圆柱 40Ah 纳米钛酸锂电池规格书

SPECIFICATION of CYLINDERICAL 40Ah-LITHIUM TITANATE CELL

（产品型号:LTO66160H/40Ah）

Document No. 文件编号	Version 版本/次	Department 拟案单位	Valid Date 生效日期
GLTO-SPP-00006	B/4	电池研究院	2024-11-28
Design 编制	**Check 审核**		**Approval 批准**
褚光辉	马美品		詹世英

Customer Approval 客户确认	Signature/Date 签字/日期	
	Company Name 公司名称	
	Company Stamp 公司印章	

公司名称：格力钛新能源股份有限公司
公司地址：珠海市金湾区三灶镇金湖路 16 号
电话：+86-0756-7637666
传真：+86-0756-7637666
网址：http://www.zhyle.com

Company: GREE Altairnano New Energy Inc.
Address: No. 16, Jinhu Road, Sanzao Town, Jinwan District, Zhuhai, China.
Tel No.: +86-0756-7637666
Fax No.:+86-0756-7637666
Web: http://www.zhyle.com

修订履历 Revision history

版本 Version	变更内容 Revision contents	编制人 Editor	修订日期 Revision date
A/0	初版发行 Initial release	马美品	2017-2-18
A/1	1、修订4.1内阻参数、重量参数 1. Revised 4.1 internal resistance parameters and weight parameters 2、修订4.5循环寿命标准 2. Revised 4.5 cycle life standard	李巧	2018-12-27
B/0	1、修订引用标准 1. Revision of reference standards 2、修订 2.1 命名规则 2. Revise 2.1 Naming Rules 3、修订 4.1 工作温度范围 3. Revised 4.1 Operating temperature range 4、修订 4.2 高温放电容量 4. Revised 4.2 High temperature discharge capacity 5、修订 4.2 常温荷电保持与容量恢复测试条件及能力标准、高温荷电保持与容量恢复能力标准 5. Revised 4.2 Test conditions and capacity standards for charge retention and capacity recovery at normal temperature, and high temperature charge retention and capacity recovery capability standards 6、增加4.3 电池充/放电参数 6. Add 4.3 Cell charge/discharge parameters 7、修订6.1 电池操作注意事项，增加6.1.2 电池运输要求 7. Revised 6.1 Cell operation precautions and added 6.1.2 Cell transportation requirements 8、修订11电池结构示意图中的公司LOGO 8. Revised 11 The company LOGO in the cell structure diagram	高娇阳	2023-3-20
B/1	1、增加页码 1. Add page numbers 2、字体修改 2. Font modification 3、修订 2.3 引用标准 3. Revision 2.3 Reference standard	黄春富	2023-5-25

技术资料 禁止外传

	4、修订存储温度与贮存温度 4. Revision storage temperature and storage temperature 5、修订扭矩范围 5. Revision torque range 6、修订 6.1 电池操作注意事项 6. Revised 6.1 Precautions for Battery Operation		
B/2	1、增加引用标准 1. Add page reference standards 2、修订电池重量 2. Revision modify the cell weight 3、PDM系统旧版本已报废 3. The old version of PDM system has been scrapped	褚光辉	2024-4-30
B/3	修订4.1.1外观描述 Revised 4.1.1 appearance description	褚光辉	2024.11.19
B/4	1、修订4.1单体电池基本参数 1. Revised 4.1 cell specification 2、修订4.2单体电池电化学性能参数 2. Revised 4.2 cell electrochemical performance 3、修订6.电池使用说明 3. Revised 6. cell application conditions	褚光辉	2024.11.28

格力钛新能源 技术资料 禁止外传

目录

Contents

1. 适用范围 Scope....1
2. 概述 Description....1
2.1 命名规则 Naming Rules....1
2.2 电池构成 Cell Component....2
2.3 引用标准 Adopted Standard....2
3. 电池性能测试条件 Test Conditions of Cell Properties....2
3.1 标准测试条件 Standard Testing Conditions....2
3.2 测量器具及设备 Measuring Instruments or Apparatus....3
4. 技术规格 Specification....4
4.1 单体电池基本参数 Cell Specification....4
4.2 单体电池电化学性能参数 Cell Electrochemical Performance....5
4.3 充/放电参数 Charge /Discharge Parameter....8
5. 单体电池可靠性测试 Cell Reliability Test....15
6. 电池使用说明 Cell Application Conditions....17
7. 安全防范 Security Precautions....21
8. 保质期及产品责任 Period of Warranty and Product Liability....23
9. 贮存 Storage....23
10. 运输注意事项 Shipment Requirement....24
11. 其它化学反应 Other Chemical Reactions....24
12. 免责声明 Disclaimer....24
13. 电池结构示意图 Scheme of the Cell Structure....25
14. 备注 Remark....25
15. 附图 Figure....25

格力钛新能源 技术资料 禁止外传

1. 适用范围 Scope

本规格书描述纳米钛酸锂电池之基本参数、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 LTO66160H/40Ah 纳米钛酸锂电池。

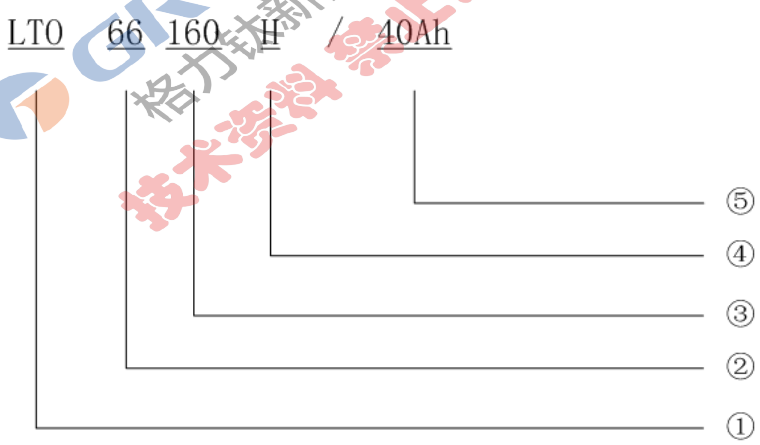
This specification describes the lithium titanate cell's basic parameters, electrochemical characteristics, reliability and its test method, decision criteria, instructions, safety procedures, quality evaluation, packaging, storage, and transportation, etc. The specification is applied to the LTO66160H/40Ah lithium ion cell manufactured by GREE Altairnano New Energy Inc.

2. 概述 Description

产品型号：LTO66160H/40Ah 纳米钛酸锂电池。

Product model: LTO66160H/40Ah Lithium Titanate Cell.

2.1 命名规则 Naming Rules



①：代表电池采用的负极材料为钛酸锂。

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

②：代表电池直径(mm)。

Indicates the diameter of cell (mm).

③：代表电池高度(mm)，用三位数字表示。

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

④：特殊编码（"A", "F"和"H"代表产品序列，电池能量密度依次升高）。

Special code ("A", "F" and "H" indicate product sequence, energy density of the cell is increased by degrees).

⑤：代表电池容量。

Indicates the capacity of cell.

2.2 电池构成 Cell Component

电池由正极、负极（钛酸锂）、隔膜、电解液和铝制金属外壳等组成，电池壳体是负极。

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

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 rechargeable 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

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 stated 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 $1I_1$(40A)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 $1I_1$ (40A), then stopped charging.

3.1.3 标准放电方式 Standard Discharge Method

在标准环境条件下，以 $1I_1$(40A)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 $1I_1$ (40A), 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 shall 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 kΩ/V。

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

3.2.3 电流表 Ammeter

国家标准或更灵敏等级，外部总体内阻包括电流表和导线应小于 0.01Ω。

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

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
4.1.1	外观 Appearance	应有清晰正确的标志 There should be clear and correct marks	/
4.1.2	额定容量 Rated Capacity	40Ah	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	单次最大满充电流 Maximum Single Full Charge Current	$6I_1$(240A)	25±2℃
4.1.8	单次最大满放电流 Maximum Single Full Discharge Current	$6I_1$(240A)	25±2℃

4.1.9	最大脉冲充/放电电流（10s） Maximum Pulse Charge/Discharge Current (10s)	$10I_1$(400A)	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 (40A) Recommended charge/discharge current ≤1 I_1 (40A), 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±2℃ Ideal storage temperature：25±2℃ 可接受存储温度：-40℃~55℃ Acceptable storage temperature：-40℃~55℃	≤90%RH 储存湿度范围。 ≤90%RH storage moisture range.
4.1.12	尺寸 Dimension	直径：66.0±0.5mm 高度：161.0±0.5mm Diameter: 66.0±0.5mm Height: 161.0±0.5mm	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.
4.1.13	重量 Weight	1220±40g	/
4.1.14	电池保护温度 Cell protection temperature	55℃	/

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

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 25000 次。 Under standard test environment, a cell is charged in accordance with 3.1.2, rest 30 minutes, and then discharged in accordance with 3.1.3, rest 30 minutes prior to next charge-discharge cycle. The cell shall be continuously charged and discharged for 25000 times.	25000 次循环后，放电容量≥80%*初始放电容量 Discharge capacity after 25000 cycles≥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 6 I_1（240A）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 6I_1 (240A). Calculate the ratio of charge capacity and initial charge capacity (%).	6I_1(240A)充电容量≥90%*初始充电容量 6I_1(240A) charge capacity ≥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 6I_1（240A）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 6I_1 (240A). Calculate the ratio of discharge capacity and initial discharge capacity (%).	6I_1(240A)放电容量≥90%*初始放电容量 6I_1(240A) discharge capacity≥90% *initial discharge capacity
4.2.4	高温(55℃)放电容量 Discharge Capacity at 55℃	电池按 3.1.2 规定充电结束后，将电池放入 55±2℃恒温环境中搁置 5±0.2h，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（%）。 The cell is charged in accordance with 3.1.2, and stored in an ambient temperature of 55±2℃ for 5±0.2h, and then discharged in accordance with 3.1.3. Calculate the ratio of discharge capacity and initial discharge capacity (%).	55℃充电容量≥100%*初始放电电容量 discharging capacity at 55℃≥100% * initial discharge capacity

4.2.5	低温充电性能 Low Temperature Charge Performance	电池按 3.1.3 规定放电结束后，将电池放入-20 ±2℃/ -40 ±2℃恒温环境中搁置 12±0.2h，然后以 $1I_1$ （40A）电流充电至标准充电截止电压，计算充电容量（Ah）与初充电始容量的比值（%）。 The cell is discharged in accordance with 3.1.3, and stored in an ambient temperature of -20 ±2℃/-40 ±2℃ for 12±0.2h, and then charged to standard charge cut-off voltage at a constant current of $1I_1$ (40A). Calculate the ratio of charge capacity and initial charge capacity (%).	-20℃充电容量≥85%*初始充电容量 charging capacity at -20℃ ≥85% * initial charge capacity
			-40℃充电容量≥60%*初始充电容量 charging capacity at -40℃ ≥60% * initial charge capacity
4.2.6	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 ±2℃/-40 ±2℃恒温环境中搁置 12±0.2h，然后以 $1I_1$（40A）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 stored in an ambient temperature of -20±2℃/-40±2℃ for 12±0.2h, and then discharged to 1.2V at a constant current of $1I_1$ (40A). Calculate the ratio of discharge capacity and initial discharge capacity (%).	-20℃放电容量≥70%*初始放电容量 discharging capacity at -20℃≥70% * initial discharge capacity
			-40℃放电容量≥60%*初始放电容量 discharging capacity at -40℃≥60% * initial discharge capacity
4.2.7	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±2℃, 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≥90%*初始放电容量，恢复容量≥95%*初始放电容量 The residual capacity is not less than 90% of the initial discharge capacity, and the recoverable capacity is not less than 95% of the initial discharge capacity at room temperature

4.2.8	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±2℃环境下储存 7 天，再在 25±2℃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±2℃ for 7 days, rest 5h (25±2℃), 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≥90%*初始放电容量，恢复容量≥95%*初始放电容量 The residual capacity is not less than 90% of the initial discharge capacity, and the recoverable capacity is not less than 95% of the initial discharge capacity at 55℃
4.2.9	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±2℃环境下储存 30 天，电池在 25±2℃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±2℃ for 30 days, rest 5h (25±2℃), 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≥95%*初始放电容量 The recoverable capacity is not less than 95% of the initial discharge capacity

4.3 充/放电参数 Charge /Discharge Parameter

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

测试条件：

①25℃恒温箱中搁置10min；

②1I_1(40A)恒流充电至 2.9V；

③搁置10min；

④1I_1(40A)恒流放电至 1.5V；

⑤搁置10min；

⑥重复②③④⑤步骤3次；

⑦以1I_1(40A)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:

①Rest 10minutes at 25℃;

②1I_1(40A)charge to 2.9V;

③Rest 10minutes;

④1I_1(40A) discharge to1.5V;

⑤Rest10minutes;

⑥Repeat②③④⑤for 3 times;

⑦1I_1(40A) charge 3minutes,rest 30min, the OCV of 5%SOC:choose the cut-off voltage;

⑧Repeat ⑦ to 2.9V.

表 1 单体电池常温充电 SOC-OCV

Table 1 Charge SOC-OCV at 25℃

方式 / SOC	充电
	电压（V）
0%	2.069
5%	2.114
10%	2.131
15%	2.144
20%	2.156
25%	2.167
30%	2.177
35%	2.186
40%	2.196
45%	2.206
50%	2.217
55%	2.230
60%	2.246
65%	2.266
70%	2.290
75%	2.319
80%	2.352
85%	2.389

90%	2.429
95%	2.472
100%	2.525

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

测试条件：

①25℃恒温箱中搁置10min；

②1I_1(40A)恒流放电至 1.5V；

③搁置10min；

④1I_1(40A)恒流充电至 2.9V；

⑤搁置10min；

⑥重复②③④⑤步骤3次；

⑦以1I_1(40A)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:

①Rest 10minutes at 25℃;

②1I_1(40A)discharge to 1.5V;

③Rest 10minutes;

④1I_1(40A)charge to2.9V;

⑤Rest10minutes;

⑥Repeat②③④⑤for 3 times;

⑦1I_1(40A)charge 3minutes,rest 30min, the OCV of 5%SOC:choose the cut-off voltage;

⑧Repeat ⑦ to 1.5V.

表 2 单体电池常温放电 SOC-OCV

Table 2 Discharge SOC-OCV at 25℃

方式 / SOC	放电
	电压（V）
100%	2.643
95%	2.494
90%	2.448
85%	2.406
80%	2.367
75%	2.331
70%	2.300
65%	2.274
60%	2.252
55%	2.234

50%	2.219
45%	2.208
40%	2.197
35%	2.187
30%	2.177
25%	2.167
20%	2.157
15%	2.145
10%	2.132
5%	2.117
0	2.094

4.3.3 单体电池单次最大满充性能 Cell Maximum Single Full Charge Performance

表 3 单体电池充电电流矩阵表

Table 3 Charge current matrix table

T(℃)\SOC(%)	100	[95,100)	[93,95)	[90,93)	[85,90)	[80,85)	[50,80)	[20,50)	[0,20)
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	0	1C	2C	3C	3C	3C	3C	3C	3C
50℃≥T＞45℃	0	2C	2C	3C	3C	3C	3C	3C	3C
45℃≥T＞35℃	0	2C	3C	3C	3C	3C	3C	3C	3C
35℃≥T＞25℃	0	3C	3C	4C	4C	4C	4C	4C	4C
25℃≥T＞20℃	0	4C	4C	4C	6C	6C	6C	6C	6C
20℃≥T＞15℃	0	4C	4C	4C	6C	6C	6C	6C	6C
15℃≥T＞12℃	0	4C	4C	4C	5C	5C	5C	5C	5C
12℃≥T＞10℃	0	4C	4C	4C	4C	4C	4C	4C	4C
10℃≥T＞7℃	0	3C	3C	3C	3C	3C	3C	3C	3C
7℃≥T＞5℃	0	3C	3C	3C	3C	3C	3C	3C	3C
5℃≥T＞2℃	0	3C	3C	3C	3C	3C	3C	3C	3C
2℃≥T＞0℃	0	1C	2C	3C	3C	3C	3C	3C	3C
0℃≥T＞-5℃	0	1C	1C	2C	3C	3C	3C	3C	3C
-5℃≥T＞-10℃	0	1C	1C	1C	3C	3C	3C	3C	3C
-10℃≥T＞-20℃	0	1C	1C	1C	2C	2C	2C	2C	2C
-20℃≥T＞-30℃	0	0.5C	0.5C	0.8C	1C	1C	1C	1C	1C
-30℃≥T＞-40℃	0	0.3C	0.3C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C

备注：电池保护温度 55℃

remark: the cell protection temperature 55℃

编制：褚光辉 日期:2024/11/29　审核：高娇阳 日期:2024/11/29　标准化：邓锦珍 日期:2024/11/29　批准：詹世英 日期:2024/11/29

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

表 4 单体电池 60s 脉冲充电电流限流表

Table 4 Charge current limit for cell pulse 60s

T(℃)\SOC(%)	0	10	30	50	60	70	75	80	85	90	93	96	100
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	2C	0
50℃≥T＞40℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	2C	0
40℃≥T＞30℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	2C	0
30℃≥T＞20℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	4C	3C	2C	0
20℃≥T＞10℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	4C	3C	2C	0
10℃≥T＞5℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	2C	0
5℃≥T＞0℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3C	2C	0
0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3.5C	2C	2C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3.5C	2C	2C	2C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	1.5C	1.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	1C	0
-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0

备注：电池保护温度 55℃

remark: the cell protection temperature 55℃

表 5 单体电池 30s 脉冲充电电流限流表

Table 5 Charge current limit for cell pulse 30s

T(℃)\SOC(%)	0	10	30	50	60	70	75	80	85	90	93	96	100
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
50℃≥T＞40℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
40℃≥T＞30℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
30℃≥T＞20℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
20℃≥T＞10℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
10℃≥T＞5℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
5℃≥T＞0℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	2C	0
0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3.5C	2C	2C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	2C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	1.5C	1.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	1C	0

-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0

备注：电池保护温度 55℃

remark: the cell protection temperature 55℃

表 6 单体电池 10s 脉冲充电电流限流表

Table 6 Charge current limit for cell pulse 10s

T(℃)\SOC(%)	**0**	**10**	**30**	**50**	**60**	**70**	**75**	**80**	**85**	**90**	**93**	**96**	**100**
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
50℃≥T＞40℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
40℃≥T＞30℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
30℃≥T＞20℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
20℃≥T＞10℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
10℃≥T＞5℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	2C	0
5℃≥T＞0℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	2C	0
0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	3.5C	2C	2C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	2C	2C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	1.5C	1.5C	1.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	1C	0
-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0

备注：电池保护温度 55℃

remark: the cell protection temperature 55℃

4.3.5 单体电池单次最大满放性能 Cell Maximum Single Full Discharge Performance

表 7 单体电池放电电流矩阵表

Table 7 Discharge current matrix table

T(℃)\SOC(%)	**0**	**（0,30)**	**[30,50)**	**[50,80)**	**[80,85]**	**(85,90)**	**[90,93)**	**[93,95)**	**[95,100]**
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	0	2C	3C	3C	3C	3C	3C	3C	3C
50℃≥T＞45℃	0	2C	3C	3C	3C	3C	3C	3C	3C
45℃≥T＞35℃	0	2C	3C	3C	3C	3C	3C	3C	3C
35℃≥T＞25℃	0	3C	3C	4C	4C	4C	4C	4C	4C
25℃≥T＞20℃	0	4C	4C	4C	6C	6C	6C	6C	6C
20℃≥T＞15℃	0	4C	4C	4C	6C	6C	6C	6C	6C
15℃≥T＞12℃	0	4C	4C	4C	5C	5C	5C	5C	5C
12℃≥T＞10℃	0	4C	4C	4C	4C	4C	4C	4C	4C
10℃≥T＞7℃	0	3C	3C	3C	3C	3C	3C	3C	3C

7℃≥T＞5℃	0	3C	3C	3C	3C	3C	3C	3C	3C
5℃≥T＞2℃	0	3C	3C	3C	3C	3C	3C	3C	3C
2℃≥T＞0℃	0	1C	2C	3C	3C	3C	3C	3C	3C
0℃≥T＞-5℃	0	1C	2C	3C	3C	3C	3C	3C	3C
-5℃≥T＞-10℃	0	1C	2C	3C	3C	3C	3C	3C	3C
-10℃≥T＞-20℃	0	1C	2C	3C	3C	3C	3C	3C	3C
-20℃≥T＞-30℃	0	0.5C	0.5C	0.8C	1C	1C	1C	1C	1C
-30℃≥T＞-40℃	0	0.3C	0.3C	0.5C	0.5C	0.5C	0.5C	0.5C	0.5C

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

表 8 单体电池 60s 脉冲放电电流限流表

Table 8 Discharge current limit for cell pulse 60s

T(℃)\SOC(%)	100	96	93	90	85	80	75	70	60	50	30	20	10	0
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
50℃≥T＞40℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
40℃≥T＞30℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
30℃≥T＞20℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	5C	5C	3C	1C	0
20℃≥T＞10℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
10℃≥T＞5℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
5℃≥T＞0℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	2C	1C	0
0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	1C	0.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	0.5C	0
-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0.5C	0

表 9 单体电池 30s 脉冲放电电流限流表

Table 9 Discharge current limit for cell pulse 30s

T(℃)\SOC(%)	100	96	93	90	85	80	75	70	60	50	30	20	10	0
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	1C	0
50℃≥T＞40℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	1C	0
40℃≥T＞30℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	1C	0
30℃≥T＞20℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	1C	0
20℃≥T＞10℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	3C	1C	0
10℃≥T＞5℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0
5℃≥T＞0℃	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	5C	3C	1C	0

0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	1C	0.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	0.5C	0
-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0.5C	0

表 10 单体电池 10s 脉冲放电电流限流表

Table 10 Discharge current limit for cell pulse 10s

T(℃)\SOC(%)	**100**	**96**	**93**	**90**	**85**	**80**	**75**	**70**	**60**	**50**	**30**	**20**	**10**	**0**
60℃≥T＞55℃	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55℃≥T＞50℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	1C	0
50℃≥T＞40℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	1C	0
40℃≥T＞30℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	1C	0
30℃≥T＞20℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	1C	0
20℃≥T＞10℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	3C	1C	0
10℃≥T＞5℃	10C	10C	10C	10C	10C	10C	10C	10C	10C	10C	6C	3C	1C	0
5℃≥T＞0℃	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	6C	2C	1C	0
0℃≥T＞-5℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-5℃≥T＞-10℃	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	4.5C	2C	1C	0
-10℃≥T＞-20℃	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C	1C	0.5C	0
-20℃≥T＞-30℃	2C	2C	2C	2C	2C	2C	2C	2C	2C	2C	1C	1C	0.5C	0
-30℃≥T＞-40℃	1C	1C	1C	1C	1C	1C	1C	1C	1C	1C	0.5C	0.5C	0.5C	0

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
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(40A)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(40A) for 90 minutes, observed for 1h.	按照 GB 38031-2020 5.1.1：不爆炸、不起火 Accordance with GB 38031-2020 5.1.1：No

			explosion, No fire
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(40A)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 1I_1(40A), observed for 1h.	按照 GB 38031-2020 5.1.2：不爆炸、不起火 Accordance with GB 38031-2020 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 5mΩ，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 a external line having a maximum resistance of 5mΩ, then observed for 1h.	按照 GB 38031-2020 5.1.3：不爆炸、不起火 Accordance with GB 38031-2020 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℃/min 的速率由室温升至 130±2℃，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±2℃ with a heating rate of 5℃/min，stopped heating , then observed for 1h.	按照 GB 38031-2020 5.1.4：不爆炸、不起火 Accordance with GB 38031-2020 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 5.1.6：不爆炸、不起火 Accordance with GB 38031-2020 5.1.6：No explosion, No fire

<table>
<tr><td>5.6</td><td>针刺
Puncture Test</td><td>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 5-8mm at a rate of 25±5 mm/s, the nail stay within the cell.， and then observed for 1h.</td><td>不爆炸、不起火
No explosion,
No fire</td></tr>
<tr><td>5.7</td><td>海水浸泡
Seawater Immersion</td><td>电池按 3.1.2 规定充电结束后，将电池完全浸没入 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.</td><td>不爆炸、不起火
No explosion,
No fire</td></tr>
<tr><td>5.8</td><td>低气压
Low Pressure</td><td>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。
A 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.</td><td>不爆炸、不起火、不漏液
No explosion,
No fire, No leakage</td></tr>
<tr><td>5.9</td><td>温度循环
Temperature Cycling</td><td>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.
<table>
<tr><th>温度(℃)
Temperature</th><th>时间增量
(min)
Incremental Time</th><th>累计时间
(min)
Total Time</th><th>温度变化率
(℃/min)
Temperature Rate</th></tr>
<tr><td>25</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>-40</td><td>60</td><td>60</td><td>13/12</td></tr>
<tr><td>-40</td><td>90</td><td>150</td><td>0</td></tr>
<tr><td>25</td><td>60</td><td>210</td><td>13/12</td></tr>
<tr><td>85</td><td>90</td><td>300</td><td>2/3</td></tr>
<tr><td>85</td><td>110</td><td>410</td><td>0</td></tr>
<tr><td>25</td><td>70</td><td>480</td><td>6/7</td></tr>
</table>
</td><td>按照 GB 38031-2020 5.1.5：不爆炸、不起火
Accordance with GB 38031-2020 5.1.5：No explosion, No fire</td></tr>
</table>

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 电池的连接 Cell Connection

（1）使用前应确认极柱螺纹及极柱凸台表面光滑平整，表面有污物或凸起会导致接触不良、功能失效。

（1）Make sure the surface of polar thread and polar column is smooth before using. Poor contact and functional failure will happened if dirty or bump on the surface.

（2）电池在成模组后 1C 放电时，连接条与极柱之间的压降＜3mV，可避免因连接电阻过大导致的异常发热和压差过大。

（2）The voltage drop between the connecting strip and the pole should < 3mV, which can avoid the case of the abnormal heating and pressure difference caused by the large connection resistance, when the cell is charging/discharging at 1C after being assembled into cell.

（3）采用专用扳手等工具进行连接操作，扭矩≤12N ṁ

（3）Use special wrench and other tools for connection operation and the torque is≤12N ṁ.

（4）电池与电池之间的连接应注意正负极柱凸台的高度差为 1.5mm，连接排的设计应避免极柱之间受到拉力或挤压，力过大，会使极柱变形或拧断。

（4）Notice the altitude difference between the positive and negative pole boss is 1.5mm when connect the cell, the design of the connection row should avoid larger tension or extrusion between the pole, which may make the pole column deformation or twist.

（5）不允许拉伸或挤压电池。

（5）Do not stretch or squeeze the cell.

6.2 电池在 pack 箱或运输过程中应平放，如下图 1 所示。禁止将电池竖放。

The cell should be arranged horizontally during transportation or in pack, which cannot be vertically positioned. As shown below.

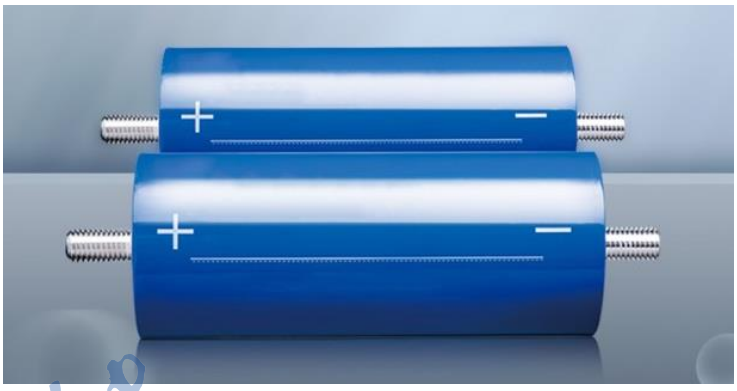


图 1 钛酸锂电池在 pack 箱和运输过程中的放置示意图

Fig.1 The schematic diagram of lithium titanate cell arranged during transportation or in pack

6.3 在 pack 设计时，电池壳体能承受的最大压力为 500N（夹持部位面积双边 30cm^2*2，夹持长度 100mm，

夹持半径 R33，夹持 10s 以内）。

It shall be ensured for the pack design that the case of the cell shell can withstand the maximum thrust is 500N (the area of the clamping part is $30cm^2$*2, the clamping length is 100mm, the clamping radius is R33, and the clamping is within 10s).

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.

6.12 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。若由于未对每支电池进行监控、

管理，导致电池发生过充、过放甚至热失控问题，责任由样品需求单位承担，格力钛新能源股份有限公司不承担任何责任。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). If the cell occurs overcharge, overdischarge or even thermal runaway due to the fairlure to monitor and manage each cell, all responsibilities shall be borne by the product demand unit, and GREE Altairnano will not take any responsibility.The BMS shall have the following functions:

序号 No.	项目 Item	规格 Specification	保护要求 Protection requirements
6.12.1	充电终止 Charge Cut-off	≤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.
6.12.2	过充保护 Over Charge Protection	≤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
6.12.3	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.
6.12.4	过放保护 Over Discharge Protection	最小 1.45V（环境温度＞-20℃） Minimum 1.45V（ambient temperature ＞-20℃） 最小 1.2V（环境温度≤-20℃） Minimum 1.2V（ambient temperature ≤-20℃）	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.
6.12.5	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℃.
6.12.6	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 overcorrect 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.

6.13 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.

6.14 禁止电池达到过放状态。电池电压低于 1.5V（环境温度＞-20℃）或低于 1.2V（环境温度≤-20℃）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℃） or less than 1.2V（ambient temperature ≤20℃）, at which point GREE Altairnano's product quality assurance product quality assurance responsibility becomes invalid.

6.15 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.

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 flows 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 ℃, 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，否则不承诺免费更换。

Warranty period of the product is 180 days from the date of manufacture. GREE Altairnano promises to return or exchange cells in case of cells with defects proven due to the manufacturing process instead of abuse 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±2℃，可接受的贮存温度为：-40℃~55℃，相对湿度≤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-40~30℃条件下，建议单体电池补电周期为6个月，30~45℃建议单体电池补电周期为3个月，45~55℃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±2℃). The acceptable storage temperature can be -40℃~55℃, and the relative humidity ≤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 -40~30℃；the recommended period to recharge is 3 months at 30~45℃; the recommended period to recharge is 1 month at 45~55℃.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≤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 shall be packed in cartons under the condition of ≤30% charged for shipment. The violent vibration, impaction 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。

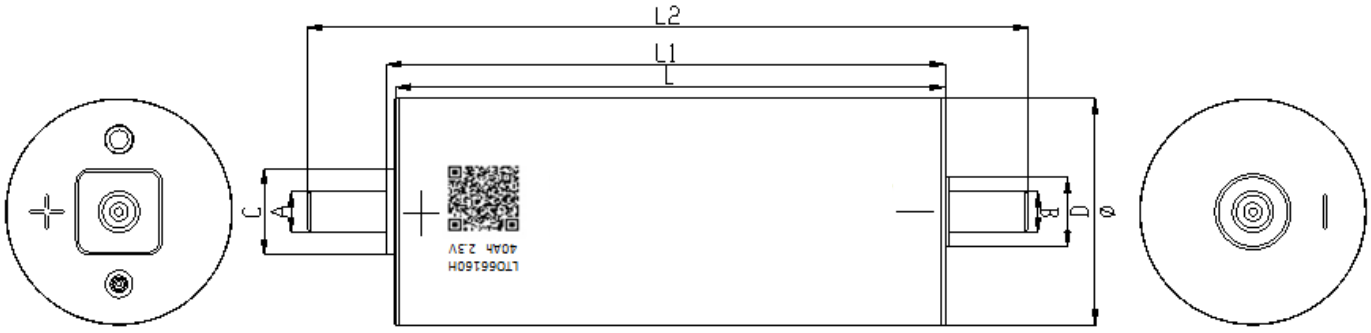
如果由于产品需求单位不按本说明书中的规定使用，造成社会性影响，并对格力钛新能源股份有限公司的声誉造成影响的，格力钛新能源股份有限公司将会追究产品需求单位的责任。根据对格力钛新能源股份有限公司造成的影响程度，产品需求单位需向格力钛新能源股份有限公司提供赔偿。

If the product demand unit does not use the cells in accordance with the regulations in this specification, which causes any problems with the batteries, 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



（单位：mm）

代码	Ø	L	L1	L2	A	B	C	D
标准	66	161	163.5	209.5	M12	M12	25*25	Ø22
公差	±0.5	±0.5	$^{+1}_{-0.5}$	±1	/	/	±0.5	±0.5

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.

15. 附图 Figure

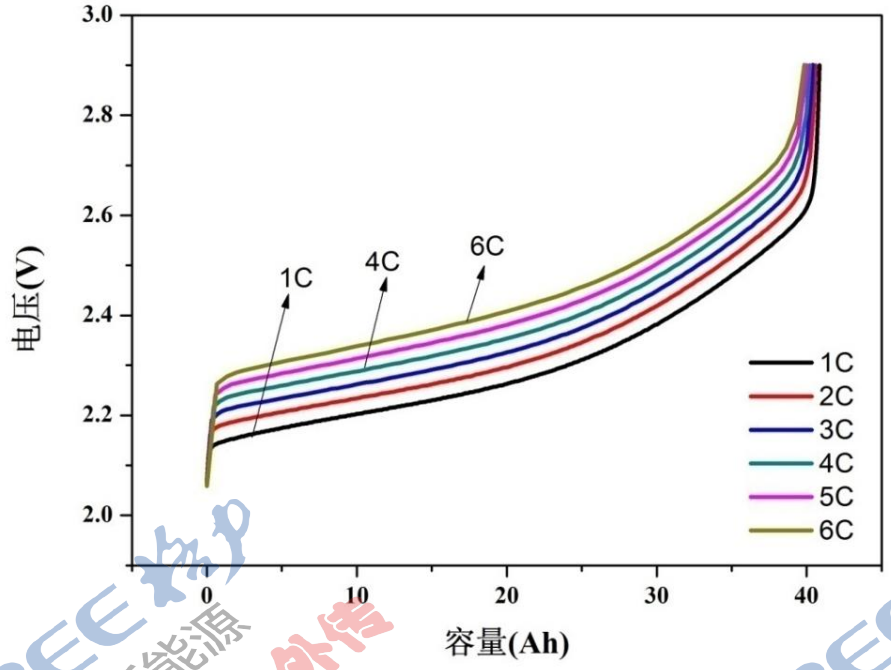


图 2 倍率充电性能曲线图

Fig.2 Rate charge performance curve

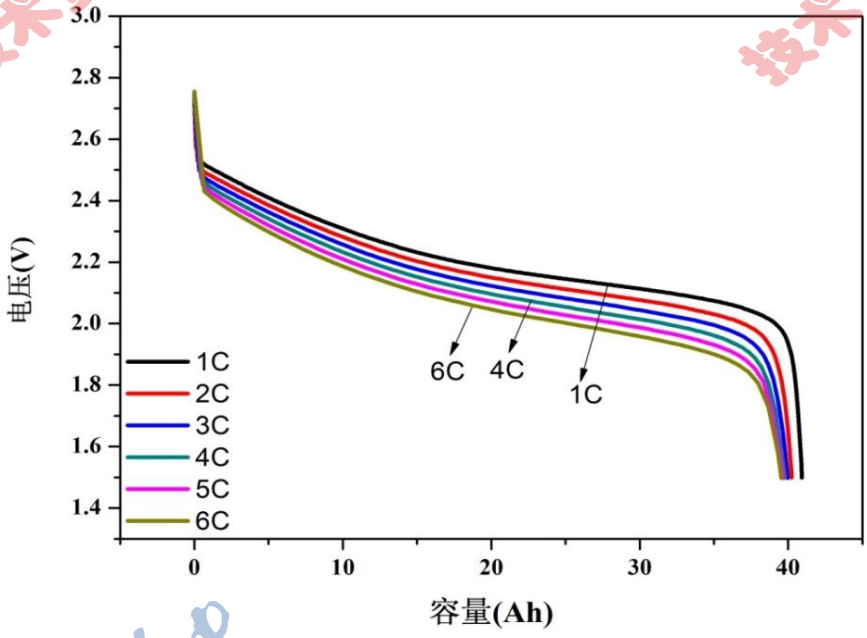


图 3 倍率放电性能曲线图

Fig.3 Rate discharge performance curve