TERRA E®

# Cell Specification

## IFR 21700 30E1

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# IFR 21700 30E1

# Cylindrical Lithium Ion Cell

## 1. Scope

The product specification describes the requirements of the Cylindrical Lithium-ion Cell to be supplied to the customer by TerraE. Should there be any additional information required by the customer, customer are advised to contact TerraE.

## 2. Description and Model

| | | |
|---|---|---|
| **2.1** | **Description** | Cylindrical Lithium Ion Cell |
| **2.2** | **Model** | IFR_21700_30E1 |

## 3. General Specifications

| | | |
|---|---|---|
| **3.1** | **Nominal Capacity** | 3000mAh (at 0.2C Discharge) |
| | **Minimum Capacity** | 2950mAh (at 0.2C Discharge) |

Nominal capacity is measured by the discharge at 0.2C to 2.0V end voltage after standard fully charged according to specification at 25°C.

| | | |
|---|---|---|
| **3.2** | **Maximum Charge Voltage** | 3.65V |
| **3.3** | **Average Working Voltage** | 3.20V |
| **3.4** | **Standard Charge Mathod (25°C ± 2°C)** | CC-CV to 3.65V 0.02C (60mA) |
| **3.5** | **Maximum Charge Current** | 1C (at 25°C, not ideal for cycle life) |

**Recommended charge rates**

| | |
|---|---|
| 0°C ≤ T ≤ 5°C | 0.1C (300mA) |
| 5°C < T ≤ 10°C | 0.5C (1500mA) |
| 10°C < T ≤ 15°C | 0.5C (1500mA) |
| 15°C < T ≤ 35°C | 1C (3000mA) |
| 35°C < T ≤ 55°C | 0.5C (1500mA) |

| | | |
|---|---|---|
| **3.6** | **Standard Discharge** | 1C (3000mA)<br>2.0V End Voltage |
| **3.7** | **Maximum Discharge Current** | 3C (at 25°C, not ideal for cycle life) |

**Recommended discharge rates**

| | |
|---|---|
| -20°C ≤ T < 0°C | 1C (3000mA) |
| 0°C ≤ T < 10°C | 2C (1500mA) |
| 10°C ≤ T < 35°C | 3C (9000mA) |
| 35°C ≤ T < 45°C | 2C (6000mA) |
| 45°C ≤ T < 60°C | 1C (3000mA) |

# IFR 21700 30E1
# Cylindrical Lithium Ion Cell

| | | | |
|---|---|---|---|
| **3.8** | **Cycle Life** | 80% SOH after 1000 cycles at 25°C with 0.5C/1C | |
| **3.9** | **Weight of Bare Cell** | ≤65g | |
| **3.10** | **Operating Environmental Temperature** | Charge | 0°C ~ 45°C |
| | | Discharge | -20°C ~ 60°C |
| **3.11** | **Storage Temperature (For Shipping State)** | 1 month | -20°C ~ 40°C |
| | | 3 months | -20°C ~ 20°C |
| | | 12 months | - 20°C ~ 20°C |

## 4. Outline Dimension (Unit: mm)

Dimension: Diameter max 21.85mm, Height max 71.15 mm. Refer to the attached drawing 1.

## 5. Appearance

There shall be no such defect as deep scratch, flaw, crack, rust, leakage, which may adversely affect commercial value of the cell.

## 6. Test condition and definitions

**6.1 Measuring Equipment**

| | | |
|---|---|---|
| **6.1.1** | **Electronical Balance** | Accuracy of the grade 1mg or higher. |
| **6.1.2** | **Manual Voltage-Impedance Tester** | Accuracy of the grade 0.1mΩ or higher. The impedance meter should be operated at AC 1kHz. |
| **6.1.3** | **Digital Caliper** | The digital caliper should have 0.01mm scale or higher. |

**6.2** Unless otherwise specified, all tests shall be performed at 25°C ± 2°C and humidity of ≤85%RH. The cells used for the test mentioned should be new ones delivered a week before at most.

**6.3 Definition**

**C Rate ("C"):**
The rate (milliamperes) at which a fully charged cell is discharged to its end voltage in one (1) hour.

## 7. Characteristics

**7.1 Charge Method**

**7.1.1** Charging shall consist of charging at a 0.5C constant current rate until the cell voltage reaches 3.65V. The cell shall then be charged at constant voltage of 3.65V while tapering the charge current. Charging shall be terminated when the charging current has tapered to 60mA.

**7.2 Discharge Method**

**7.2.1** Cells shall be discharged at a constant current of 1C to 2.0 volts.

**7.3 Internal Impedance** The impedance shall be measured by 6.1.2

# IFR 21700 30E1

# Cylindrical Lithium Ion Cell

Initial Internal Impedance ≤40mΩ

**7.4 Discharge rate characteristics**

After standard charge, left the cell for 15 minutes. Than discharge the cell to 2.0V at 0.2C/1C/2C/3C rate, record the discharge capacity. Note: Discharge efficiency = discharge capacity at different rate / discharge capacity@0.2C ×100%

| Table 1 | |
|---|---|
| **0.2C** | **100%** |
| **1.0C** | **≥95%** |
| **2.0C** | **≥90%** |
| **3.0C** | **≥90%** |

**7.5 Cycle Life**

Charge cells per 7.1.1. Rest 15 minutes. Discharge per 7.2.1. Rest for 15 minutes before recharge. The rest environmental temperature is 25°C±2°C. A cycle is defined as one charge and one discharge. Discharge capacity shall be measured after 1000 cycles.
Discharge capacity (1000$^{th}$ Cycle) ≥80% of 1$^{st}$ Cycle Capacity.

**7.6 Storage Characteristics**

**7.6.1** After charge as per standard charge method 7.1.1, store the testing cells at 25°C±2°C for 28 days. Then discharge as per 7.2.1. Then the same cell is fully charged as per 7.1.1 again and discharged a second time and measured as per 7.2.1. Standard charge / standard discharge cycle shall be repeated for 3 times to measure the recovery capacity. The recovery discharge capacity (3$^{nd}$ discharge capacity) ≥90% of Initial capacity.

**7.6.2** After charge as per standard charge method 7.1.1, store the testing cells at 55°C±2°C for 7 days. Then discharge as per 7.2.1. Then the same cell is fully charged as per 7.1.1 again and discharged a second time and measured as per 7.2.1. Standard charge / standard discharge cycle shall be repeated for 3 times to measure the recovery capacity. The recovery discharge capacity (3$^{nd}$ discharge capacity) ≥90% of Initial capacity.

**7.7 Temperature Characteristics**

Cells shall be charged with 0.5C and discharged with 0.5C. Each cell shall meet or exceed the requirements of Table 2

| Table 2 | |
|---|---|
| **-20 ° C** | **≥50%** |
| **25 ° C** | **100%** |
| **55 ° C** | **≥90%** |

# IFR 21700 30E1
# Cylindrical Lithium Ion Cell

## 8. Safety

**8.1 External Short-Circuiting Test at 25°C±2°C**

Cell, charged per standard charge method, is to be short circuited by connecting the positive (+) and negative (-) terminals with a total external resistance of <5mΩ for 10 minutes.
**Criteria:** No Fire, No Explosion

**8.2 Overcharge Test**

Cell, charged per standard charge method, is to be overcharged with 1C to 5.475V while tapering the charge current. Monitoring change of cell temperature during testing. Stop the test when cell temperature decays to room temperature.
**Criteria:** No Fire, No Explosion

**8.3 Overdischarge Test**

Cell, charged per standard charge method, is discharged at constant current of 1C for 90min.
**Criteria:** No Fire, No Explosion

**8.4 Heating Test**

Cell, charged per standard charge method, is to be placed in the hot oven. Store the testing cells connecting with thermocouple in constant temperature box, heating the cells and box (speed of ascending temperature is 5°C per min) together at room temperature simultaneity, monitor the temperature change of the box, keep for 30 minutes after the box temperature reaches 130°C, then stop the test.
**Criteria:** No Fire, No Explosion

**8.5 Drop Test**

After standard charge, drop the cell with both ends from a height of 1.0m onto the cement floor. The cell shall be observed for 1h afterwards.
**Criteria:** No Fire, No Explosion

## 9. Packaging

Loading 100 cells per box, 2 boxes per case for a total of 200 cells. Refer to attachment 2.

## 10. Others

Any matter not included in this specification shall be conferred between the both parties.

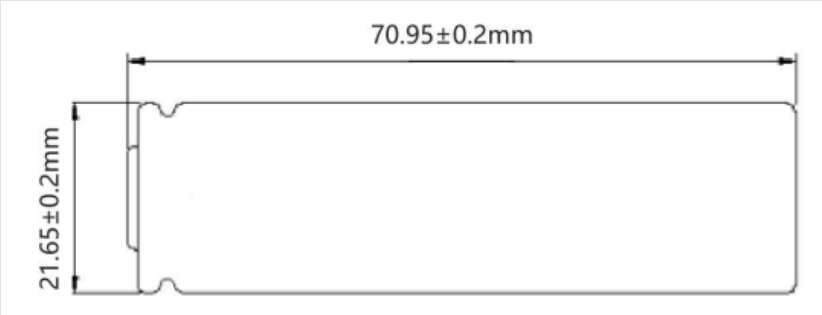
## 11. Others

The cell voltage in delivery is approx 3.22V, or in accordance with customers' requirement. The remaining capacity before charging shall be changed depending on the storage time and conditions.

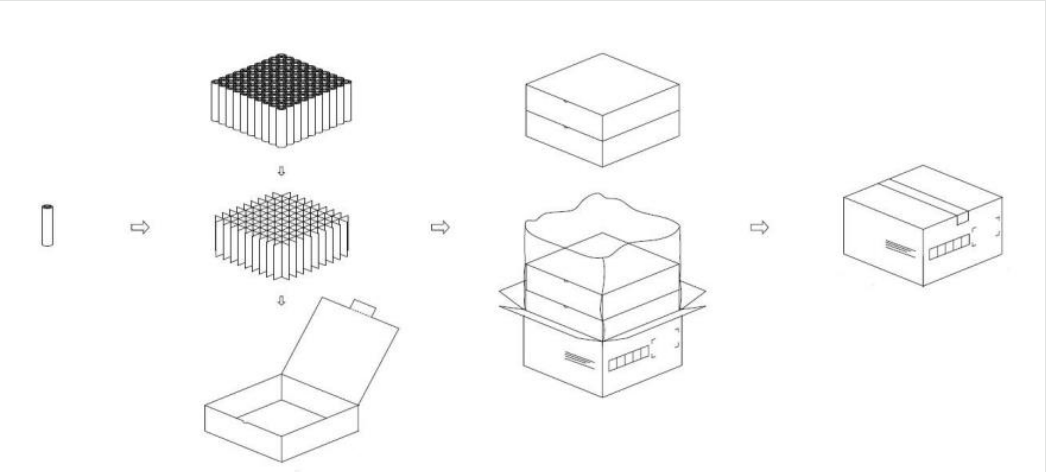
# IFR 21700 30E1

## Cylindrical Lithium Ion Cell

**Attached 1:** Cell Size Drawing




**Attached 2:** Packaging per box



# IFR 21700 30E1

# Handling Instructions

The following caution and warning should appear in manuals and/or instructions for users, especially at the point of use.

# Handling Instructions for Lithium Ion Rechargeable Cell

## 1. Electric Car, Charger and Battery Pack Design Considerations

### 1.1 Charging

**1.1.1** Cell suggested to be charged with constant current-constant voltage method. Charging voltage must below 3.65V/cell and the charging cut-off current is greater than or equal to 1/50C. Even if the charge could be out of order, charge voltage of charger should not be above 3.65V/cell to avoid over-charging. Cell life will be shorten by charging voltage above 3.65V.

**1.1.2** Charger should be equipped with a pre-charging system, and the function should be used to prevent the abnormal high rate charging after the deep discharging. In case of cell voltage is below 2.0V(and higher than 1.9V), cell should be pre-charged with current below 0.2A (0.1C) and until cell voltage reach 2.0V, use standard charging method. And if cell voltage cannot reach 2.0V in 30 minutes, stop charging. Do not charge if voltage is below 1.9V.

**1.1.3** Charger should be equipped with a complete charging detection device including the timer, current detector, and open circuit voltage detector to monitor until full state of charge. Whichever one of the time, current and voltage detected as full charge, charge should be cut off to avoid trickle charge.

**1.1.4** Charger should start charging at temperature range 0℃~ +55℃.When the cell temperature exceeds this range, it should be placed in the battery temperature cool down into above range and start charging again.

**1.1.5** For cycle life, use the normal charging or trickle charging method and minimize the fast charge.

### 1.2 Discharging

**1.2.1** Discharge end voltage must be over 2.0V

**1.2.2** Discharge temperature range should be -20℃ ~ +60℃. If surface temperature exceeds 75 ℃, the discharge must be stopped, the cell be placed until temperature cool down into above range and start discharging again.

# IFR 21700 30E1

# Handling Instructions

**1.3 Overdischarge**

If the voltage of a single battery is less than 2.0V, the battery is considered to be overdischarge and cannot continue to be used.

**1.4 Storage**

Cell should be stored in low humidity (less than 65%RH), no corrosive gas atmosphere. And cell should not under pression or condensation liquid on the cell surface. The optimum storage temperature range is 0℃~25℃.For long time storage, charging state of cell should be less than 50% SOC, and must check the voltage of the cell before usage. It is also recommended to charge and discharge the cell every six months.

| | |
|---|---|
| **When stored within 1 month:** | -20°C ~ 60°C |
| **When stored within 3 months:** | -20°C ~ 45°C |
| **When stored within 12 months:** | -20°C ~ 25°C |

**1.5 Precautions on Battery Pack Design**

**1.5.1 Battery pack Shape, Mechanism and Material**

The battery pack should be designed to ensure that it should only be used with its specified charger. The battery pack should be designed to ensure that it should only be connected to its specified equipment. The positive and negative terminals of the battery pack should be designed to avoid short circuits or reverse connection. The positive and negative connection wires of the battery should no overlap. The battery pack should be designed with anti-static function and can prevent intrusion from intruding dust, liquid, etc. The battery pack should have a device with over-current protection function to avoid external short-circuiting. The battery should be designed so that even if the battery leakage occurs, the electrolyte cannot reach the protection circuit board. The battery pack should be designed to ensure that the cell is fixed in the battery pack and cannot move freely. The structure of the battery pack should be designed to ensure that the dent, deformation and other mechanical stresses of the battery should not be caused after the foreseeable fall. The materials of battery pack such as double-sided tape and rubber should be nonflammable. Welding mold should be sealed with glue; if the welding die in the sealed when the welding of the mold cannot be used, The use of ultrasonic welding method, for the emergence of any defects, God does not bear anything Either. The welding mold should be sealed with glue; TerraE is not liable for any defect caused by ultrasonic welding when sealing the welding mold.

# IFR 21700 30E1
# Handling Instructions

**1.5.2 Battery pack structure (battery pack limits the number of batteries used)**

The battery pack should pass the overcharge test (charging current of the overcharge test is the maximum charging current of the charger multiple the paralleled number). The pack fuse is required. The battery should be away from the heat Device to avoid deterioration of battery performance. PCBA circuit board and battery pack should be insulated (by such as plastic barrier air isolation or non-heat conducting insulation material). Cell module should be used with cooling system. (Note: If charged and discharged at high rate and high temperature (≥35℃) frequently, cell cycle life can be shorten. If discharged at high temperature (≥75℃) frequently, cell safety risk can be occurred.). Cell voltage monitoring system. The system (charger or pack) should be equipped with a device to monitor each voltage of cell block to avoid cell imbalance which can cause damage to the cells. The recommended spacing between the cells is more than 1mm.

**1.5.3 Protection Circuit insure safety of battery**

The following protection circuit should be installed in the battery pack:

**Over charge protection**

For safety and in order not to shorten the cycle life, the maximum overcharge protection voltage for the individual cells within each module should be less than 3.65V (including tolerances).

**Over discharge protection**

If the single cell voltage reaches 2.0V, recommend that discharge protection should cut off the discharge current, the consuming circuit current should be as low as possible.

**Over current protection**

If the single cell discharge current exceeds about 9.0A, the overcurrent protection should cut off the discharge current circuit.

**External short protection**

The battery pack should have function prevent from external short cut.

**Over temperature protection**

Set pack over temperature protection according to the cell using condition in the specification.

Battery pack should have cell voltage balancing function and cell imbalance protection function. Battery pack should have function to avoid thermal propagation when the cell goes failure. The battery pack should have thermal balance and when pack discharge, temperature of cell in the pack should be less or equal to 5°C. In order to avoid over discharge mode under long-term storage, the consuming current of battery pack protection circuit should be set as low as possible. Should regularly check the remaining state of capacity when cell is not used for long time, to ensure that the single cell in battery not in the over-discharge state.

**1.5.4 Cell connection**

Do not use soldering or ultrasonic welding to in connection process. In order to avoid a damage on the cell, use spot welding to connect. The battery pack should be designed with anti-vibration function to prevent from deformation damage of cell

## 1.6 Cell Usage

**1.6.1** When cells are used in series and parallel connection, they need to use the same grade, the same batch code and the same state of charge. This information can be obtained from the inside and outside box labels. Before using the cell, the voltage and internal resistance need to be detected and the cells should be assembled according to its purpose. TerraE recommends that the cell voltage difference is within 20mV and the internal resistance difference is within 6mΩ at least.

**1.6.2** The pack manufacturers should check the voltage, internal resistance, protection circuit function, thermistor of the battery pack before shipment

**1.6.3** During the transfer of the cells to the assembly factory, special attention should be paid to prohibiting causing damage from external forces during transportation. TerraE recommends that the same transportation packaging is used during the transfer process, even if there is a process of opening the package.

**1.6.4** Do not use damaged or leaked batteries due to transport damage, drop, short circuit or other reasons.

## 1.7 Quality assurance immunity

**1.7.1** Within one year of normal use, any quality problem caused by any manufacturing process, other than abuse, shall be solved by the manufacturer. Outside this period, the reason is not the manufacturing process but the cell quality problem caused by customer misuse. TerraE does not promise free replacement.

**1.7.2** When conducting resistance welding and laser welding of cells, it is necessary to conduct DOE process experiment and confirm welding parameters. TerraE is not responsible for the safety problems related to internal damage of the cell caused by improper welding.

**1.7.3** TerraE shall not be liable for any loss caused by violation of the specifications;

**1.7.4** TerraE will not be responsible for any problems caused by design defects of battery packs and chargers;

**1.7.5** TerraE does not accept abnormal cells due to improper assembly.

**1.7.6** TerraE is not responsible for spot welders

# IFR 21700 30E1
# Handling Instructions

## 2. Safety Instructions

Batteries containing organic solvents and other flammable substances, improper use may cause cell produce heat or get fire, which can cause damage to cell or personal injury. Please pay attention to compliance with the use of prohibited items, while add protection device to avoid any cell accident caused by abnormal equipment using. Before using lithium-ion chargeable cells, please read the following safety guidelines carefully. In addition, TerraE strongly recommend adding these instructions to the user manual.

### 2.1 Dangerous matter

**2.1.1** Do not use or place cells in high temperature (above 60℃) environment. Do not put it into fire, water or moisturize it. Do not repair or disassemble cells, which has risk of causing the cells overheated, leak, fire or explode.

**2.1.2** Do not place the cells out of order, away from metal and other conductive materials to avoid positive (+) negative (-) short circuit, do not reverse the positive (+) negative (-) pole.

**2.1.3** Do not use non-specified charger and violate charging instructions. Charging under non-specified conditions will cause the cell to overcharge or abnormal chemical reactions, causing heat generation, smoke, fire or explode.

**2.1.4** Do not directly connect the battery to the AC plug (outlet) or the car plug. The battery needs to have a specific charger. If the battery is connected directly to the plug, the battery may generate heat, smoke, fire or explode.

**2.1.5** Do not overcharge, over-discharge, drive nail into the cell, strike it by hammer or tread and step on it.

**2.1.6** Do not hit or throw cells. If the cells fall, please dispose it as a waste product and cannot continue to use.

**2.1.7** Do not disassemble cell. If the protection circuit is damaged, battery will no longer be protected. Then the battery may generate heat, smoke, fire or explode.

**2.1.8** Do not charge under high temperatures. If the battery is charged near a high temperature, the battery cannot be recharged due to the protection circuit. In this case, the protection circuit might be interrupted and the battery may generate heat, smoke, fire or explode.

**2.1.9** Do not use obviously damaged or deformed batteries, which may generate heat, smoke, rupture or fire.

**2.1.10** Do not solder on the cell directly. Overheating may cause deformation of cell and cell components such as insulation gaskets cell deformation, and cause leakage, fire or explode.

**2.1.11** Do not reverse charging. If the battery is reverse charging, will occur abnormal chemical reaction and may cause an unpredictable high current during discharging. These may cause heat generation, smoke, rupture or fire.

### 2.2 Warning

**2.2.1** Batteries should be kept away from infants and young children. In case of swallowing the battery, please seek medical immediately.

**2.2.2** Do not place the battery in a microwave oven or other cooking utensils. Due to the heating and electrical shock of the microwave oven, the battery may generate heat, smoke, fire or explode.

# Handling Instructions

**2.2.3** Do not mix with other batteries. The battery cannot be mixed with other different capacities, chemical systems, or manufacturers' batteries. Do not connect other batteries or mix other batteries. The battery may catch fire, smoke, explode or cause heat.

**2.2.4** Do not use an abnormal battery. If there is obvious abnormity, such as odor, heating, deformation, or discoloration, stop using the battery. Using such battery might generate heating, smoke, fire or explode due to the defect.

**2.2.5** If the charging cannot complete within its specified period of time, stop charging process. Otherwise, battery may generate heat, smoke, fire or explode.

**2.2.6** If battery or leaking battery has a pungent odor, the battery should remain away from the flame. Otherwise, battery may generate heat, smoke, fire or explode.

**2.2.7** Do not touch the leaking battery. If the liquid leaking from the battery into eyes, will cause serious injury. If the liquid gets into your eyes, rinse your eyes with water immediately and consult a doctor immediately.

**2.2.8** To avoid short circuit or damage, please put the battery into a box or carton tightly.

**2.2.9** Do not store the cell together with metallic objects such as keys, necklaces, hairpins, coins, or screws.

**2.2.10** Soaking the cell in water is strictly prohibited, because it may cause corrosion and leakage of components to be damaged to functions.

## 2.3 Precautions

**2.3.1** Do not use or place batteries in high temperature environments. It may cause battery performance and life degradation. It may also generate heat, smoke, fire or explode.

**2.3.2** Battery pack has a protective circuit. Do not use batteries in places where static electricity (over 100V) is generated, which may damage the protection circuit. If the protective circuit is damaged, battery may generate heat, smoke, fire or explode.

**2.3.3** Specified the charging temperature range 0℃~55℃. Do not charge the battery outside the specified temperature range. Otherwise, it may cause battery performance and life degradation. It may also generate heat, smoke, fire or explode.

**2.3.4** Please read the manual before use. Please keep this manual for future reference.

**2.3.5** Please read the charging method of the charger manual.

**2.3.6** In the first use, if the battery has an abnormal smell, heat or rust, please contact the supplier

**2.3.7** Keep away from flammable materials during charging and discharging. May cause fire, smoke, explode or cause heat.

**2.3.8** If the electrolyte leaks from the battery, gets on the clothes or on the skin, rinse it immediately with water. Other- wise it may irritate the skin.

**2.3.9** If wires or metal objects come out of the battery, completely seal and insulate them. Otherwise, the battery may cause a short circuit, fire, smoke, explosion, or cause heat.

**2.3.10** After use, please carry out battery recycling according to local laws and regulations.

# IFR 21700 30E1

# Handling Instructions

**3. Exclusion Liability**

**3.1** TerraE is not liable for any loss caused by breach of notice in the specification

**3.2** TerraE is not responsible for any problems caused by design defects in battery packs, electric cars and chargers

**3.3** TerraE does not accept abnormal batteries caused by improper assembly

**3.4** TerraE is not liable for any loss caused by incorrect or incongruent with the SPEC charge and discharge method and inappropriate environment

**3.5** TerraE is not liable for any force majeure (ex. Lightening, storm, flood, fire, earthquake, etc)

**3.6** In order to standardize the use of sample batteries, the rights, obligations and responsibilities of every customer and TerraE are clarified. Before using the battery, please read carefully and thoroughly understand the contents of the specification. In order to ensure the safety of the battery, please contact TerraE to discuss design of the application. Also, if there are special usage conditions (for example: a large current load, a quick charge method, or a special usage pattern), please consult TerraE before finalizing the product specification.

If you choose to use this battery, your use will be regarded as an endorsement of all the contents of this statement. The amendment, renewal and final interpretation of this statement are belong to TerraE.

# Any questions?

Contact us, we will be pleased to advise you.

## A full load of advantages

Customized cells tailored to your individual requirements with the best choice in Li-Ion technology for the coming development.

- One-Stop Shop
- Customized
- High Quality
- More Power
- High Energy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