产品规格书

Product Specification

产品型号/ Product No.：PF173-280A

制定/Producer	审核/Checker	批准/Approver

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前　言 Preview

本标准为公司统一执行的企业标准。

本标准的编写格式符合 GB/T 1.1-2009《标准化工作导则 第 1 部分：标准的结构和编写》的规定。

本标准在参照 GB/T 36276-2018 《电力储能用锂离子电池》的基础上，结合我公司产品实际和试验条件进行制定，并对试验方法、判定标准内容进行了修订和补充，以指导 PF173-280A 锂离子电芯产品的制造和验收。

This file defines the detail specifications (e.g. performance and diameter) of the rechargeable Lithium-ion cell (PF173-280A), manufactured by the enterprise.

Based on national standards: GB/T 36276-2018 (Lithium-ion battery for electrical energy storage) and combined with the company's actual product & testing environment, this file is issued to guide the production, testing and acceptance of rechargeable Lithium-ion cell - PF173-280A.

修订记录 revision record

版本号 Version	变更内容 Content modified	修订日期 Date	修订者 Modified by
A	首次发布 First released	2021-09-28	崔献广
B	优化循环寿命表述方式；优化电芯最大充放电倍率	2022-10-11	崔献广
C	1.增加 8000 次循环寿命; 2.调整电芯重量均值。	2023-02-24	

1 适用范围 Scope of Application

本产品规格书规定了本企业生产的 PF173-280A 锂离子电芯的性能要求、试验方法、检验规则、标志、包装、运输、贮存、安全要求。

This file defines the performance requirements, test methods, inspection rules, signs, packing, transportation, storage and safety requirements of rechargeable Lithium-ion battery cell - PF173-280A, produced by the enterprise.

2 规范性引用文件 Applicable standards

下列文件中的条款通过本标准的引用而成为本标准的条款。凡是不注日期的引用文件，其最新版本适用于本标准。

GB/T 36276-2018 《电力储能用锂离子电池》

The clauses in the following documents become clauses of this standard after being quoted in this standard. For undated references, the latest version is applicable to this standard.

GB/T 36276-2018 Lithium-ion battery for electrical energy storage

3 术语和定义 Terms & Definition

3.1 产品：本规格书中的“产品”是指本企业生产的 PF173-280A 可充电磷酸铁锂电芯。

Product: Rechargeable Lithium-ion cell PF173-280A, produced by the enterprise.

3.2 客户：客户是指购买本规格书所述产品的公司，企业或个人。

Customer/client: Company or person to buy this product.

3.3 室温条件：缩写符号 RT，环境温度为 25±2℃。

Room temperature: The abbreviation RT, the ambient temperature is 25±2℃.

3.4 额定充电容量：室温下，标准放电后，标准充电至 3.65V 所充入的容量。

Rated charging capacity: At room temperature, the capacity of standard charge to 3.65V after standard discharge.

3.5 额定放电容量：室温下，标准充电后，标准放电至 2.5V 所放出的容量。

Rated discharging capacity: At room temperature, the capacity of standard

discharge to 2.5V after standard charge.

3.6 额定充电能量：室温下，标准放电后，标准充电至 3.65V 所充入的能量。

Rated charging energy: At room temperature, the energy of standard charge to 3.65V after standard discharge.

3.7 额定放电能量：室温下，标准充电后，标准放电至 2.5V 所放出的能量。

Rated discharging energy: At room temperature, the energy of standard discharge to 2.5V after standard charge.

3.8 倍率电流：缩写符号 C，1C 表示电芯以 1 小时率充放电的电流，0.5C 表示电芯以 2 小时率充放电的电流。

Rate Current: Abbreviated in C, 1C represents the current that the cell charge and discharge at 1 hour; 0.5C represents the current that the cell charge and discharge at 2 hours.

3.9 倍率充电功率：缩写符号 P_c，$1P_c$ 表示电芯以 1 小时率充电的功率，$0.5P_c$ 表示电芯以 2 小时率充电的功率。

Rate charging power: Abbreviated in P_c, $1P_c$ represents the power that the cell charge at 1 hour；$0.5P_c$ represents the power that the cell charge at 2 hours.

3.10 倍率放电功率：缩写符号 P_d，$1P_d$ 表示电芯以 1 小时率放电的功率，$0.5P_d$ 表示电芯以 2 小时率放电的功率。

Rate discharging power: Abbreviation in P_d, $1P_d$ represents the power that the cell discharge at 1 hour, $0.5P_d$ represents the power that the cell discharge at 2 hours.

3.11 最大持续充电功率：电芯在指定温度下，保证电芯正常工作所允许进行持续充电的最大功率。

Maximum continuous charging power: The maximum power allowed for continuous charge to ensure the cell normal operation at specified temperature

3.12最大持续放电功率：电芯在指定温度下，保证电芯正常工作所允许进行持续放电的最大功率。

Maximum continuous discharging power: The maximum power allowed for continuous discharge to ensure the cell normal operation at specified temperature.

3.13能量效率：在规定的试验条件和试验方法下，电池的放电能量与充电能量的比值，用百分数表示。

Energy efficiency: Under the specified test conditions and methods, the ratio of the discharge energy to the charge energy of the cell, expressed as a percentage.

3.14周围环境温度：电池所处的周围环境温度。

Ambient temperature: The ambient temperature where the cell is located.

3.15电芯温度：由接入电池的温度传感器测量的电芯的温度，温度传感器和测量线路的选择由双方共同商定。

Cell temperature: The temperature of the cell measured by the temperature sensor connected to the battery. The selection of the temperature sensor and the measurement circuit is jointly negotiated by the customer and the enterprise

3.16充电状态（SOC）：在无负载的情况下，以安培小时或者以瓦特小时为单位计量的电池充电容量状态的所有的线性关系。100%的状态表示电池满充到 3.65V，0%的状态表示电池完全放电到 2.5V。

State of Charge (SOC): All linear relationships of the state of cell charging capacity measured in ampere-hours or watt-hours under no-load conditions. A state of 100% means that the battery is fully charged to 3.65V, and a state of 0% means that the battery is fully discharged to 2.5V.

4 基本性能 Basic performance

表 1 基本性能

Table 1 Basic performance

序号 No.	项目 Item		规格 Spec	备注 Remark
4.1	外观 Appearance		表面清洁、无锈蚀、无划痕、无毛刺、无变形及机械损伤，无电解液泄露 clean surface, no rust, no scratches, no burrs, no deformation and mechanical damage, no electrolyte leakage	N.A.
4.2	尺寸 Dimension		厚度 Thickness：71.5±0.5mm 宽度 Width：174.4±0.5mm 肩高 Shoulder height：204.3±0.5mm 总高 Total height：207.2±0.5mm	厚度测试条件：SOC≤30%、300±10kgf 压力详见附录 Thickness test condition: SOC≤30%，pressure of 300±10kgf see appendix for details
4.3	重量 Weight		5.40±0.2Kg	N.A.
4.4	标称电压 Nominal voltage		3.2V	RT，0.5P_d/0.5P_c
4.5	交流内阻 AC internal Resistance		0.18±0.05mΩ	RT，1KHz
4.6	额定充电容量 Rated charging capacity		280Ah	RT，0.5P_d/0.5P_c
4.7	额定放电容量 Rated discharging capacity		280Ah	RT，0.5P_c/0.5P_d
4.8	额定充电能量 Rated charging energy		896Wh	RT，0.5P_d/0.5P_c
4.9	额定放电能量 Rated discharging energy		896Wh	RT，0.5P_c/0.5P_d
4.10	充电 Charge	标准充电功率 Standard charging power	448W（0.5P_c）	RT
4.11		最大持续充电功率 Maximum continuous	不允许充电 not allowed to charge	＜-10℃

		charging power	见功率 Map	-10℃≤温度≤55℃
			不允许充电 not allowed to charge	＞55℃
4.12		最大允许充电电压 Cut-off charging voltage	3.65V	实际使用充电电压 以技术协议为准
4.13		最大允许充电温度范围 Maximum charging temp. range	-10℃～55℃	N.A.
4.14		最佳充电温度范围 Optimal charging temperature range	10℃～35℃	N.A.
4.15	放电 Discharge	标准放电功率 Standard discharging power	448W（0.5P_d）	RT
4.16		最大脉冲放电功率 Maximum pulse discharging power	896W（1P_d）	RT，50% SOC，10s
4.17		最低允许放电电压 cut-off discharging voltage	2.5V（T＞0℃）	实际使用放电电压 以技术协议为准
			2.0V（T≤0℃）	
4.18		允许放电温度范围 Allowable discharging temperature range	-30℃～55℃	N.A.
4.19		最佳放电温度范围 Optimal discharging temperature range	10℃～35℃	N.A.
4.20	存储条件 Storage Conditions	最佳存储温度范围 Optimal storage temperature range	10℃～35℃	可存储温度 Allowed storage temperature：-40℃～60℃
4.21		最佳存储荷电状态	30%～50% SOC	N.A.

		Optimal storage state of charge		
4.22		存储湿度 Storage humidity	≤75% RH	N.A.
4.23	出货荷电状态 Delivery capacity (SOC)		20%SOC	可调整 Adjustable

5 电性能 Electric performance

5.1 初始充放电容量、能量性能

Initial charging and discharging capacity, initial charging and discharging energy

表 2 初始充放电容量、能量性能

Table 2 Initial charging and discharging capacity, initial charging and discharging energy

序号 No.	项目 Item	规格 Spec	备注 Remark
5.1.1	初始充电容量（0.25P_c） Initial charging capacity (0.25P_c)	≥280Ah	RT，0.25P_c，参见 7.4 more on 7.4
5.1.2	初始放电容量（0.25P_d） Initial discharging capacity (0.25P_d)	≥280Ah	RT，0.25P_d，参见 7.4 more on 7.4
5.1.3	初始充电能量（0.25P_c） Initial charging energy (0.25P_c)	≥896Wh	RT，0.25P_c，参见 7.4 more on 7.4
5.1.4	初始放电能量（0.25P_d） Initial discharging energy (0.25P_d)	≥896Wh	RT，0.25P_d，参见 7.4 more on 7.4
5.1.5	初始充电容量（0.5P_c） Initial charging capacity (0.5P_c)	≥280Ah	RT，0.5P_c，参见 7.4 more on 7.4
5.1.6	初始放电容量（0.5P_d） Initial discharging capacity (0.5P_d)	≥280Ah	RT，0.5P_d，参见 7.4 more on 7.4
5.1.7	初始充电能量（0.5P_c） Initial charging energy (0.5P_c)	≥896Wh	RT，0.5P_c，参见 7.4 more on 7.4
5.1.8	初始放电能量（0.5P_d） Initial discharging energy (0.5P_d)	≥896Wh	RT，0.5P_d，参见 7.4 more on 7.4

5.2 倍率充放电性能 Rate charge and discharge performance

表 3 倍率充放电性能

Table 3 Rate charge and discharge performance

序号 No.	项目 Item	规格 Spec	备注 Remark
5.2.1	倍率充电能量保持率 Rate charge energy retention rate	≥95%	RT，$1P_c/0.5P_c$，参见 7.5 More on 7.5
		≥90%	RT，$2P_c/0.5P_c$，参见 7.5 More on 7.5
5.2.2	倍率放电能量保持率 Rate discharge energy retention rate	≥95%	RT，$1P_d/0.5P_d$，参见 7.5 More on 7.5
		≥90%	RT，$2P_d/0.5P_d$，参见 7.5 More on 7.5
5.2.3	倍率充放电能量效率 Rate charge and discharge energy efficiency	≥90%	RT，$0.5P_d/0.5P_c$，参见 7. More on 7.5
		≥85%	RT，$1P_d/1P_c$，参见 7.5 More on 7.5
		≥80%	RT，$2P_d/2P_c$，参见 7.5 More on 7.5

5.3 高低温充放电性能 High and low temperature charge and discharge performance

表 4 高低温充放电性能

Table 4 High and low temperature charge and discharge performance

序号 No.	项目 Item	规格 Spec	备注 Remark
5.3.1	高温充电能量保持率 Charging energy retention rate@ high-temp.	≥98%	45±2℃，$0.5P_c$，参见 7.6 More on 7.6
5.3.2	高温放电能量保持率 Discharging energy retention rate@ high-temp.	≥98%	45±2℃，$0.5P_d$，参见 7.6 More on 7.6
5.3.3	高温充放电能量效率 Charging and discharging energy efficiency@ high-temp.	≥90%	45±2℃，$0.5P_d/0.5P_c$，参见 7.6 More on 7.6
5.3.4	低温充电能量保持率 Charging energy retention rate@ low-temp.	≥80%	5±2℃，$0.5P_c$，参见 7.7 More on 7.7
5.3.5	低温放电能量保持率 Discharging energy retention	≥75%	5±2℃，$0.5P_d$，参见 7.7 More on 7.7

	rate@ low-temp.		
5.3.6	低温充放电能量效率 Charging and discharging energy efficiency@ low-temp.	≥75%	5±2℃，0.5P_d/0.5P_c，参见 7.7 More on 7.7

5.4 存储性能 Storage performance

表 5 存储性能

Table 5 Storage performance

序号 No.	项目 Item	规格 Spec	备注 Remark
5.4.1	室温能量保持率 Discharging energy retention rate@ RT	≥90%	RT，28D， 参见 7.8 More on 7.8
5.4.2	室温充电能量恢复率 Charging energy recovery rate@ RT	≥92%	
5.4.3	室温放电能量恢复率 Discharging energy recovery rate@ RT	≥92%	
5.4.4	高温能量保持率 Discharging energy retention rate@ high-temp.	≥90%	45±2℃，7D， 参见 7.9 More on 7.9
5.4.5	高温充电能量恢复率 Charging energy recovery rate@ high-temp.	≥92%	
5.4.6	高温放电能量恢复率 Discharging energy recovery rate@ high-temp.	≥92%	
5.4.7	储存充电能量恢复率 Charging energy recovery rate of storage	≥90%	45±2℃，28D， 参见 7.10 More on 7.10
5.4.8	储存放电能量恢复率 Discharging energy recovery rate of storage	≥90%	

5.5 循环性能 Cycle life

表 6 循环性能

Table 6 Cycle life

序号 No.	项目 Item	规格 Spec	备注 Remark
5.5.1	标准循环寿命 Cycle life	≥6000 次	RT，0.5P_c/0.5P_d，80%EOL 带夹具测试，参见 7.11 With fixture, more on 7.11
5.5.2	标准循环寿命 Cycle life	≥8000 次	RT，0.5P_c/0.5P_d，70%EOL 带夹具测试，参见 7.11 With fixture, more on 7.11

6 安全性能 Safety performance

表 7 安全性能

Table 7 **Safety performance**

序号 No.	项目 Item	规格 Spec	备注 Remark
6.1	过放电 Over discharge	不爆炸，不起火 No fire, No explosion	测试方法见 7.12 See test method on 7.12
6.2	过充电 Over charge	不爆炸，不起火 No fire, No explosion	测试方法见 7.13 See test method on 7.13
6.3	短路 Short circuit	不爆炸，不起火 No fire, No explosion	测试方法见 7.14 See test method on 7.14
6.4	跌落 Drop	不爆炸，不起火 No fire, No explosion	测试方法见 7.15 See test method on 7.15
6.5	加热 Heating	不爆炸，不起火 No fire, No explosion	测试方法见 7.16 See test method on 7.16
6.6	挤压 Crush	不爆炸，不起火 No fire, No explosion	测试方法见 7.17 See test method on 7.17
6.7	低气压 Altitude simulation	不爆炸，不起火，不漏液 No fire, No explosion; No electrolyte leakage	测试方法见 7.18 See test method on 7.18
6.8	热失控	不爆炸，不起火	测试方法见 7.19

	Thermal runaway	No fire, No explosion	See test method on 7.19

7 测试方法 Test methods

7.1 标准测试条件 Standard test method

电芯应为新产品（在制造后少于 1 个月储存），循环次数少于 5 次。除非另有说明，本规范中的所有测试条件如下：

温度为 25 ℃ ±5 ℃，相对湿度为≤90%，大气压力 86 kPa～106 kPa。本规格书所提到的室温（RT），是指 25 ℃ ±2 ℃。

The cell being tested should be newly manufactured (less than one-month storage and less than 5 times cycled). Unless otherwise indicated, all test conditions in this specification are as follows:

The temperature is 25 ℃ ± 5 ℃, the relative humidity is 15% to 90%, and the atmospheric pressure is 86 kPa to 106 kPa. The room temperature (RT) mentioned in this specification refers to 25 ℃ ±2 ℃.

7.2 初始化充电 Initial charge

①在室温下搁置 5h；

②电芯以 0.5P_d 恒功率放电至电压为 2.5V，静置 30min；

③电芯以 0.5P_c 恒功率充电至电压为 3.65V，静置 30min。

①The cell is stored for 5h at RT；

②The cell is discharged to 2.5V at constant power of 0.5P_d, then rest 30 minutes;

③The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30 minutes.

7.3 初始化放电 Initial discharge

①在室温下搁置 5h；

②电芯以 0.5P_c 恒功率充电至电压为 3.65V，静置 30min；

③电芯以 0.5P_d 恒功率放电至电压为 2.5V，静置 30min。

①The cell is stored for 5h at RT;

②The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30 minutes;

③The cell is discharged to 2.5V at constant power of 0.5P_d, then rest 30 minutes.

7.4 初始充放电容量、初始充放电能量 Initial charging and discharging capacity, initial charging and discharging energy

1）在室温下（0.25P_c /0.25P_d）

①电芯按 7.3 进行初始化放电；

②电芯以 0.25P_c 恒功率充电至电压为 3.65V，静置 30min；

③电芯以 0.25P_d 恒功率放电至电压为 2.5V，静置 30min；

④重复②~③3 次；

以三次充放电容量、充放电能量均值作为结果。

At room temperature（0.25P_c /0.25P_d）

② The cell is discharged according to term 7.3;

②The cell is charged to 3.65V at constant power of 0.25P_c, then rest 30 minutes;

③The cell is discharged to 2.5V at constant power of 0.25P_d, then rest 30 minutes;

④Repeat ②~③ 3 times;

Take the average of three charge and discharge capacity and charge-discharge energy as the result.

2）在室温下（0.5P_c /0.5P_d）

①电芯按 7.3 进行初始化放电；

②电芯以 0.5P_c 恒功率充电至电压为 3.65V，静置 30min；

③电芯以 0.5P_d 恒功率放电至电压为 2.5V，静置 30min；

④重复②~③3 次；

以三次充放电容量、充放电能量均值作为结果。

At room temperature（0.5P_c /0.5P_d）

①The cell is discharged according to term 7.3;

②The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30 minutes;

③The cell is discharged to 2.5V at constant power of 0.5P_d, then rest 30 minutes;

④Repeat ②~③ 3 times;

Take the average of three charge and discharge capacity and charge-discharge energy as the result.

7.5 室温倍率充放电 Rate charge and discharge at RT:：

在室温下，按照如下步骤测试电芯倍率充放电性能

①以 7.3 进行电芯初始化放电；

②电芯单体以 0.5P_c 恒功率充电至 3.65V，静置 30min；

③电芯单体以 0.5P_d 恒功率放电至 2.5V，静置 30min；

④电芯单体以 1P_c 恒功率充电至 3.65V，静置 30min；

⑤电芯单体以 0.5P_c 恒功率充电至 3.65V，静置 30min；

⑥电芯单体以 1P_d 恒功率放电至 2.5V，静置 30min；

⑦电芯单体以 0.5P_d 恒功率放电至 2.5V，静置 30min；

⑧电芯单体以 2P_c 恒功率充电至 3.65V，静置 30mn；

⑨电芯单体以 0.5P_c 恒功率充电至 3.65V，静置 30min；

⑩电芯单体以 2P_d 恒功率放电至 2.5V，静置 30min；

⑪电芯单体以 0.5P_d 恒功率放电至 2.5V，静置 30min；

⑫电芯单体以 1P_c 恒功率充电至 3.65V，静置 30min；

⑬电芯单体以 1P_d 恒功率放电至 2.5V，静置 30min；

⑭电芯单体以 0.5P_d 恒功率放电至 2.5V，静置 30min；

⑮电芯单体以 2P_c 恒功率充电至 3.65V，静置 30min；

⑯电芯单体以 2P_d 恒功率放电至 2.5V，静置 30min；

⑰记录步骤②、③、④、⑥、⑧、⑩、⑫、⑬、⑮、⑯的充电能量、放电能量、充电时间、放电时间、充电容量、放电容量；根据步骤②、③、④、⑥、⑧、⑩的数据分别计算 1P_c、2P_c 和 1P_d、2P_d 条件下的充电能量、放电能量分别相对于 0.5P_c，0.5P_d 条件下的充电能量、放电能量的能量保持率；根据步骤⑫、⑬、⑮、⑯的数据分别计算 0.5P_c 和 0.5P_d、1P_c 和 1P_d、2P_c 和 2P_d 条件下的能量效率。

At room temperature, test the charge and discharge rate performance according to following steps:

①The cell is discharged according to 7.3;

②The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30 minutes;

③The cell is discharged to 2.5V at constant power of 0.5P_d, then rest 30 minutes;

④The cell is charged to 3.65V at constant power of 1P_c, then rest 30 minutes;

⑤The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30 minutes;

⑥The cell is discharged to 2.5V at constant power of $1P_d$, then rest 30 minutes;

⑦The cell is discharged to 2.5V at constant power of $0.5P_d$, then rest 30 minutes;

⑧The cell is charged to 3.65V at constant power of $2P_c$, then rest 30 minutes;

⑨The cell is charged to 3.65V at constant power of $0.5P_c$, then rest 30 minutes;

⑩The cell is discharged to 2.5V at constant power of $2P_d$, then rest 30 minutes;

⑪The cell is discharged to 2.5V at constant power of $0.5P_d$, then rest 30 minutes;

⑫The cell is charged to 3.65V at constant power of $1P_c$, then rest 30 minutes;

⑬The cell is discharged to 2.5V at constant power of $1P_d$, then rest 30 minutes;

⑭The cell is discharged to 2.5V at constant power of $0.5P_d$, then rest 30 minutes;

⑮The cell is charged to 3.65V at constant power of $2P_c$, then rest 30 minutes;

⑯The cell is discharged to 2.5V at constant power of $2P_d$, then rest 30 minutes;

⑰Record the charging energy, discharging energy, charging time, discharging time, charging capacity and discharging capacity of steps ②、③、④、⑥、⑧、⑩、⑫、⑬、⑮、⑯;Respectively calculate $1P_c$,$2P_c$ $1P_d$,$2P_d$ charging and discharging energy retention rate relative to $0.5P_c$, $0.5P_d$ according to the data of steps ②、③、④、⑥、⑧、⑩; Respectively calculate charging and discharging energy efficiency of $0.5P_c$ and $0.5P_d$, $1P_c$ and $1P_d$, $2P_c$ and $2P_d$ according to the data of steps⑫、⑬、⑮、⑯.

7.6 高温充放电 High temperature charge and discharge：

①按 7.3 进行初始化放电；

②在 45℃±2℃下储存 5h；

③在 45℃±2℃下以 $0.5P_c$ 恒功率充电至 3.65V，静置 30min；

④在 45℃±2℃下以 $0.5P_d$ 恒功率放电至 2.5V；

高温放电能量与充电能量的比值为高温充放电能量效率，高温充电能量与初始充电能量（$0.5P_c$）的比值为高温充电能量保持率，高温放电能量与初始放电能量（$0.5P_d$）的比值为高温放电能量保持率。

①The cell is discharged according to 7.3;

②The cell is stored for 5h at 45℃±2℃;

③The cell is charged to 3.65V at constant power of $0.5P_c$ at 45℃±2℃, then rest 30min;

④The cell is discharged to 2.5V at a constant power of $0.5P_d$ at 45℃±2℃;

The ratio of discharging energy to charging energy is the charging and discharging energy efficiency@ high-temp, the ratio of charging energy to initial charging energy ($0.5P_c$) is the charging energy retention rate@ high temp., the ratio of discharging energy to initial discharging energy ($0.5P_d$) is discharging energy retention rate@ high-temp.

7.7 低温充放电 Low temperature charge and discharge：

①按 7.3 进行初始化放电；

②在 5℃±2℃下储存 20h；

③在 5℃±2℃下以 $0.5P_c$ 恒功率充电至 3.65V，静置 30min；

④在 5℃±2℃下以 $0.5P_d$ 恒功率放电至 2.5V；

低温放电能量与充电能量的比值为低温充放电能量效率，低温充电能量与初始充电能量（$0.5P_c$）的比值为低温充电能量保持率，低温放电能量与初始放电能量（$0.5P_d$）的比值为低温放电能量保持率。

①The cell is discharged according to 7.3;

②The cell is stored for 20h at 5℃±2℃;

③The cell is charged to 3.65V at constant power of $0.5P_c$ at 5℃±2℃, then rest 30min;

④The cell is discharged to 2.5V at constant power of $0.5P_d$ at 5℃±2℃;

The ratio of discharging energy to charging energy is the charging and discharging energy efficiency@ low-temp, the ratio of charging energy to initial charging energy ($0.5P_c$) is the charging energy retention rate@ low-temp., the ratio of discharging energy to initial discharging energy ($0.5P_d$) is discharging energy retention rate@ low-temp

7.8 室温能量保持、能量恢复 energy retention, energy recovery at room temperature

①按 7.2 进行初始化充电；

②在室温下储存 28 天；

③在室温下，以 $0.5P_d$ 恒功率放电至 2.5V，静置 30min，得到放电能量，其与初始放电能量（$0.5P_d$）的比值即为能量保持率；

④再以 0.5Pc 恒功率充电至 3.65V，以 $0.5P_d$ 恒功率放电至 2.5V，得到充电恢复能量和放电恢复能量，其与初始充电能量（$0.5P_c$）和初始放电能量（$0.5P_d$）的比值即为充电能量恢复率和放电能量恢复率。

①The cell is charged according to 7.2;

②The cell is stored for 28 days at RT;

③The cell is discharged to 2.5V at constant power of 0.5P_d at RT, then rest 30min; The ratio of the discharging energy to the initial discharging energy (0.5P_d) is the discharging energy retention rate@ RT;

④The cell is charged to 3.65V at constant power of 0.5P_c, then discharged to 2.5V at constant power of 0.5P_d; record the charging recovery energy and discharging recovery energy, the ratio of the charging recovery energy to the initial discharging energy (0.5P_d) is the charging energy recovery rate@ RT, and the ratio of the discharging recovery energy to the initial discharging energy (0.5P_d) is the discharging energy recovery rate@ RT.

7.9 高温能量保持、能量恢复 energy retention, energy recovery at high temperature

①按 7.2 进行初始化充电；

②在 45℃±2℃下储存 7 天；

③在室温下静置 5h，以 0.5P_d 恒功率放电至 2.5V，静置 30min，得到放电能量，其与初始放电能量（0.5P_d）的比值即为能量保持率；

④再以 0.5 P_c 恒功率充电至 3.65V，以 0.5P_d 恒功率放电至 2.5V，得到充电恢复能量和放电恢复能量，其与初始充电能量（0.5 P_c）和初始放电能量（0.5P_d）的比值即为充电能量恢复率和放电能量恢复率。

①The cell is charged according to 7.2;

②The cell is stored for 7 days at 45℃±2℃;

③The cell is stored for 5h at RT, then discharged to 2.5V at constant power of 230W (0.5P_d), then rest 30min; The ratio of the discharging energy to the initial discharge energy (0.5P_d) is the discharging energy retention rate@ high-temp.;

④The cell is charged to 3.65V at constant power of 0.5P_c,then discharged to 2.5V at constant power of 0.5P_d; record the charging recovery energy and discharging recovery energy, the ratio of the charging recovery energy to the initial charging energy (0.5P_d) is the charging energy recovery rate@ high-temp, and the ratio of the discharging recovery energy to the initial discharging energy (0.5P_d) is the discharging energy recovery rate@ high-temp.

7.10 存储能量恢复率 Stored energy recovery rate

①按 7.2 进行初始化充电；

②在室温下以 0.5P_d 恒功率放电至初始放电能量的 50%后，在 45℃±2℃下储存 28 天；

③在室温下静置 5h 后，以 0.5P_d 恒功率放电至 2.5V；

④在室温下以 0.5Pc 恒功率充电至 3.65V，静置 30min，得到充电恢复能量；

⑤在室温下以 0.5P_d 恒功率放电至 2.5V，得到放电恢复能量；

充电恢复能量、放电恢复能量与初始充电能量（0.5P_c）、初始放电能量（0.5P_d）的比值即为存储充电能量恢复率与放电能量恢复率。

①The cell is charged according to 7.2;

②The cell is discharged to 50% of initial discharging energy at constant power of 0.5P_d at RT, then stored for 28 days at 45℃±2℃;

③The cell is stored for 5h at RT, then discharged to 2.5V at constant power of 0.5P_d, rest 30min;

④The cell is charged to 3.65V at constant power of 0.5P_c at RT, then rest 30 minutes, record the charging recovery energy;

⑤The cell is discharged to 2.5V at constant power of 0.5P_d at RT, record the discharging recovery energy;

The ratio of the charging recovery energy to the initial charging energy (0.5P_c) is the charging energy recovery rate of storage, and the ratio of the discharging recovery energy to the initial discharging energy (0.5P_d) is the discharging energy recovery rate of storage.

7.11 标准循环寿命 Cycle life

电芯在室温环境下，50%SOC 状态下上夹具，夹具尺寸不小于电芯大面尺寸（推荐：长度 250mm，高度 185mm），夹具力 300±20kgf，按照如下步骤测试循环寿命。

① 按 7.3 进行初始化放电；

② 电芯以 0.5P_c 恒功率充电至 3.65V，搁置 30min；

③ 电芯以 0.5P_d 恒功率放电至 2.5V，搁置 30min；

④ 按照②～③连续循环，直至达到截止条件，记录循环次数。

Take the cell on a fixture of the size more than the cell (for example: 250mm length and 185mm height), keep the cell under pressure of 300±20kgf@50%SOC, then test the cycle life according to following steps at RT:

② The cell is discharged according to 7.3;

②The cell is charged to 3.65V at constant power of 0.5P_c, then rest 30min;

③ The cell is discharged to 2.5V at constant power of 0.5P_d, then rest 30min;

⑤Repeat②～③, until the end condition, record the cycle times.

7.12 过放电 Over discharge

①按 7.2 进行初始化充电；

②在室温下以 1C 电流放电 90min 或电压达到 0V 时停止放电，结束后观察 1h。

① The cell is charged according to 7.2;

② Discharge at 1C current for 90 minutes or the voltage reached 0V at RT, observe for 1 hour.

7.13 过充电 Over charge

①按 7.2 进行初始化充电；

②电芯带夹具，夹具尺寸不小于电芯大面尺寸（推荐：长度 250mm，高度 185mm），预紧力 300±20kgf；

③在室温下以 1C 电流充电至 1.5 倍终止电压或充电时间达到 1h，结束后观察 1h。

①The cell is charged according to 7.2;

②Take the cell on a fixture of the size more than the cell (for example: 250mm length and 185mm height), keep the cell under pressure of 300±20kgf ;

③Charge at 1C current to 1.5 times the cut-off voltage or the charging time reached 1h, observe for 1h.

7.14 短路 Short circuit

①按 7.2 进行初始化充电；

②将电芯正、负极经外部短路 10min，外部线路电阻＜5mΩ，结束后观察 1h。

①The cell is charged according to 7.2;

②Short circuit externally for 10 minutes with line resistance <5mΩ, observe for 1 hour.

7.15 跌落 Drop

①按 7.2 进行初始化充电；

②将电芯正负极端子朝下，从 1.5m 高度处自由跌落到水泥地面上 1 次，观察 1h。

①The cell is charged according to 7.2;

②Dropped from a height of 1.5m upside down to a concrete surface, observe for 1 hour.

7.16 加热 Heating

①按 7.2 进行初始化充电；

②将电芯在热滥用试验箱中加热，以 5℃/min 速度升温至 130±2℃，并保持此 30min 后停止加热，观察 1 小时。

①The cell is charged according to 7.2;

②The cell is placed into oven, and the temperature to of the oven is raised at a rate of 5°C/min to a temperature of 130±2°C and remain for 30 minutes at the temperature before the test is discontinued, observe for 1 hour.

7.17 挤压 Crush

挤压试验按照如下步骤进行:

①按 7.2 进行初始化充电；

②按下列条件进行试验：

——挤压方向：垂直于电芯极板方向施压（参考图 1 所示）；

——挤压板形式：半径 75 mm 的半圆柱体，半圆柱体的长度（L）大于被挤压电芯的尺寸；

——挤压速度：（5±1）mm/s；

——挤压程度：电压达到 0 V 或变形量达到 30%或挤压力达到（13±0.78）kN 后停止挤压，保持 10min。

③观察 1 h。

Test the crush according to following steps：

① The cell is charged according to 7.2;

② Test according to following conditions:

— Crushing direction: The force for the crushing shall be applied in direction nearly perpendicular to a layered face of positive and negative electrodes inside cell (refer to Figure 1);

— Crushing tool shape : A semicylinder with a 75mm diameter, and the length more than the cell

— Crushing speed: (5±1) mm/s;

— Crushing degree: voltage of the cell to 0V, or a deformation of 30 % or more of initial cell dimension occurs, or the pressure has reached（13±0.78）kN, remain for 10 minutes before the test is discontinued.

③ Observe for 1 hour.

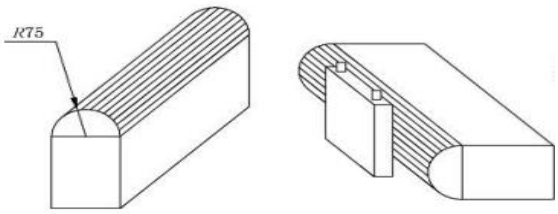


图 1 挤压板和挤压示意图

Figure 1 Schematic diagram of extrusion plate and extrusion

7.18 低气压 Altitude simulation

①按 7.2 进行初始化充电；

②将电芯放入气压为 11.6kPa 的试验箱中，温度为室温，静置 6h，观察 1h。

① The cell is charged according to 7.2;

② Placed in an altitude simulation test chamber, the pressure is reduced to 11.6 kPa and maintaining this pressure for 6h @RT, and observe for 1h.

7.19 热失控 Thermal runaway

①使用平面状加热装置，并且其表面应覆盖陶瓷，金属或绝缘层，加热装置加热功率 600~800W。完成单体电池与加热装置的装配，加热装置与电池应直接接触，加热装置的尺寸规格不应大于电池单体的被加热面；安装温度监测器，监测点温度传感器布置在远离热传导的一侧，即安装在加热装置的对侧（参见图 2），温度数据的采样间隔不应大于 1s，准确度应为 ±2℃，温度传感器尖端的直径小于 1mm；

②电池单体按 7.2 进行初始化充电后，再用 1C 恒流继续充电 12min；

③启动加热装置，并以其最大功率对测试对象持续加热，当发生热失控或监控点温度达到 300℃时，停止触发，关闭加热装置；

④记录试验结果。

是否发生热失控应按下列条件判定：

a）测试对象产生电压降；

b）监测点温度达到电池的保护温度；

c）监测点的温升速率≥1℃/s；

d）当 a）+c）或 b）+c）发生时，判定电池单体发生热失控；

e）加热过程中及加热结束 1h 内，如果发生起火、爆炸现象，试验应终止并判定为发生热

失控。

①Use flat heating device of the surface should be covered with ceramic, metal or insulating layer, and the heating power is 600~800W. The cell and the heating device fit together, and the heating device and the cell should be in direct contact, and the size of the heating device should not be larger than the heated surface of the cell; Then fit a temperature monitor onto the side away from heat side (the opposite side of the heating device)(see Figure 2), record the temperature data interval of the time less than 1s, The tolerance and the diameter of the temperature monitor should be less than ±2℃and 1mm;

②After the cell is charged according to 7.2, continue charged for 12 minutes at 1C constant current;

③Start the heating device and continue heating the cell with it's maximum power. When thermal runaway is occurred or the temperature of the monitoring point reached 300°C, turn off the heating device;

④ Record the test results.

Whether thermal runaway occurs shall be determined according to the following conditions:

a) The test object occur voltage drop;

b) The temperature at the monitoring point reaches the protection temperature of the cell;

c) Temperature rise rate at the monitoring point ≥1℃/s;

d) When a) +c) or b) +c) occurs, determine that the cell has thermal runaway;

e) During the heating process and within 1h after the heating, if the cell fire or explosion, the test shall be terminated and be judged the cell has thermal runaway.

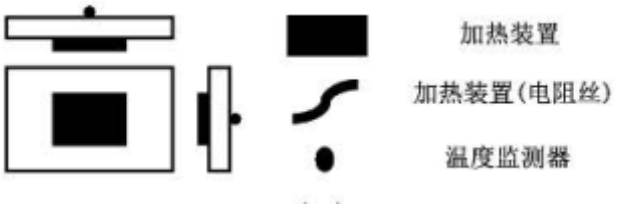


图 2 热失控试验加热示意图

Figure 2 Schematic diagram of thermal runaway test heating

结合上述标准内容及电芯实际应用场景，特进行测试方法补充说明，具体如下

Combining the above standard content and the actual application scenarios of the cell, a supplementary explanation of the test method is provided, as follows：

1）测试工装：为更贴近实际使用工况，要求带夹具、电芯保持直立状态测试，夹具尺寸不小于电芯大面尺寸；

2）加热板防护：为避免热失控测试过程中电芯蓝膜熔融导致加热板和电芯粘接在一起，测试完成后无法取下，电芯和加热板中间需添加一层环氧板进行隔绝。

1) Test tooling: In order to be closer to the actual working conditions, it is required to have a fixture and the cell core to be tested in an upright state. The size of the fixture is not less than the cell;

2) Heating device protection: In order to prevent the insulating film of the cell from being melted during the thermal runaway test, the heating device and the cell can't be separated after the test, a layer of epoxy board should be placed between the cell and the heating device.

8 检验规则 Test regulations

8.1 检验项目按表 8 的规定

The inspection items shall be as specified in Table 8

表 8 检验项目

Table 8. Inspection Items

检验类型 Inspection Type	检验项目 Inspection Items	检验数量 Inspection Times
初始参数 Initial parameter	4.4 标称电压 4.6 额定充电容量 4.7 额定放电容量 4.8 额定充电能量 4.9 额定放电能量 4.10 标准充电功率 4.11 最大持续充电功率 4.12 最大允许充电电压 4.13 最大允许充电温度范围 4.14 最佳充电温度范围 4.15 标准放电功率 4.16 最大持续放电功率 4.17 最大脉冲放电功率 4.18 最低允许放电电压 4.19 允许放电温度范围 4.20 最佳放电温度范围 4.21 最佳存储温度范围 4.22 最佳存储荷电状态 4.23 存储湿度 4.4 Nominal voltage 4.6 Rated charging capacity 4.7 Rated discharging capacity 4.8 Rated charging energy 4.9 Rated discharging energy 4.10 Standard charging power 4.11 Maximum continuous charging power 4.12 Cut-off charging voltage 4.13 Maximum charging temp. range 4.14 Optimal charging temperature range 4.15 Standard discharging power	/

	4.16 Maximum continuous discharging power 4.17 Maximum pulse discharging power 4.18 Cut-off discharge voltage 4.19 Allowable discharge temperature range 4.20 Optimal discharge temperature range 4.21 Optimal storage temperature range 4.22 Optimal storage state of charge 4.23 Storage humidity	
出厂检验 Pre - delivery inspection	4.1 外观 4.2 尺寸 4.5 交流内阻 4.1 appearance 4.2 dimension 4.5 internal resistance	100%
	4.3 重量 4.3 Weight	抽检 Spot Check
型式检验 Type Test	免检项目、出厂检验项目以外的其余指标 indicators other than inspection-free items and factory inspection items: 5.1.1 初始充电容量 5.1.2 初始放电容量 5.1.3 初始充电能量 5.1.4 初始放电能量 5.2.1 倍率充电能量保持率 5.2.2 倍率放电能量保持率 5.2.3 倍率充放电能量效率 5.3.1 高温充电能量保持率 5.3.2 高温放电能量保持率 5.3.3 高温充放电能量效率 5.3.4 低温充电能量保持率 5.3.5 低温放电能量保持率 5.3.6 低温充放电能量效率 5.4.1 室温能量保持率 5.4.2 室温充电能量恢复率 5.4.3 室温放电能量恢复率 5.4.4 高温能量保持率 5.4.5 高温充电能量恢复率 5.4.6 高温放电能量恢复率 5.4.7 储存充电能量恢复率 5.4.8 储存放电能量恢复率 5.5.1 标准循环寿命 6.1 过放电 6.2 过充电 6.3 短路 6.4 跌落 6.5 加热 6.6 挤压 6.7 低气压 6.8 热失控 5.1.1 Initial charging capacity 5.1.2 Initial discharging capacity 5.1.3 Initial charging energy 5.1.4 Initial discharging energy 5.2.1 Rate charge energy retention rate 5.2.2 Rate discharge energy retention rate 5.2.3 Rate charge and discharge energy efficiency 5.3.1 Charging energy retention rate@ high-temp. 5.3.2 Discharging energy retention rate@ high-temp. 5.3.3 Charging and discharging energy efficiency@ high-temp. 5.3.4 Charging energy retention rate@ low-temp. 5.3.5 Discharging energy retention rate@ low-temp 5.3.6 Charging and discharging energy efficiency@ low-temp 5.4.1 Discharging energy retention rate@ RT	参考 GBT 36276-2018

	5.4.2 Charging energy recovery rate@ RT 5.4.3 Discharging energy recovery rate@ RT 5.4.4 Discharging energy retention rate@ high-temp. 5.4.5 Charging energy recovery rate@ high-temp. 5.4.6 Discharging energy recovery rate@ high-temp. 5.4.7 Charging energy recovery rate of storage 5.4.8 Discharging energy recovery rate of storage 5.5.1 Cycle life 6.1 Over discharge 6.2 Over charge 6.3 Short circuit 6.4 Drop 6.5 Heating 6.6 Crush 6.7 Altitude simulation 6.8 Thermal runaway	

8.2 出厂检验

8.2.1 采用 GB/T 2829.1-2012 的正常检验一次抽样方案，检验项目、要求的章条号、试验的章条号见表 10，检验水平（IL）为Ⅱ，接收质量限（AQL）为 2.5。

Adopt the GB/T 2829.1-2012 normal inspection one-time sampling plan. The inspection items, required chapter numbers and test chapter numbers are shown in Table 10. The inspection level (IL) is Ⅱ and the acceptance quality limit (AQL) is 2.5.

8.2.2 在出厂检验中，若有一项或一项以上不合格时，应将该产品退回生产部门返工普检，然后再次提交验收。若再次检验仍有一项或一项以上不合格，则判定该产品为不合格。

In the pre-delivery inspection, if there is one or more unqualified items, the product should be returned to the production department for reproduction and general inspection, and then submitted for acceptance again. If there's still one or more failures in the re-inspection, the product should be judged as unqualified.

8.3 型式检验 Type Test

8.3.1 产品在下列情况之一时进行型式检验：

8.3.1 The product undergoes type testing in one of the following situations

a）新产品投产和老产品转产；/ New product production and old product conversion

b）转厂；/ Factory transfer

c）停产超过一年后复产；/ Reproduction after suspension for more than one year

d）结构、工艺或材料有重大改变；/ Significant changes in structure, process or materials

e) 连续生产，每隔 12 个月型式检验一次。/ Type test one time per 12 months

8.3.2 判定规则 Decision rule

在型式检验中，若有一项不合格时，应判定为不合格。

Any item failed the type testing, the cell should be regarded as unqualified.

9 标志、包装、运输、贮存 Label, Packing, Transportation, storage

9.1 标志 Labeling

每个产品上应有清晰的二维码。

Each product should have a clear QR code on it.

9.2 包装 Packing

产品有外包装，保证产品在运输、装卸、堆放过程中不受机械损伤。

The product has outer packaging to ensure that the product is not mechanically damaged during transportation, loading, unloading and stacking.

9.3 运输 Transportation

在运输过程中应严禁暴力装卸，防止剧烈振动、冲击或挤压，防止日晒雨淋。

During transportation, violent loading and unloading should be strictly prohibited, to prevent server vibration, impact or squeeze, and to prevent from the sun and rain.

9.4 贮存 Storage

产品应贮存在环境温度为-30℃～60℃，相对湿度≤75％的清洁、干燥、通风的库房内，库房内不应含有腐蚀性气体；产品应远离火源和热源（不得少于 2m）。

The product should be stored in a clean, dry and ventilated warehouse with an ambient temperature of -30℃～60℃ and a relative humidity of ≤75％. The warehouse should not contain corrosive gases; the product should be away from fire and heat sources (not less than 2m.)

建议电芯在 30%～50% SOC 下存储。电芯长期不使用时，每三个月进行一次充放电，并补电至 30%～50% SOC，以免电芯过放，影响性能。

It is recommended that the cell be stored at 30% to 50% SOC. When the cell is not used for a long time, charge and discharge it every three months, and charge to 30%~50% SOC to avoid over discharge and affect its performance.

10 安全及警告 safety & warning

10.1 在使用之前，应详细阅读规格书。

Before using, you should read the specifications in detail.

10.2 禁止将电芯浸入水中或者其它导电性液体中。

Do not immerse the cell into water or other conductive liquids.

10.3 禁止将电芯投入火中或者长期暴露电芯工作范围外的温度中，电芯温度不能超过 60℃，如果电芯中电芯温度超过 60℃，停止电芯运行。

It is forbidden to put the cell into fire or expose it to the environment beyond its working temperature range for a long time. If the working temperature of the cell exceeds 60℃, stop its operation!

10.4 严格按照标示和说明连接电芯正负极，禁止反向充电。

Connect the positive and negative poles of the cell strictly in accordance with the signs and instructions. No reverse charging!

10.5 当电解液泄漏时，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。禁止任何人或动物吞食电芯的任何部件或电芯所含物质。

When the electrolyte leaks, avoid contacting the electrolyte to skin and eyes. In case of contacting, wash with plenty of water and seek medical advice. It is forbidden for any person or animal to swallow any part of the cell or the substance contained in the cell.

10.6 尽力保护电芯，使其免受机械振动、碰撞及压力冲击，否则电芯内部可能短路，产生高温或火灾。

Protect the cell from mechanical vibration, collision and pressure impact, otherwise the cell might be short-circuited, causing high temperature or fire.

10.7 严禁使电芯承受过重的机械冲击。

Strictly forbidden to subject the cell to excessive mechanical shock.

10.8 严禁使用过程中发生挤压、跌落、短路、漏液及其他不正常问题的电芯。

Squeeze, drop, short circuit, leakage and other abnormal problems is strictly forbidden during cell operation.

10.9 在使用过程中严禁各电芯之间外壳直接接触或通过导体连接在一起形成通路。

During use, it is strictly forbidden to contact the cover of cells directly or connect them together via conductors to form a circuit.

10.10 电芯应该在远离静电的场所进行存储、使用。

Cells should be stored and used in a place away from static electricity

10.11 在使用、充放电或者存储过程中发现电芯急剧变热、散发气味、变色、变形或者其他反应，应立即停止使用，并进行相应的处理。

During operation, charge, discharge or storage, if the cell suddenly heats-up, emits odor, discolors, deforms or has other reactions, it should be stopped immediately and treated accordingly.

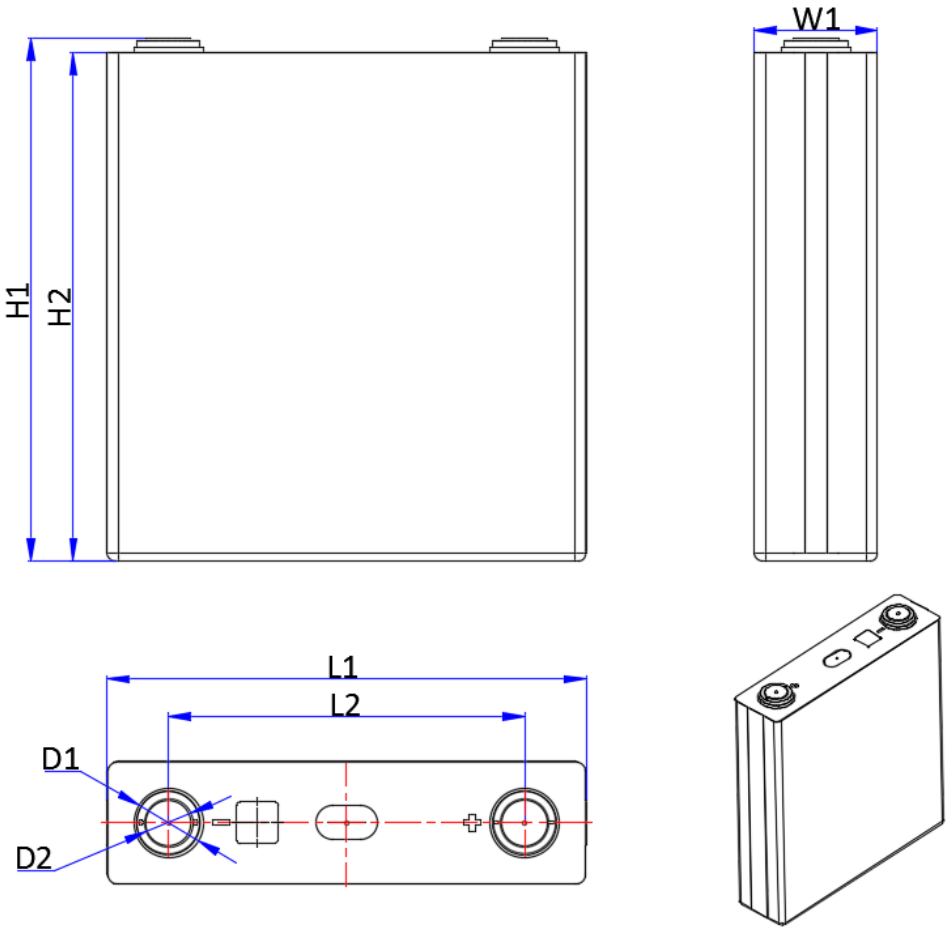
11 产品寿命终止管理 End of life management

为了确保电芯的安全应用，客户需要建立有效的跟踪系统监测并记录每个电芯的电压、内阻，电芯容量衰减的测量方法和计算方法需要客户和本企业共同讨论和双方同意，当使用电芯的容量衰减到初始容量的 80%时应停止使用电芯，违反该项要求，将免除本企业依据产品销售协议以及本规格书所应承担的产品质量保证责任。

In order to ensure the security during using cells, the clients should establish an effective tracking system to monitor and record the voltage and internal resistance of each cell. The measurement and calculation methods should be discussed and commonly agreed by the clients and Our enterprise When the capacity of the cell decays to 80% of the initial capacity, the use of the cell should be stopped. Otherwise, Our enterprise will not bear the product quality assurance responsibility based on the product sales agreement and this specification.

附录 Appendix

(一) 电芯尺寸图 / cell dimension



序号 No.	代码 Item	尺寸（mm）Dimensions
1	L1	174.4±0.5
2	L2	123.0±0.5
3	H1	207.2±0.5
4	H2	204.3±0.5
5	W1	71.5±0.5
6	D1	26.0±0.2
7	D2	16.0±0.2