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.3，不爆炸、不起火 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.3, no explosion, no fire
5.4	加热 Heating	电池按 3.1.2 规定充电结束后，在温度箱中按照 $5^\circ C/min$ 的速率由室温升至 $130 \pm 2^\circ C$，并保持 30min 后停止加热，观察 1h。 The cell is charged in accordance with 3.1.2, stored in a temperature box for 30min at the temperature of $130 \pm 2^\circ C$ with a heating rate of $5^\circ C/min$, stopped heating, then observed for 1h.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.4，不爆炸、不起火 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.4, no explosion, no fire

5.5	挤压 Crush	电池按 3.1.2 规定充电结束后，挤压板（半径 75mm、长度大于被挤压电池的尺寸的半圆柱体）以 (5 ± 1) mm/s 的速度垂直于电池极板方向施压，直至电池电压变为 0V 或变形量达到 30%或挤压力达到 200kN 后停止挤压，观察 1h。 The cell is charged in accordance with 3.1.2, crushed by a plate (a half cylinder with the radius of 75mm and length is longer than the cell's) in the vertical direction at a rate of (5 ± 1) mm/s until the voltage drops to 0V or the cell's deformation rate increases to 30% or the pressure increases to 200kN, and then observed for 1h.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.6，不爆炸、不起火 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.6, no explosion, no fire
5.6	针刺 Puncture Test	电池按 3.1.2 规定充电结束后，用 1 个直径 5mm~8mm 的钢针以 (25 ± 5) mm/s 的速度从垂直于电池极板的方向贯穿电池(靠近所刺面的几何中心)，并把钢针停留在电池内，观察 1h。 The cell is charged in accordance with 3.1.2, punctured through (near the geometric center of the surface) by a nail which diameter of 5mm to 8mm at a rate of 25 ± 5 mm/s, the nail is kept in the cell, and then observed for 1h.	不爆炸、不起火 No explosion, No fire
5.7	海水浸泡 Seawater Immersion	电池按 3.1.2 规定充电结束后，将电池完全浸入 3.5%NaCl 溶液中 2h。 The cell is charged in accordance with 3.1.2, completely soaked into the 3.5% NaCl solution for 2h.	不爆炸、不起火 No explosion, No fire
5.8	低气压 Low Pressure	电池按 3.1.2 规定充电结束后，在室温下将电池放入气压为 11.6kPa 的低气压箱中，静置 6h 后，观察 1h。 The cell is charged in accordance with 3.1.2, stored in a case with the low pressure of 11.6kPa at room temperature for 6 hours, then observed for 1h.	不爆炸、不起火、不漏液 No explosion, No fire, No leakage
5.9	温度循环 Temperature Cycling	电池按 3.1.2 规定充电结束后，放入温度箱中，温度按照下表进行调节，循环 5 次后，观察 1h。 The cell is charged in accordance with 3.1.2, stored in a temperature box, regulating temperature as the following table, observed for 1 h after cycling 5 times.	按照 GB 38031-2020 电动汽车用动力蓄电池安全要求 5.1.5，不爆炸、不起火 According to GB 38031-2020 Electric vehicles traction cell safety requirements 5.1.5, no explosion, no fire

温度(°C) Temperature	时间增量 (min) Incremental Time	累计时 间 (min) Total Time	温度变化率 (°C/min) Temperature Rate
25	0	0	0
-40	60	60	13/12
-40	90	150	0
25	60	210	13/12
85	90	300	2/3
85	110	410	0
25	70	480	6/7

6. 电池使用说明 Cell application conditions

在使用电池之前，客户应当仔细阅读并确保严格遵守以下与电池相关的应用条件。
Customer shall carefully read and ensure that the following application conditions in connection with the products are strictly observed before using the cells.

6.1 在 pack 设计时，应避免采用电池堆叠方式，即一个电池的重力施加到另外一个电池上。
It shall be ensured for the pack design to avoid cell stacking, where the gravity of one cell is applied to another one.

6.2 在 pack 设计时，应确保电池的大面受力均衡，应避免电池大面某一点的应力集中，同时避免电池大面不受力。模组组装的预紧力 500~3000N，电池应均匀受力，壳体无变形。

The pack design shall ensure uniform force distribution, avoid stress concentration at any point and any binding force on the large surface of the cell. The pre tightening force is 500~3000N.The cell shall be uniformly stressed and the shell should not deform.

6.3 在 pack 设计时，应确保电池在±X/±Y/±Z 方向上有充分约束。±X/±Y 方向能承受的最大扭力 12N•m。±Z 方向能承受的最大推力 1200N。

It shall be ensured for the pack design that the cell have sufficient constraints in the ±X/±Y/±Z directions。The maximum torque that can be withstood in the ±X/±Y directions is 12N•m. The maximum thrust that can be withstood in the ±Z directions is 1200N.

6.4 在 pack 设计时，应确保电池的防爆阀排气通道不能被遮挡。
It shall be ensured for the pack design that the explosion-proof valve exhaust channel of the cell is not obstructed.

6.5 在 pack 设计和组装模组时，应确保外部工装或配件不会碰撞或挤压到防爆阀。
It shall be ensured for the pack design and assembly module, that the explosion-proof valve shall not be collided or squeezed by external fixtures or accessories.

6.6 在 pack 设计时，应确保与电池接触的外部材料不会腐蚀电池。
It shall be ensured for the pack design that the cell is not corroded by external materials in contact with it.

6.7 在电池箱设计中应充分考虑电芯的散热问题，特别是电池在高倍率充放电的情况下的散热问题，应确保电池均匀散热。由于电池箱散热设计问题导致的电芯或电池过热损坏，格力钛不承担质量保证责任。

The heat dissipation of the cells should be fully considered in the electric box design, especially during high rate charging and discharging, to ensure uniform heat dissipation of the cell. GREE Altairnano does not take the responsibility due to the overheating of the cell or batteries caused by the thermal design problem of the electric box.

6.8 电池箱设计中应充分考虑电芯的防水、防尘问题。由于防水、防尘问题而导致的电芯或电池的损坏（如腐蚀、生锈等），格力钛不承担质量保证责任。

The design of the electric box must fully consider the waterproof and dustproof problems of the cells. GREE Altairnano does not take the responsibility due to damage to the cell or batteries (such as corrosion, rust, etc.) caused by water and dust.

6.9 电池在下仓、转移、生产等过程中应做好防护处理，避免蓝膜、壳体或极柱损伤。

The cell shall be properly protected during storage, transfer, and production to avoid damage to the blue film, shell, or the terminal.

6.10 电池在成组时，应确保电池正、负极连接正确，避免电池短路。

It shall be ensured for assembly module that the cathode and anode of the cell are connected correctly to avoid short circuits.

6.11 电池极柱尺寸 27.5mm（长）*27.5mm（宽）。在焊接 Busbar 时不能超出焊接区域（如附图 1 所示）进行焊接，焊接熔深：1.5mm；焊接熔宽：2mm；推荐的焊缝总长 $\geq 38\text{mm}$ ；

The terminal size is 27.5mm (length) * 27.5mm (width). The weldable areas cannot be exceeded when welding busbars (as show in figure 1). The welding penetration depth is 1.5mm, the welding width is 2mm, and the recommended weld length is more than 38mm.

6.12 当采用激光焊接电芯极柱与外部集流体（例如 busbar）时，焊印轨迹不能超出指定焊接区域，电芯极柱塑胶的温度 $\leq 150^{\circ}\text{C} 5\text{ s}$ ，瞬时温度 $\leq 260^{\circ}\text{C} 0.5\text{ s}$ 。

When using laser welding to connect the terminal of the cell to the external current collector (such as busbar), the welding mark trajectory cannot exceed the welding area. The temperature of plastic parts for the terminal e does not exceed 150°C for 5 seconds, and the instantaneous temperature does not exceed 260°C for 0.5 seconds.

6.13 在 pack 组装时，确保电池底部开窗区域 100%做好绝缘处理。

It shall be ensured for packing that the bottom window area of the cell is fully insulated.

6.14 电池模组或 Pack 应具备热管理功能，以确保电池的散热，并确保电池在规定的使用温度内工作。

The module or pack shall have thermal management function to ensure the heat dissipation of the cell and ensure that the cell is used within the specified temperature range.

6.15 客户必须配置电池管理系统（BMS），严格监控、管理与保护每个电池。电池管理系统应具备以下基本功能：

Each cell shall be strictly monitored, managed, and protected by battery management system (BMS). The BMS shall have the following functions:

序号 No.	项目 Item	规格 Specification	保护要求 Protection requirements
6.15.1	充电终止 Charge Cut-off	$\leq 2.9V$	当电池电压达到 2.9V 时，BMS 终止充电。 Stop charging when the cell voltage reaches 2.9V.
6.15.2	过充保护 Over charge protection	$\leq 2.95V$	当电池电压达到 2.95V 时，BMS 强制终止充电。 Forcefully stop charging when the cell voltage reaches 2.95 V
6.15.3	放电终止 Discharge Cut-off	最小 1.5V Minimum 1.5V	当电池电压达到 1.5V 时，BMS 终止放电。 Stop discharging when the cell voltage reaches 1.5 V.
6.15.4	过放保护 Over discharge protection	最小 1.45V (环境温度 $> -20^{\circ}C$) Minimum 1.45V (ambient temperature $> -20^{\circ}C$) 最小 1.2V (环境温度 $\leq -20^{\circ}C$) Minimum 1.2V (ambient temperature $\leq -20^{\circ}C$)	当电池电压达到 1.45V 时，BMS 强制终止放电。 当电池电压低于 1.45V 时，应及时以 1C 电流将电池充电至 50%SOC。 Forcefully stop discharging when the cell voltage reaches 1.45 V. The cell should be charged back to 50% SOC at 1C in time.
6.15.5	过热保护 Over heat protection	最高 55℃ Maximum 55℃	当温度超过 55℃ 时，终止充电/放电。 Stop charging and discharging when temperature exceeds 55℃.
6.15.6	短路保护 Short Circuit protection	不允许短路 No short circuit allowed	发生短路时，过流保护装置应断开电池。 When a short circuit occurs, the cell is disconnected by the overcurrent protection device.

备注：当电池达到上述任何一项条款描述的指标和参数状态时，意味着电池已超出本技术协议规定的使用条件，客户需依上述“保护要求”及本规格书其他相关规定对电池采取保护措施，同时，格力钛声明对上述使用状态的电池质量不承担任何保证责任，并对因此而导致的客户及第三方的任何损失不予赔偿。

Note: When the cell reaches any of the terms described in the above, means that the cell has been used beyond the specifications, the customer shall take protective measures on the cell in accordance with the "protection action" and other relevant provisions of this specification. At the same time, GREE Altairnano shall not take any responsibility for the damage in connection therewith.

6.16 禁止电池达到过充状态。当电池电压高于 3.0V 时，电池内部可能会遭到永久性的损坏，此时格力钛的产品质量保证责任失效。

Prevent any cell from reaching overcharge state. The interior of the cell may be permanently damaged when the cell voltage is higher than 3.0V, at which point GREE Altairnano's product quality assurance product quality assurance responsibility becomes invalid.

6.17 避免电池到达过放状态。 电池电压低于 1.5V（环境温度 $> -20^{\circ}\text{C}$ ）或低于 1.2V（环境温度 $\leq -20^{\circ}\text{C}$ ）时，电池内部可能会遭到永久性的损坏，此时格力钛的产品质量保证责任失效。

Prevent any cell from reaching over discharge state. The interior of the cell may be permanently damaged when the cell voltage is less than 1.5V (ambient temperature $> -20^{\circ}\text{C}$) or less than 1.2V (ambient temperature $\leq -20^{\circ}\text{C}$), at which point GREE Altairnano's product quality assurance product quality assurance responsibility becomes invalid.

6.18 当实际放电截止电压低于标准放电截止电压时，先将系统内部能耗降低到最小，并在重新充电之前延长休眠时间。 客户需要培训使用者在最短的时间内重新充电，防止电池进入过放状态。

When the cell voltage is lower than the standard discharge cut-off, internal power consumption of the system should be reduced to a minimum to prolong the idle time before recharge. Customer undertakes to educate the users of the products or other parties who may come to handle the products to recharge the cells at minimum time intervals to prevent reaching the over-discharge state.

6.19 避免长期应用高于本规格书规定的最大持续电流进行充放电，否则电池温度将会迅速升高并超出规格的温度范围，格力钛不承担质量责任。

Avoid long-term use of charging and discharging with a current higher than the maximum continuous current specified in this specification, otherwise the cell temperature will rapidly rise and exceed the specified temperature range. GREE Altairnano does not assume any responsibility for quality assurance.

7. 安全防范 Security precautions

7.1 在使用过程中，应远离热源、高压，避免儿童玩弄电池，切勿摔打电池。

The cell shall be kept out of heat, high voltage and avoided children's touching. Do not drop the cell.

7.2 应使用制造商认可的充电器和充电程序，不恰当的充电方式会导致电池发热或损坏。

Use only approved chargers and procedures, improperly charging the cell may cause to flame or damage.

7.3 禁止使用高于本规格书规定的最大电流或电压充电。

Do not charge with a current higher than the maximum specified in this specification.

7.4 禁止在高于本技术协议规定的温度条件下充电，否则格力钛不承担质量保证责任。

Charging at temperatures higher than the specified in this specification is prohibited, otherwise GREE Altairnano's will not be responsible for quality assurance.

7.5 切勿自行拆解电池，也勿让电池放在受潮处，以免发生危险。

Do not disassemble the cell and put the cell in the damp place.

7.6 废弃电池请安全妥当处理，不要投入火中或水中。

Safely disposed the disused cell. Do not put it into fire or water.

7.7 禁止拆解电池 Forbid disassemble the Cell

自行拆解会造成电池发热、冒烟、变形或燃烧。

Disassemble the cell can cause it to heat up, smoke, deform or burn.

7.8 禁止让电池短路 Forbid short-circuit the cell

不要将电池的正负极用金属连接，也不要将电池与金属片放在一起存储和移动。如果电池被短路，将会有超大电流流过，将会损坏电池，造成电池发热、冒烟、变形或燃烧。

Do not connect the cell's positive and negative with metal. Do not put the cell with metal together either storage or movement. If the cell is short circuit, there will be a large current flowing through the cell, will cause the cell heat, smoke, deformation or burn and damage the cell.

7.9 禁止加热电池至超出本规格书规定的使用温度范围，可能会造成电池隔离物的熔化、安全功能丧失或电解液燃烧，甚至可能引发火灾。

It is prohibited to heat the cell beyond the temperature range specified in this specification, otherwise it will cause the melting of cell isolation materials, loss of safety functions or electrolyte combustion, and even trigger a fire.

7.10 禁止焚烧电池，否则可能导致电池起火、爆炸，甚至引发火灾。

Burning cells is prohibited as it may cause them to catch fire or explode, and even trigger a fire.

7.11 避免在热源附近使用电池 To Avoid Using the Cell near the Heat

不要在火源、烤炉附近或超过 80℃ 的环境中使用电池，过热将会导致电池内部短路，使电池发热、冒烟、变形或燃烧。

Do not use the cell near the fire, stove, or the environment temperature over 80 °C, and overheating will cause the cell internal short-circuit and make it heat, smoke, distort or burning.

7.12 禁止将电池浸入水中。

Do not immerse the cell in water.

7.13 禁止用金属凿入电池、锤打或摔打电池或其他方法破坏电池，否则会造成电池发热、冒烟、变形或燃烧，甚至会发生危险。

Do not use metal to chisel into the cell, hammer, throw or other methods to damage the cell, otherwise it will cause the cell to heat up, smoke, deform or burn.

7.14 禁止在电池主体上直接焊接

Forbid directly welding on the cell.

7.15 不要直接触漏液电池。当电解液泄露时，应避免皮肤和眼睛接触电解液。如有接触，应使用大量的清水清洗接触到的区域并向医生寻求帮助。

Do not touch the leak-out cell. When the electrolyte leaks, skin and eye contact with the electrolyte should be avoided. In case of contact, a large amount of clean water should be used to clean the contact area and seek help from the doctor.

7.16 禁止任何人或动物吞食电池的任何部件或电池所含物质。

It is forbidden for any person or animal to swallow any part or substance contained in the cell.

7.17 不要混用电池。避免将新的和旧的或不同型号、不同规格、不同化学成分的电池配对使用。

Do not mixed-using cells, avoid pairing old and fresh cells with different models, specifications and chemical compositions.

7.18 在进行滥用测试实验时如操作不当可能会引起电池起火或者爆炸。该测试实验只能由配备适当的防护装备的专业人员在专业的实验室进行。否则，可能会导致严重的人身伤害和财产损失。

Cell fire or explosion may be caused by improper operation during abuse test. The test can only be carried out in a professional laboratory by professionals equipped with appropriate protective equipment. Otherwise, it may lead to serious personal injury and property loss.

7.19 禁止使用电压低于 1.2V 的电池进行充电，否则可能导致防爆阀破开，电解液泄露的风险。

Do not use the cells with the voltage lower than 1.2V, otherwise it may cause the explosion-proof valve to break and the risk of electrolyte leakage.

7.20 其它注意事项 Other Warnings

不要将电池放入微波炉、洗衣机或者烘干机里；不要使用已经损坏的电池。

Do not put the cell into microwave, washing machine or drying machine. Do not use a damaged cell.

7.21 其它 Others

如不按以上规定操作导致发生意外，本公司不承担相应责任。

GREE Altairnano shall make no liability for problems that occur when the above specifications are not followed.

8. 保质期及产品责任 Period of Warranty and Product Liability

电池的保质期：从出厂日期开始起 180 天。如果有证据表明电池的缺陷是在制造过程中形成的，而不是由于用户滥用造成的，格力钛承诺退换电池，否则本公司不承诺免费更换。

Warranty period of this product is 180 days from the date of manufacture. GREE Altairnano to return or exchange cells in case of cells with defects proven due to the manufacturing process instead of abuse and misuse by the customers, otherwise, GREE Altairnano is not promised free replacement.

9. 贮存 Storage

电池理想的贮存温度为 $25\pm 2^{\circ}\text{C}$ ，可接受的贮存温度为： $-40^{\circ}\text{C}\sim 55^{\circ}\text{C}$ ，相对湿度 $\leq 90\%$ 的清洁、干燥、通风的环境中，应避免与腐蚀性物质接触，远离火源及热源。

在 $-40\sim 30^{\circ}\text{C}$ 条件下，建议单体电池补电周期为6个月， $30\sim 45^{\circ}\text{C}$ 建议单体电池补电周期为3个月， $45\sim 55^{\circ}\text{C}$ 建议单体电池补电周期为1个月，建议存储的SOC为50%~75%。实际存储SOC不得低于20%。

The ideal storage temperature is $(25\pm 2^{\circ}\text{C})$. The acceptable storage temperature can be $-40^{\circ}\text{C}\sim 55^{\circ}\text{C}$, and the relative humidity $\leq 90\%$. The cells shall be kept away from sources of ignition and heat, while avoiding contact with corrosive substances.

The recommended period to recharge is 6 months at $-40\sim 30^{\circ}\text{C}$; the recommended period to recharge is 3 months at $30\sim 45^{\circ}\text{C}$; the recommended period to recharge is 1 month at $45\sim 55^{\circ}\text{C}$. The recommended SOC is 50%~75% for storage. The actual storage SOC cannot be less than 20%.

10. 运输注意事项 Shipment Requirement

电池应在荷电 $\leq 30\%$ 状态下包装成箱进行运输，在运输过程中应防止剧烈振动、冲击或挤压，防止日晒雨淋。

The cell should be packed in cartons under the condition of $\leq 30\%$ charged for shipment. The violent vibration, impact or squeezing shall be avoided in the transport process; Avoid to be exposed to the sun and rain.

11. 其它化学反应 Other Chemical Reactions

电池利用的是化学反应的原理，即使存放很长一段时间不使用，电池的性能也会随时间的增加而降低。如果使用条件如充电、放电及周围环境温度等情形不在本规格书指定的使用范围内，会缩短电池的使用寿命，或者会产生漏液导致设备损坏。如果电池长时间不能充电，即使充电方法正确，也需要更换电池了。

Because cells utilize principle of chemical reaction, the cell performance will deteriorate over time even if stored for a long period of time without being used. In addition, if the various usage conditions such as charge, discharge, ambient temperature, etc. are not maintained within the specified ranges, the life expectancy of the cell may be shortened or the device in which the cell used may be damaged by electrolyte leakage. If the cells cannot maintain a charge for long periods of time, even they are charged correctly, this may indicate it is time to change the cell.

12. 免责声明 Disclaimer

如果因产品需求单位不按本规格书中的规定使用而导致的任何问题，所有责任由产品需求单位承担，格力钛新能源股份有限公司将不承担任何责任。

如果由于产品需求单位不按本规格书中的规定使用，造成社会性影响，并对格力钛新能源股份有限公司的声誉造成影响的，格力钛新能源股份有限公司将会追究产品需求单位的责任。根据对格力钛新能源股份有限公司造成的影响程度，产品需求单位需向格力钛新能源股份有限公司提供赔偿。

If the product demand unit does not use the cells in accordance with the regulations in this specification, which causes any problems with the cells, all responsibilities shall be borne by the product demand unit, and GREE Altairnano will not take any responsibility.

If the product demand unit does not use the product according to the provisions of this specification, causing social impact and affecting the reputation of GREE Altairnano, GREE Altairnano will investigate the responsibility of the product demand unit. According to the degree of impact on GREE Altairnano, the product demander should provide compensation to GREE Altairnano.

13. 电池结构示意图 Scheme of the Cell Structure

详见附图 1

See Figure 1 for details

14. 备注 Remark

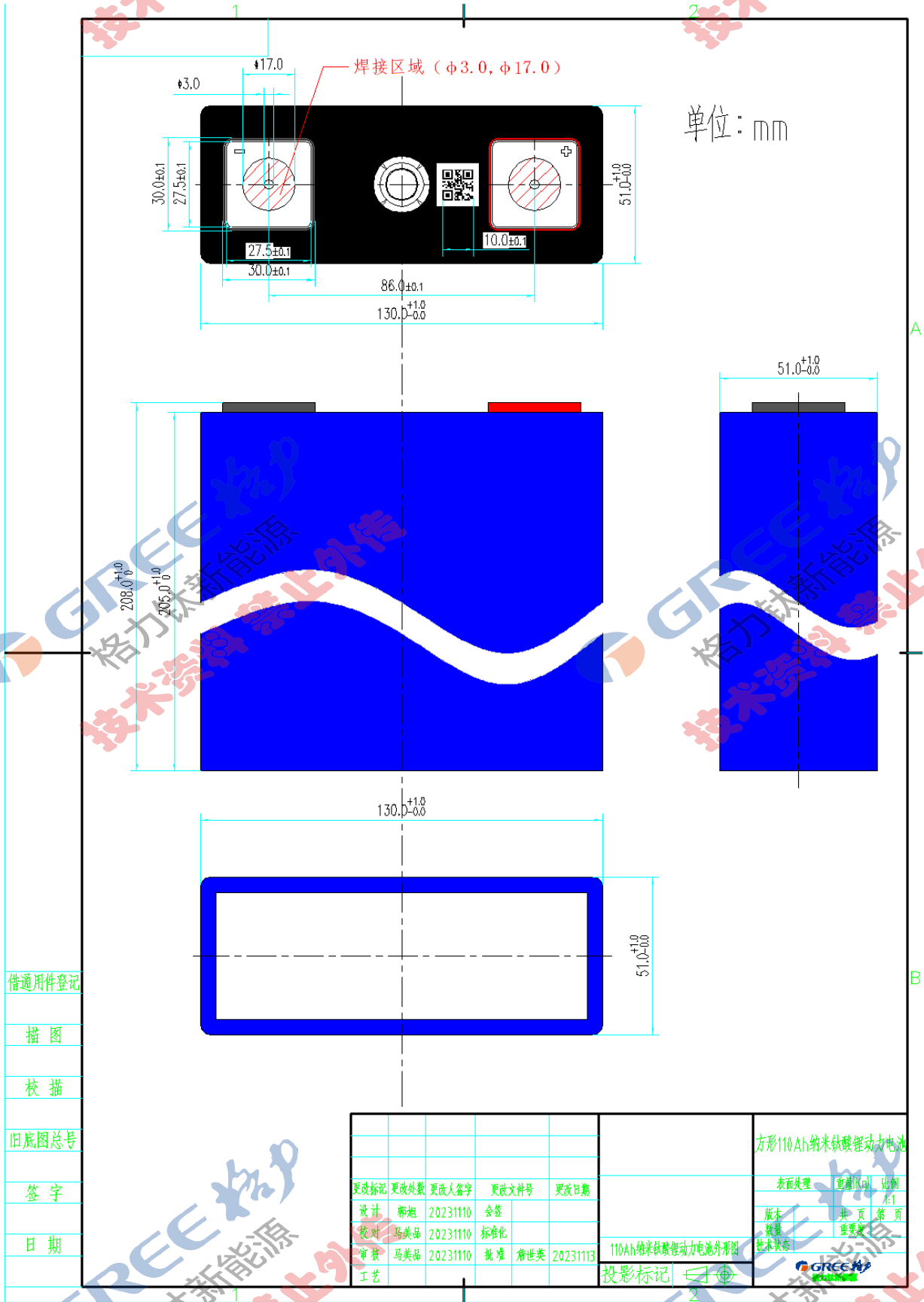
本说明书未包括事项应由双方协议确定。

Any other items which are not covered in this specification shall be agreed by both sides.

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