PRODUCT SPECIFICATION

Rechargeable Lithium Ion Battery
Model : INR21700 M50T 18.2Wh

Revision History

Revision	Date	Originator	Description
0	2018-07-16	Jong Han Ha	Draft

Contents

1. General Information

1.1 Scope

This product specification defines the requirements of the rechargeable lithium ion battery to be supplied to the Customer by LG Chem.

1.2 Product classification: Cylindrical rechargeable lithium ion battery

1.3 Model name: INR21700 M50T

2. Nominal Specification

Item	Condition / Note	Specification
2.1 Energy	By Std. Charge / Discharge	Nominal 18.2Wh Minimum 17.6Wh
2.2 Nominal Voltage	Average by Std. Charge / Discharge	3.63V
2.3 Nominal Shipping SOC	-	Below 30%
2.4 Standard Charge	Constant current Constant voltage End current(Cut off)	0.3C (1,455mA) 4.2V 50mA
2.5 Max. Charge Voltage	In all measurements and operations of the cell, the minimum closed circuit voltage allowable shall not be over the following value	4.20V
2.6 Over Voltage Protection	Cell voltage should not go over the following value to prevent any safety events. And cell performance can't be guaranteed between 4.20V and 4.25V	4.25V
2.7 Min. Discharge Voltage	In all measurements and operations of the cell, the minimum closed circuit voltage allowable shall not be below the following value	2.50V

2.8 Under Voltage Protection	Cell voltage should not go down the following value to prevent any safety events. And cell performance can't be guaranteed between 2.50V and 2.00V	2.00V
2.9 Standard Discharge (Refer to 4.1.2)	Constant current End voltage(Cut off)	0.2C (970mA) 2.50V
2.10 Storage Temperature (for shipping state)	1 month 3 months 1 year Recovery energy** after the storage ≥ 80% of minimum energy	-20 ~ 55℃ -20 ~ 45℃ -20 ~ 25℃
2.11 Weight	Without washer	Max. 70.0 g (Tentative)

* The temperature range herein doesn't have an affect on the safety, and it is only possible to operate cell and has nothing to do with guarantee of cycle performance

** Recovery Energy: After storage, cells shall be discharged with std. discharge condition (4.1.2), and then cells shall be charged with std. charge condition (4.1.1), and then discharged with Std. condition (4.1.2).

3. Appearance and Dimension

3.1 Appearance

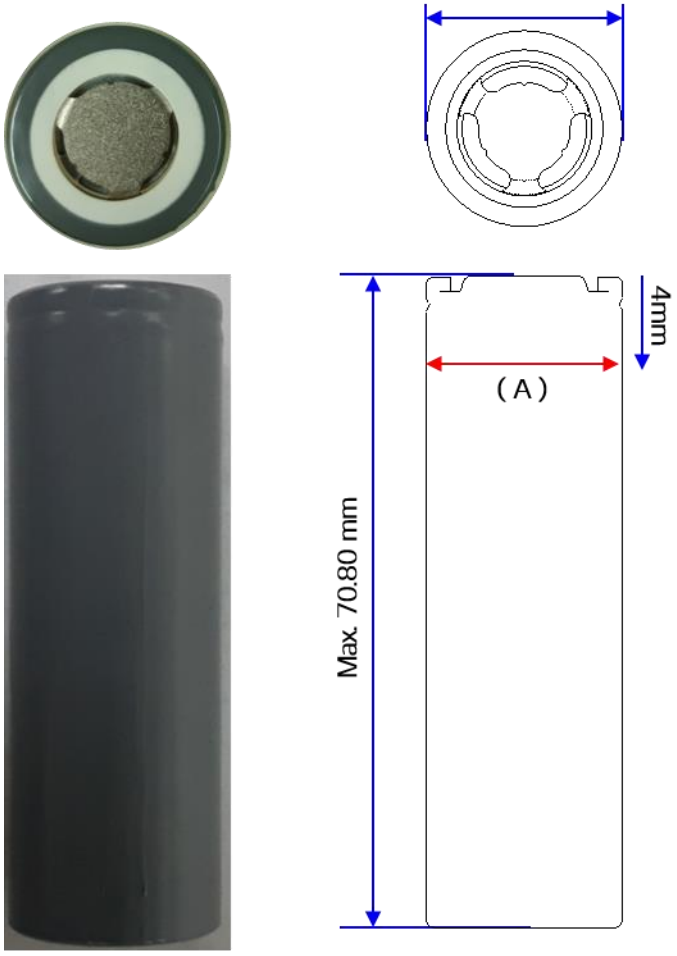
There shall be no such defects as deep scratch, crack, rust, discoloration or leakage, which may adversely affect the commercial value of the cell.

3.2 Dimension

Diameter : ≤ 21.44 mm (Tentative)

Diameter is defined as the largest data value measured on the "A" area (4 mm from the top / Please refer to the following image) of a cylindrical cell, measured by Vernier Calipers - Mitsutoyo (500-182-20).

Height : ≤ 70.80 mm (Tentative)



4. Performance Specification

4.1 Standard Test Condition

4.1.1 Standard Charge

Unless otherwise specified, “Standard Charge” shall consist of charging at constant current of 0.3C. The cell shall then be charged at constant voltage of 4.20V while tapering the charge current. Charging shall be terminated when the charging current has tapered to 50mA. For test purposes, charging shall be performed at 25ºC ± 2ºC.

4.1.2 Standard Discharge

“Standard Discharge” shall consist of discharging at a constant current of 0.2C to 2.50V. Discharging is to be performed at 25 ºC ± 2 ºC unless otherwise noted (such as capacity versus temperature).

4.1.3 Charge / discharge condition

Cells shall be charged at constant current of 0.33C to 4.20V with end current of 1/20C

Cells shall be discharged at constant current of 0.33C to 2.85V.

Cells are to rest 10 minutes after charge and 20 minutes after discharge at 25 ºC ± 2 ºC.

4.2 Electrical Specification

Item	Condition / Note	Specification
4.2.1 Initial AC Impedance	Cell shall be measured at 1kHz after charge per 4.1.1.	≤ 25 mΩ
4.2.2 Cycle Life	Cells shall be charged and discharged per 4.1.3 for 300 cycles. A cycle is defined as one charge and one discharge. 300th discharge energy efficiency.	80% (vs. initial cycle energy)
4.2.3 Max. Charge Current(Continuous)*	0 ~ 25℃	0.3C (1,455mA)
	25 ~ 45℃	0.7C (3,395mA)
4.2.4 Max. Discharge Current(Continuous)*	-20 ~ 10℃	0.5C (2,425mA)
	10 ~ 25℃	3.0C(14,550mA)
	25 ~ 55℃	1.5C (7,275mA)

* The maximum continuous charge or discharge current herein is the allowable current to operate cell preventing Li-plating or overheating. It's apart from the allowable high rate current for implementing fast charge current profile. The C-rate herein doesn't have an affect on the safety, and it is just for operating cell and has nothing to do with guarantee of cycle performance.

4.3 Environmental Specification.

Item	Condition / Note		Specification
4.3.1 Storage Characteristics	Cells shall be charged per 4.1.1 and stored in a temperature-controlled environment at 24ºC ± 2ºC for 30 days. After storage, cells shall be discharged per 4.1.2 to obtain the remaining energy*.		*Energy remaining rate ≥90% of Wh_{min}
4.4.2 High Temperature Storage Test	Cells shall be charged per 4.1.1 and stored in a temperature-controlled environment at 55ºC for 1 week. Recovery Energy: After storage, cells shall be discharged with std. discharge condition 4.1.2, and then cells shall be charged with std. charge condition 4.1.1, and then discharged with Std. condition 4.1.2.		No leakage, **Energy recovery rate ≥ 80% of Wh_{min}
4.3.2 Temperature Dependency of Capacity	Cells shall be charged per 4.1.1 at 25ºC ± 2ºC and discharged per 4.1.2 at the following temperatures.		
	Charge	Discharge	Energy
	25℃	-10℃ 0℃ 25℃ 55℃	≥70% of Wh_{min} ≥80% of Wh_{min} ≥100% of Wh_{min} ≥95% of Wh_{min}

4.4 Safety Specification

- Cell satisfies UN38.3 regulation.

5. Caution and Prohibition in Handling

Warning for using the lithium ion rechargeable battery. Mishandling of the battery may cause heat, fire and deterioration in performance. Be sure to observe the following.

5.1 Cautions for Use and Handling

- When using the application equipped with the battery, refer to the user's manual before usage.
- Please read the specific charger manual before charging.
- Charge time should not be longer than specified in the manual.
- When the cell is not charged after long exposure to the charger, discontinue charging.
- Battery must be charged at operating temperature range 0 ~ 45^{o}C.
- Battery must be discharged at operating temperature range -20 ~ 55^{o}C.
- Please check the positive (+) and negative (-) direction before packing.
- When a lead plate or wire is connected to the cell for packing, check out insulation not to short-circuit.
- Battery must be stored separately.
- Battery must be stored in a dry area with low temperature for long-term storage.
- Do not place the battery in direct sunlight or heat.
- Do not use the battery in high static energy environment where the protection device can be damaged.
- When rust or smell is detected on first use, please return the product to the seller immediately.
- The battery must be away from children or pets
- When cell life span shortens after long usage, please exchange to new cells.
- Do insulate between the metal plate and cell or other components not to make a electrical short.
- When use cells for an assembly of module or pack, the "first-in, first-out" (FIFO) principle should be applied
- The cells should be handled and used in Pack/System manufacturing companies only.
- The cells should be sold only to Battery Pack Maker(s) or System Integrator(s). The cells should not be handled by individual consumers and should not be sold to individual consumers by individual markets.
- Be sure to request and confirm the most current product specifications in advance which explain the specifications in detail, before the final stage of your design, purchasing or use for any application.
- It is recommended to store and use cells under the following conditions within 15 days after removing the pallet plastic wrap. Under 25°C and 60 % RH.

5.2 Prohibitions

- Do not use different charger. Do not use cigarette jacks (in cars) for charging.
- Do not charge with constant current more than maximum charge current.
- Do not disassemble or reconstruct the battery.
- Do not throw or cause impact.
- Do not pierce a hole in the battery with sharp things. (such as nail, knife, pencil, drill)
- Do not use with other batteries or cells.
- Do not solder on battery directly.
- Do not press the battery with overload in manufacturing process, especially ultrasonic welding.
- Do not use old and new cells together for packing.
- Do not expose the battery to high heat. (such as fire)
- Do not put the battery into a microwave or high pressure container.
- Do not use the battery reversed.
- Do not use the battery experienced any drop.
- Do not connect positive(+) and negative(-) with conductive materials (such as metal, wire)
- Do not allow the battery to be immerged in or wetted with water or sea-water.
- Do not give immoderate heat and force to battery cell during a welding process of metal plates on it

5.3 Caution for the battery and the pack

Pack shall meet under condition to maintain battery safety and last long performance of the lithium rechargeable cells.

5.3.1 Installing the battery into the pack

-. The cell should be inspected visually before battery assembly into the pack.

-. Damaged cell should not be used. (damaged surface, can-distortion, electrolyte-smell)

-. Cells from the same lot and the same voltage grade should be used in a module and voltage and the cell voltage of every single cell must be checked before putting into the module manufacturing process, (The criteria to sort out NG cell should be agreed between both parties.)

-. Cells from consecutive lots should be used in the same pack and details for the number of lots should be agreed between both parties.

-. Different types of cells, or same types but different cell maker's should not be used together.

5.3.2 Design of battery pack

-. The battery pack should not be connected easily to any charger other than the dedicated charger.

-. The battery pack has function not to cause external short cut easily.

-. The design of battery pack and its structure should be reviewed physically, mechanically and electrically not to cause cell imbalance.

-. The battery pack for multiple cells should be designed to monitor the voltage of each bank.

5.3.3 Charge

-. Charging method is Constant Current-Constant Voltage (CC/CV) or Constant Power (CP).

-. Charging should be operating under maximum charge voltage and current which is specified in the product specification.

-. The battery should be charged under operating temperature specified in the product specification.

5.3.4 Discharge

-. Discharging method could be Constant Current (CC) or Constant Power (CP).

-. Discharging should be operating under maximum discharge current which is specified in the product specification.

-. Discharging should be done by cut off voltage which is specified in the product specification.

-. The battery should be discharged under operating temperature specified in the product specification.

5.3.5 Protection Circuit

-. The protection circuit should be installed in the battery pack, charger.

-. Charger or pack should have voltage sensing system to control over charge or discharge in order to maintain the battery's normal operating mode and protect cell imbalance.

-. Charger or pack should have warning system for over temperature, over voltage and over current

-. When battery packs for any applications are assembled with cells, following functions must be designed into the battery packs and/or in the charger or charging adapter. The detailed levels, values, conditions for each following functions should be referring to the contents specified in this Product Specification. If one or more than one function is/are to be omitted, the Packer Company (and/or System Integration Company) must be informing to LG Chem's or to LG Chem's sales Agent company. Without informing to LGC, LGC will not be liable for any field quality issues happened due to exclusion of following functions.

(1) Over voltage protection circuit
(2) Under voltage protection circuit
(3) Over Charge current protection circuit
(4) Over Discharge current protection circuit
(5) Short circuit protection
(6) Over Temperature protection circuit
(7) 2nd over voltage protection
(8) FET failure protection (in case FET is out of order)
(9) Cell imbalance protection circuit (only for battery packs assembled with more than one cell)
(10) Cell Voltage balancing function (only for battery packs assembled with more than one cell)

※ If the customer or user doesn't comply with this item(5. Caution and Prohibition in Handling), LG Chem is not responsible for any problems

6. Compliance details of buyer

-. The Buyer shall read, understand, and comply with all the conditions set forth in this Contract and the PRODUCT SPECIFICATION provided by the Seller, in particular the section(s) related to the cautions and prohibitions of the Products.

-. The Buyer shall not make any use of the Products without obtaining and fully understanding the PRODUCT SPECIFICATION.

-. The Buyer or buyer's customer shall not make different product or set up the different equipment, with the product ,which is not following the PRODUCT SPECIFICATION

-. The Buyer fully understands and agrees that the Products should be sold to and handled only by battery pack makers, system integrators or other entity expressly authorized by the Seller. The Products can be used solely for the application(s) set forth in the PRODUCT SPECIFICATION and no other application is permitted for use without obtaining the express prior written consent/confirmation as well as the most current PRODUCT SPECIFICATION from the Seller.

-. The Buyer shall provide (a) the most recent PRODUCT SPECIFICATION, (b) the terms of this Special Responsibilities of the Buyer and (c) the terms of the Prohibited Sales of the Buyer under this Contract to its customers, have them acknowledge the contents and require that the Buyer's customers be bound by the terms and conditions set forth therein.

-. During the Effective Period of this Contract and for three (3) years thereafter, the Seller may, at any time with fourteen (14) days' prior notice, audit the Buyer's information, records and data (which may include battery pack and system application data) to validate Buyer's compliance with the terms contained in this Special Responsibilities of the Buyer and the Prohibited Sales of the Buyer.

In the event that the Buyer (or the Buyer's customer) violates the terms and conditions of the PRODUCT SPECIFICATION, the Special Responsibilities of the Buyer or the Prohibited Sales of the Buyer of this Contract, the Seller shall bear no liability for any losses or damages incurred by any party arising out of or resulting from any such violation. The Buyer shall be solely liable for such violation and shall indemnify, defend, and hold the Seller and its affiliates, officers, directors, agents and employees harmless from and against any and all losses, damages, liabilities, settlements, penalties, fines, costs and expenses (including, without limitation, costs of suit, attorney's

fees, other professional fees and expenses), which may at any time be suffered by or incurred by, or be asserted against Seller, directly or indirectly, and which are attributable to any and all allegations, claims, or suits arising out of or in connection with any such violation, or any breach of Buyer's obligations under this Contract. Furthermore, such violation of the Buyer (or such violation of the Buyer's customer) shall cause this Contract to be immediately terminated.

The Seller shall cooperate with the Buyer and its legal representatives in the investigation and defense of any claim, lawsuit or other action covered by this indemnification, all at the reasonable expense of the Buyer. The Seller shall have the right to be represented by counsel of its own selection and expense.

※ If the customer or user doesn't comply with this item(6. Compliance details of purchaser),
LG Chem is not responsible for any problems

7. Exclusion of Liability

The warranty shall not cover defects caused by normal wear and tear, inadequate maintenance, handling, storage faulty repair, modification to the battery or pack by a third party other than LG Chem or LG Chem's agent approved by LG Chem, failure to observe the product specification provided herein or improper use or installation, including but not limited to, the following:

-. Damage during transport or storage
-. Incorrect installation of battery into pack or maintenance
-. Use of battery or pack in inappropriate environment
-. Improper, inadequate, or incorrect charge, discharge or production circuit other than stipulated herein
-. Incorrect use or inappropriate use
-. Insufficient ventilation
-. Ignoring applicable safety warnings and instructions
-. Altering or attempted repairs by unauthorized personnel
-. In case of force majeure (ex. lightening, storm, flood, fire, earthquake, etc.)

There are no warranties-implied or express-other than those stipulated herein. LG Chem. shall not be liable for any consequential or indirect damages arising or in connection with the product specification, battery or pack.