



Product Specifications 1(12)

| | |
|---|-------------------------------|
| Title: Coin Type Lithium ion Rechargeable Battery | Number: PD3535-04J18 |
| Model: <i>Powerdisc</i> 3535 | Date: 2005. 05. 16 Rev : 3 |

PRODUCT SPECIFICATIONS OF COIN TYPE LI-ION RECHARGEABLE BATTERY

MODEL: PD3535

PRESENTED TO:

Accepted by :

Date:

Korea PowerCell Inc.

Prepared by : Hyo-Seok Park ()

Approved by : Geun-Chang Chung ()

Date :



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|---|-------------------------------|
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Product Specifications 3(12)

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|---|----------------------------|
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| Model: Powerdisc 3535 | Date: 2005. 05. 16 Rev : 3 |

1. Preface

This Product Specification describes the requirements of Coin Type Lithium-ion Rechargeable Battery ("Cell") to be supplied to customer by **Korea PowerCell Inc.**

2. Description

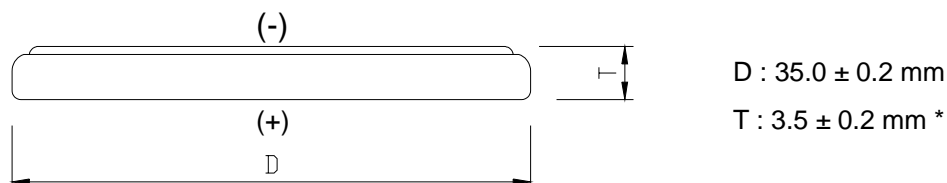
| | |
|------------------|---|
| 2.1 Product | Lithium-ion Rechargeable Battery |
| 2.2 Model (Type) | Powerdisc 3535 (PD3535) |

3. Specifications

| Item | Specification | Remark |
|--------------------------------|---------------|-------------------------------------|
| 3.1 Nominal Capacity | 320 mAh | 0.2C rate, 3.0V cut-off |
| 3.2 Nominal Voltage | 3.7 V | From 4.20 V to 3.00V |
| 3.3 Charging Method | CC/CV | Constant Current / Constant Voltage |
| 3.4 Charging Current (Std.) | 0.5CA (160mA) | 0 ~ 45°C |
| 3.5 Charging Voltage | 4.2 ± 0.03 V | |
| 3.6 Charging End Condition | 32~10mA | At CV mode |
| 3.7 Charging Time (Std.) | > 3.0 hours | |
| 3.8 Discharge Current (Std.) | 0.2CA (64mA) | - 20 ~ 60°C |
| 3.9 Discharge Current (Max) | 0.5CA (160mA) | - 20 ~ 60°C |
| 3.10 Discharge Cut-off Voltage | 3.0 V | |
| 3.11 Cell Weight | Approx. 10±1g | |
| 3.12 Storage Temperature Range | -20 ~ 35 | |

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|---|-------------------------------|
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4. Dimensions (unit : mm)



* Swelling of max. 5% over battery life is not included in the specification.

5. Standard Test Conditions

Unless otherwise specified, all tests stated in this Product Specification are conducted at temperature 25 ± 3 and humidity $65 \pm 20\%$ RH.

6. Electrical Characteristics

6.1 Standard Charge and Discharge Conditions

The "Standard Charge" means charging the Cell with initial charge current 160mA (0.5C) and with a constant voltage 4.20V (± 0.03 V) and a cut off current 10mA at 25 for 3.0 hours.

The "Standard Discharge" means discharging the Cell with constant discharge current 64mA (0.2C) and with 3.0V cut-off voltage at 25 .

6.2 Initial Discharge Capacity

The initial capacity measured under the standard test conditions stated in 6.1

Initial Discharge Capacity Typical 320mAh, Minimum 310mAh

6.3 Initial Internal Impedance

Internal resistance measured at 1KHz after Standard Charge.

Initial Internal Impedance 500 m

6.4 Cycle Life

Capacity after 500 cycles, measured under the test conditions stated in 6.1.

Capacity 250 mAh after 500cycles. (Std. Charge/Discharge condition)

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6.5 Temperature Dependence of Discharge Capacity

Relative capacity at each temperature, measured with constant discharge current 64mA (0.2C) with 2.75V cut-off after the Standard Charge shown below.

| Charge Temp. | Discharge Temp. | | | |
|--------------|-----------------|------|-------|------|
| 25 | -20 | -10 | 25 | 60 |
| | >40 % | >70% | 100 % | >95% |

6.6 Discharge Characteristics on Current Load (C-Rate)

Relative capacity at each load, measured with constant discharge current 0.2C, 0.5C with 3.00V cut-off after Standard Charge shown below.

| Charge Current | Discharge Current | |
|-----------------|-------------------|--------|
| Standard Charge | 0.2 CA | 0.5 CA |
| | 64 mA | 160 mA |
| | 100 % | >90 % |

6.7 Storage characteristic

After stored at the following several conditions, the battery is measured at the standard charge and discharge condition stated in 6.1.

| Storage condition | Charge state | Capacity retention | Capacity recovery |
|-------------------------|-----------------|--------------------|-------------------|
| 20 days at 60°C | Shipping charge | - | > 85% |
| 20 days at 60°C | Full charge | > 60% | > 80% |
| 60 days at 60°C | Full charge | > 30% | > 50% |
| 30 days at 60°C, 90%RH | Full charge | > 30% | > 50% |
| 96 hours at 65°C, 90%RH | Full charge | > 80% | > 90% |

| | |
|---|----------------------------|
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7. Safety Test

| Test Item | Test Method | Criteria |
|--|--|--|
| 7.1 High Temperature | Storing a Cell at 90 for 4 hours after charged at 4.2 V | No leakage |
| 7.2 High Temperature and High Humidity | Storing a Cell at 60 (90 % RH) for 1 week after charged at 4.2V. | No leakage |
| 7.3 Thermal Shock Test | Storing a fully charged Cell(4.2V) at 60 for 2hour and at -20 for 2hour (1 cycle). Total 10 cycles with the maximum transition time, 5 mins. | No leakage |
| 7.4 Hot Box Test | A cell is to be heated in a gravity convection oven. The temperature of the oven is to be raised at a rate of 5 ± 2 per minute to a temperature of 130 ± 2 and remain for 30 minutes at the temperature before the test is discontinued. | No explosion, No fire |
| 7.5 Overcharge Test | Charging the Cell up to 250% of its Nominal capacity at 25 for 2.5 hours. | No explosion, No fire |
| 7.6 Impact Test | A test cell is to be placed on a flat surface. The bar of 9.1 kg weight and 15.8 mm diameter is dropped from a height of 610 mm onto the cell. | No explosion, No fire |
| 7.7 Short-Circuit Test | A Cell is to be short-circuited by connecting the positive and negative terminals of the battery with copper wire having a maximum resistance load of 100m . | No fire or no explosion, until it is completely discharged |
| 7.8 Nail Test | A stainless steel nail having a diameter of 4.0 mm is punched through the cell until the nail has passed through the opposite side of the cell. | No explosion, No fire |
| 7.9 Applying Pressure | Giving Pressure on whole surface of a fully charged cell with 7kg _f for 72 hours | No leakage, No weight decrease |



| | |
|---|-------------------------------|
| Title: Coin Type Lithium ion Rechargeable Battery | Number: PD3535-04J18 |
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8. Shipment

The Cell shall be shipped in 25% charged state. (Cell voltage range: 3.7 ~ 3.8 V)

*The remaining capacity before charging shall be changed depending on the storage time and conditions.

9. Warranty

The Warranty of battery is one year from the date of shipment. However, even though the problem occurs within this period, PowerCell won't replace a new battery for free as long as the problem is not due to the failure of PowerCell manufacturing process or is due to customer's abuse or misuse.

- PowerCell will not be responsible for trouble occurred by handling outside of the precautions in this specification.
- PowerCell will not be responsible for trouble occurred by matching electric circuit, battery pack and charger.
- PowerCell will be exempt from warrantee any defect cells during assembling after acceptance.

10. Precautions and Safety Instructions

Lithium-Ion rechargeable batteries subject to abusive conditions can cause damage to the battery and/or personal injury. Please read and observe the standard battery precautions below before using utilization.

Note 1. The customer is required to contact PowerCell in advance, if and when the customer needs other applications or operating conditions than those described in this document.

Note 2. PowerCell will take no responsibility for any accident when the cell is used under other conditions than those described in this Document.

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10.1 Precautions and Safety Instructions:

- a. Do not expose the battery to extreme heat or flame.
- b. Do not short circuit, over-charge or over-discharge the battery.
- c. Do not subject the battery to strong mechanical shocks.
- d. Do not immerse the battery in water or sea water, or get it wet..
- e. Do not reverse the polarity of the battery for any reason.
- f. Do not disassemble or modify the battery.
- g. Do not remove charge/discharge protection circuitry.
- h. Do not handle or store with metallic like necklaces, coins or hairpins, etc.
- i. Do not use the battery with conspicuous damage or deformation.
- j. Do not connect battery to the plug socket or car-cigarette-plug.
- k. Do not make the direct soldering onto a battery. Weld spot welding lead plate onto a battery.
- l. Do not touch a leaked battery directly.
- m. Do not use for other equipment.
- n. Do not use Lithium-ion battery in mixture.
- o. Do not use or leave the battery under the blazing sun (or in heated car by sunshine).
- p. Keep battery away from children.
- q. Do use the specified charger and observe charging requirement.
- r. Do not drive a nail into the battery, strike it by hammer or tread it.
- s. Do not give battery impact or fling it.

10.2 Battery Operation Instruction:

A. Charging

- a. Charge the battery in a temperature range of 0°C to + 45°C.
- b. Charge the battery at a constant current of 0.5C until 4.20±0.03V per cell is attained. Charge rates greater than 0.5C are NOT recommended. (C : Rated Capacity of Battery)
- c. Maintain charge voltage at 4.20V per cell for 3.0 hours (recommended for maximum capacity).

* Use a constant current, constant voltage (CC/CV) lithium-ion (Li+) battery charge controller.

* Do not continue to charge battery over specified time.

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B. Discharging

- a. Recommended cut-off voltage to 3.0V. Recommended maximum discharge rate is 0.5C at constant current.
- b. For maximum performance, discharge the battery in a temperature range of -20°C to $+45^{\circ}\text{C}$.

C. Protection Circuit

A protection circuit is provided for protecting the battery against damage and/or performance deterioration.

| | |
|--------------------------------------|-------------------------------|
| Over charge voltage protection | : $4.275 \pm 0.025 \text{ V}$ |
| Over discharge voltage protection | : $2.30 \pm 0.058 \text{ V}$ |
| Over current protection | : $2.90 \pm 0.5 \text{ A}$ |
| Current consumption(leakage current) | : I 6.0 μA |

D. Storage Recommendations

- a. Storage Temperature and Humidity
 - Storage the battery at temperature range of $-20 \sim +35^{\circ}\text{C}$, low humidity and no corrosive gas atmosphere.
 - No condensation on the battery
- b. Long Period Storage
 - In case of long period storage (more than 3 months), storage the battery at temperature range of $-10 \sim +20^{\circ}\text{C}$, low humidity, no corrosive gas atmosphere.
 - No condensation on the battery

11. Consultation

As to the obscurity, contact the following.

PowerCell Korea Inc. Sales & Marketing Division

sales@powercellkorea.com

Tel : +82-42-864-0255

Fax : +82-42-864-4342

12. Requirement for Safety Assurance

For the sake of safety assurance, please discuss the equipment design, its system and protection circuit of Lithium-ion battery with PowerCell in advance.

And consult about the high rate current, rapid charge and special application in the same way.

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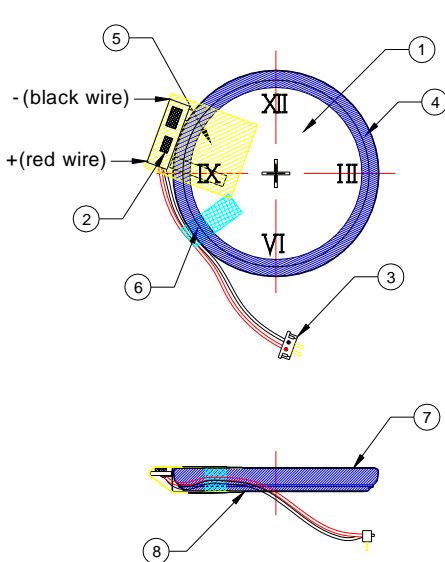
Appendix. 1

A. PCM Specifications (H-PCM)

| Item | Specification | Remark |
|--------------------------------------|---------------|--------|
| 1. Protection IC | R5426D106EA | RICOH |
| 2. Over charge protection voltage | 4.275±0.025V | |
| 3. Over discharge protection voltage | 2.30±0.058V | |
| 4. Over current protection current | 2.90±0.5A | |
| 5. Leakage current | < 6uA | |
| 6. PCB type | Hard PCB | |

B. Drawing of Cell with PCM

| SW | ZON | REVISIONS | REV NO | CHG DATE | CHECK | APPR |
|----|-----|-----------|--------|----------|-------|------|
| | | | | | | |
| | | | | | | |
| | | | | | | |



| | DWG NO | DWG NAME | MTL | NOTE |
|---|--------------|--------------------|--------------------|------------|
| ① | SMP - 050501 | PD 3535 | Ni coated SUS 316L | |
| ② | SMP - 050502 | H - PCM | - | |
| ③ | SMP - 050503 | Kyocera 8005 | - | |
| ④ | SMP - 050504 | Insulation tube | PET | t=0.1±0.03 |
| ⑤ | SMP - 050505 | Insulation tape | - | |
| ⑥ | SMP - 050506 | Fixing tape | - | |
| ⑦ | SMP - 050507 | Insulation tape(+) | | ø32 , 40um |
| ⑧ | SMP - 050508 | Insulation tape(-) | | ø30 , 80um |
| ⑨ | | | | |
| ⑩ | | | | |

| | |
|--------------------|---------|
| Bare cell diameter | 35.05mm |
| Max cell thickness | 3.8mm |
| Max height | 4.1mm |

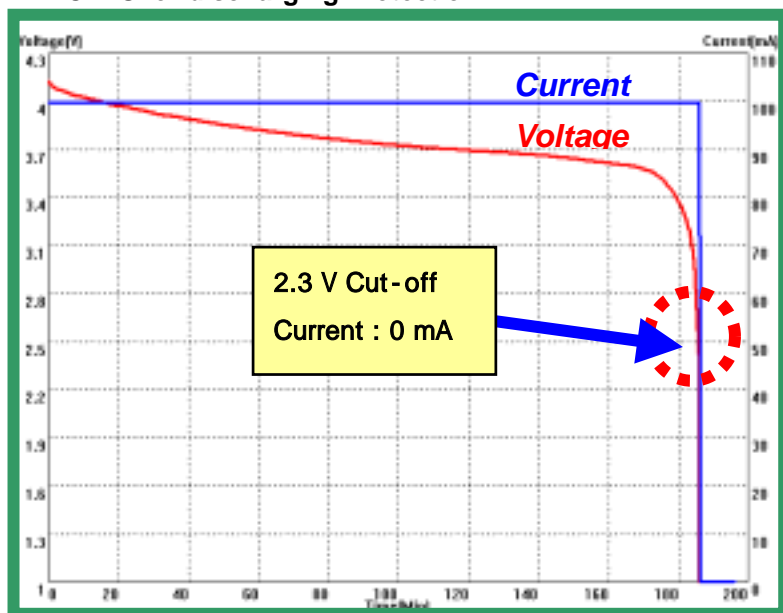
Notes;

- 1) All Dimensions in mm
- 2) Battery KPC PD 3535
- 3) Tab material Stainless steel - Ni plating
- 4) Spot weld Tab to battery
- 5) Welding position can be changed slightly
- 6) PCM's dimension & welding position can be changed slightly
- 6) *Insulation tube
- Color: Deep green

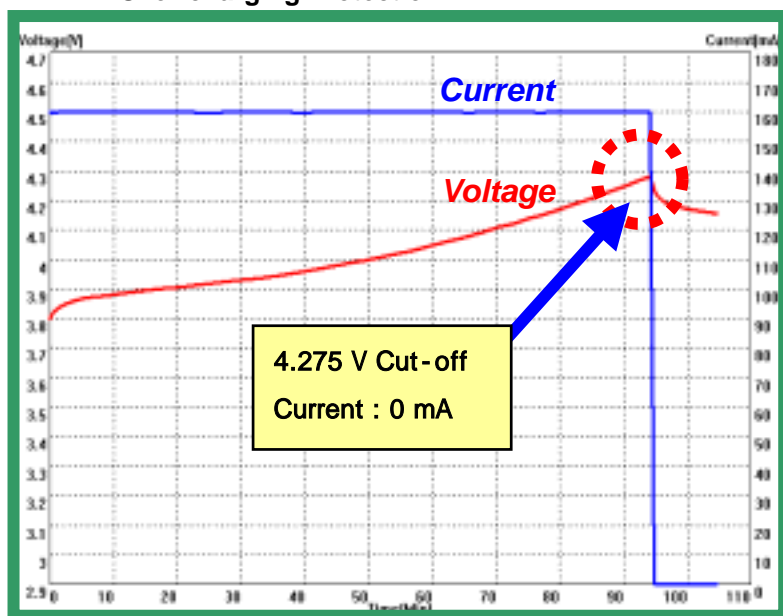
| | | | |
|------------------------|----------------------|----------------------------|-------------|
| TITLE PD 3535 with PCM | | REV. NO 3 | QTY/SET |
| MODEL NAME PD 3535 | | MATERIAL SUS 316L / Ni | |
| ASSY NAME | | Tolerance ±0.5 | PART NO |
| DRAWN BY Y.H. Jung | CHECKED BY T.H. Jeon | APPROVED BY | SCALE 1/1 |
| 14. May. 2005 | 16. May. 2005 | 200 | MM |
| | | DRAWING NO PD 3535-SMP-101 | PAGE 1 OF 1 |

| | |
|---|----------------------------|
| Title: Coin Type Lithium ion Rechargeable Battery | Number: PD3535-04J18 |
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C. Over-discharging Protection



D. Over-charging Protection





| | |
|---|----------------------------|
| Title: Coin Type Lithium ion Rechargeable Battery | Number: PD3535-04J18 |
| Model: Powerdisc 3535 | Date: 2005. 05. 16 Rev : 3 |

E. Inspection Result

| Item No. | Protection Function | | | | | | | |
|------------|-------------------------|------------------------------------|--------------------------|------------------------------------|-------------------------|-----------------|---------------------|-----------------------------|
| | Over Voltage Protection | | Under Voltage Protection | | Over Current Protection | | Current Consumption | Short protection Delay time |
| | Protection(V) | Release(V) | Protection(V) | Release(V) | Charge(A) | Dis- Charge(A) | Normal(uA) | |
| | Delay Time(sec) | | Delay Time(sec) | | Delay Time(sec) | Delay Time(sec) | Powerdown(uA) | |
| 1 | 4.283 | Auto Relaese | 2.291 | Auto Relaese | 2.98 | 2.84 | 3.21 | 0.340 |
| | 0.938 | | 20.42 | | 7.63 | 5.95 | 0.00 | |
| 2 | 4.287 | Auto Relaese | 2.295 | Auto Relaese | 3.02 | 2.82 | 3.35 | 0.324 |
| | 0.968 | | 20.11 | | 7.78 | 6.07 | 0.00 | |
| 3 | 4.291 | Auto Relaese | 2.291 | Auto Relaese | 2.96 | 2.86 | 3.23 | 0.312 |
| | 0.922 | | 19.23 | | 7.42 | 5.80 | 0.00 | |
| 4 | 4.283 | Auto Relaese | 2.295 | Auto Relaese | 2.98 | 2.84 | 3.39 | 0.316 |
| | 0.960 | | 19.68 | | 7.72 | 6.04 | 0.00 | |
| 5 | 4.277 | Auto Relaese | 2.297 | Auto Relaese | 2.94 | 2.80 | 3.32 | 0.288 |
| | 0.903 | | 19.01 | | 7.32 | 5.71 | 0.00 | |
| 6 | 4.285 | Auto Relaese | 2.293 | Auto Relaese | 2.98 | 2.84 | 3.49 | 0.296 |
| | 0.942 | | 20.78 | | 7.78 | 6.08 | 0.00 | |
| 7 | 4.287 | Auto Relaese | 2.291 | Auto Relaese | 2.96 | 2.82 | 3.19 | 0.304 |
| | 0.935 | | 19.23 | | 7.57 | 5.92 | 0.00 | |
| 8 | 4.283 | Auto Relaese | 2.293 | Auto Relaese | 3.02 | 2.86 | 3.37 | 0.312 |
| | 0.922 | | 19.29 | | 7.42 | 5.83 | 0.00 | |
| 9 | 4.277 | Auto Relaese | 2.293 | Auto Relaese | 2.98 | 2.82 | 3.30 | 0.320 |
| | 0.975 | | 20.11 | | 7.84 | 6.10 | 0.00 | |
| 10 | 4.283 | Auto Relaese | 2.291 | Auto Relaese | 2.94 | 2.84 | 3.11 | 0.316 |
| | 0.944 | | 20.48 | | 7.63 | 6.01 | 0.00 | |
| Spec. | 4.275±0.025 V | @Remove charger &Discharge current | 2.300±0.058 V | @Remove charger &Discharge current | 3.0±0.5A | 2.9±0.5A | Max. 6.0 uA | Max. 1.0ms |
| | 0.6~1.4 sec | | 10~30msec | | 5~15 msec | 4~16 msec | Max. 0.1 uA | |
| Max | 4.291 | Auto Relaese | 2.297 | Auto Relaese | 3.02 | 2.86 | 3.49 | 0.340 |
| | 0.975 | | 20.78 | | 7.84 | 6.10 | 0.00 | |
| Min | 4.277 | Auto Relaese | 2.291 | Auto Relaese | 2.94 | 2.80 | 3.11 | 0.288 |
| | 0.903 | | 19.01 | | 7.32 | 5.71 | 0.00 | |
| Aver. (/X) | 4.283 | Auto Relaese | 2.293 | Auto Relaese | 2.97 | 2.84 | 3.30 | 0.313 |
| | 0.938 | | 19.73 | | 7.59 | 5.94 | 0.00 | |



Lithium-ion
Rechargeable
Batteries

Technical Data Sheet ***PD3535***

www.powercellkorea.com

Dec, 2004
Korea PowerCell Inc.

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Appendix. Capacity vs. OCV Graph

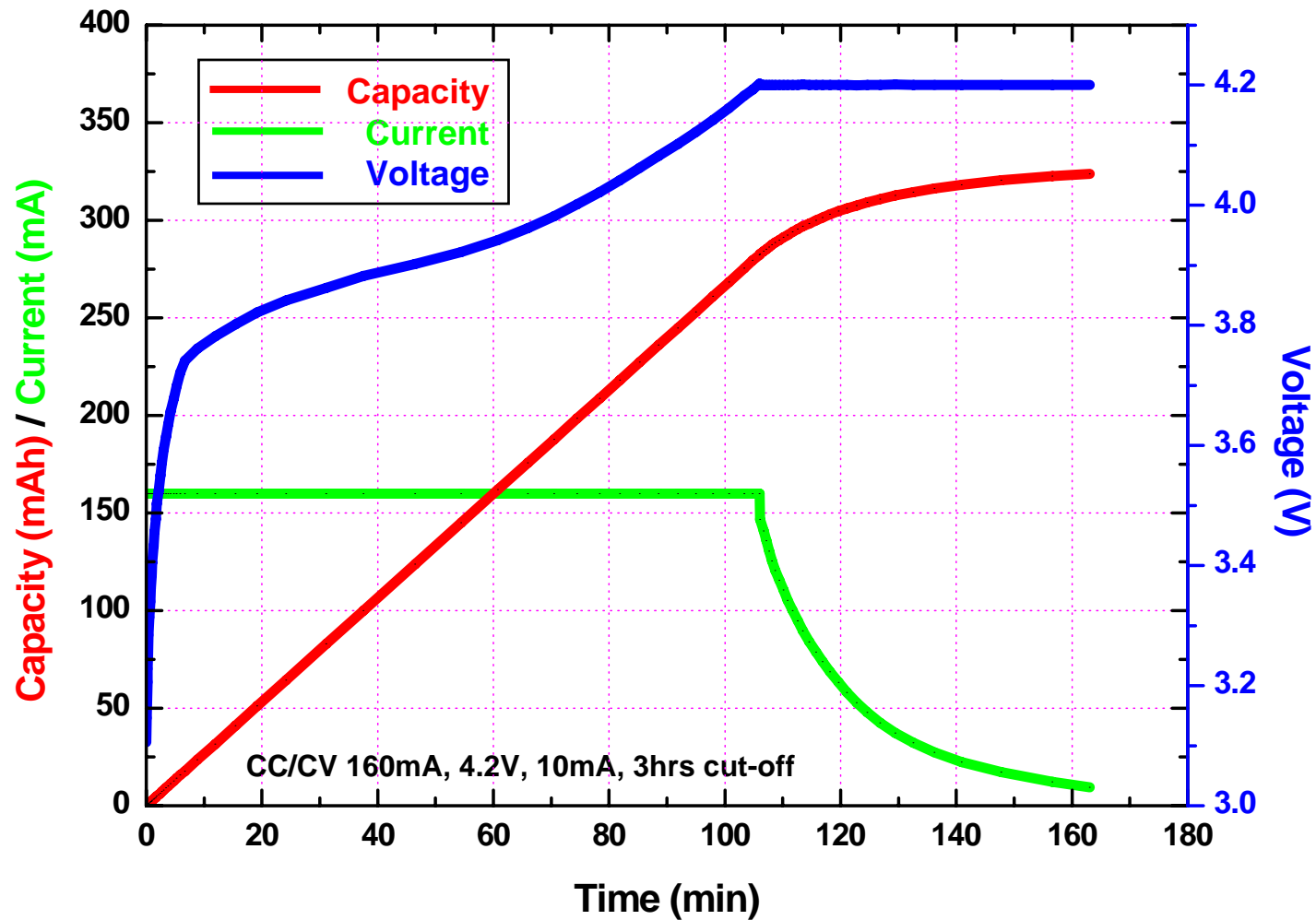
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1. Specification

| | | |
|-----------------------|-----------|---|
| Model | | PD 3535 |
| Nominal Capacity | | 320 mAh (0.2C, 3.0V Cut-off) |
| Nominal Voltage | | 3.7 V |
| Dimension | Thickness | 3.5 ± 0.2 mm (center) |
| | Diameter | 35.0 ± 0.2 mm |
| Charge Method | | CC-CV |
| Charge Voltage | | 4.2 V |
| Charge Current | | * Standard 160 mA, (End - Current : 30~9 mA) |
| Discharge Current | | * Standard 60 mA, Max. 160 mA |
| Discharge end voltage | | 3.0 V |
| Discharge Temperature | | - 20°C ~ + 60°C |
| Internal Impedance | | Max. 500 mohm |
| Weight | | approx 10g (± 1g) |

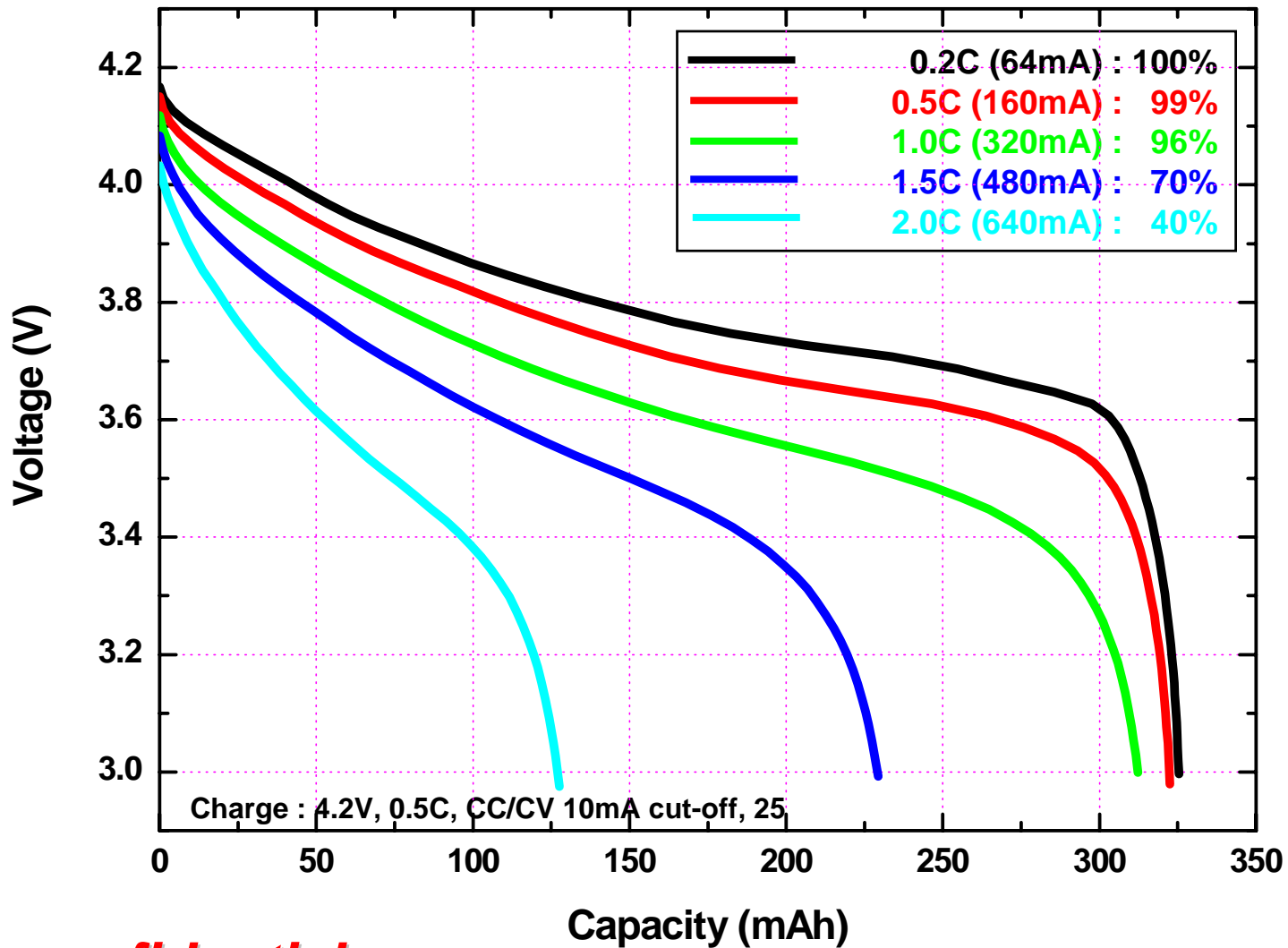
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2. Charge Characteristics – 0.5C at 25



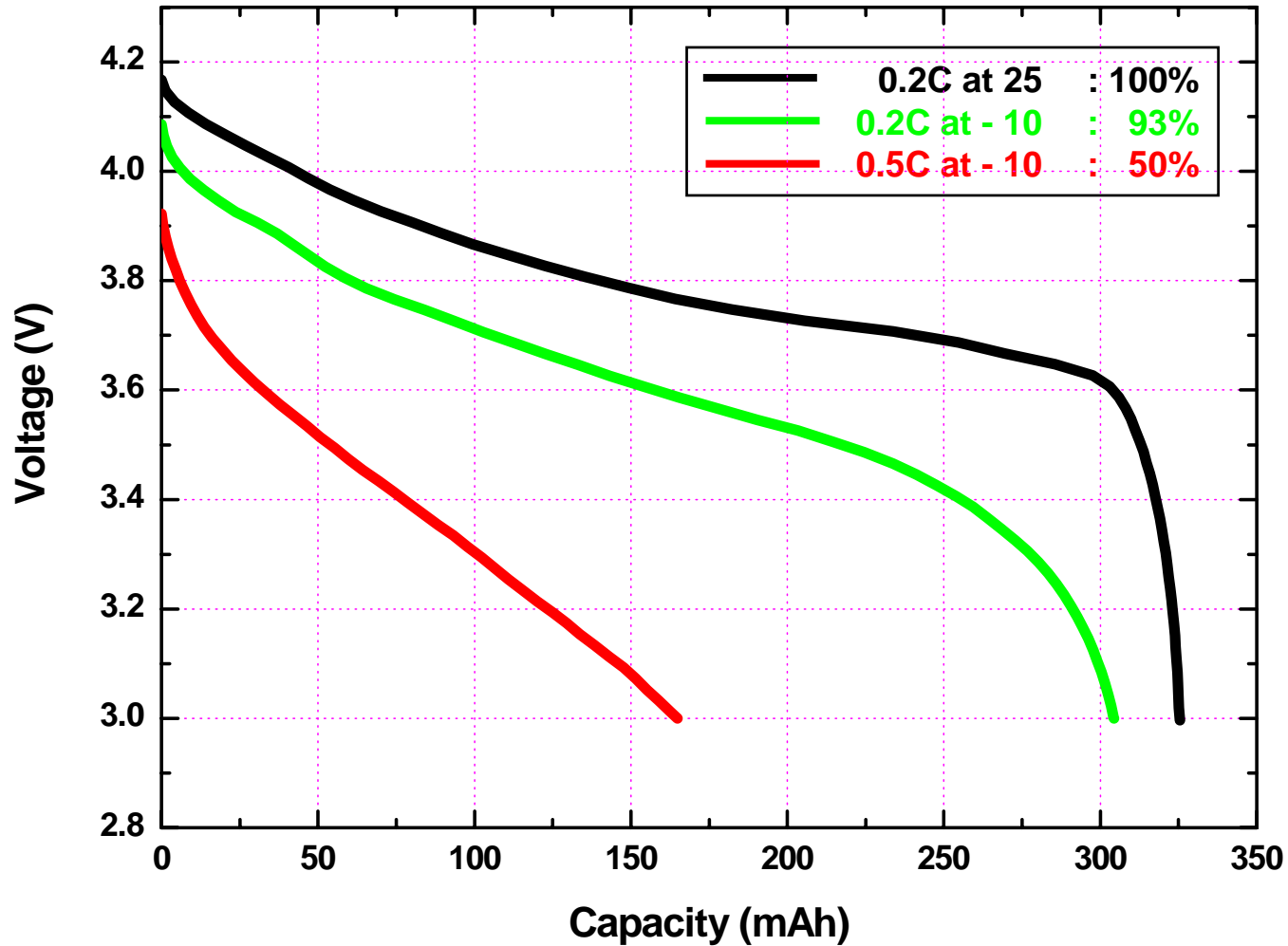
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3.1. Discharge Characteristics at 25



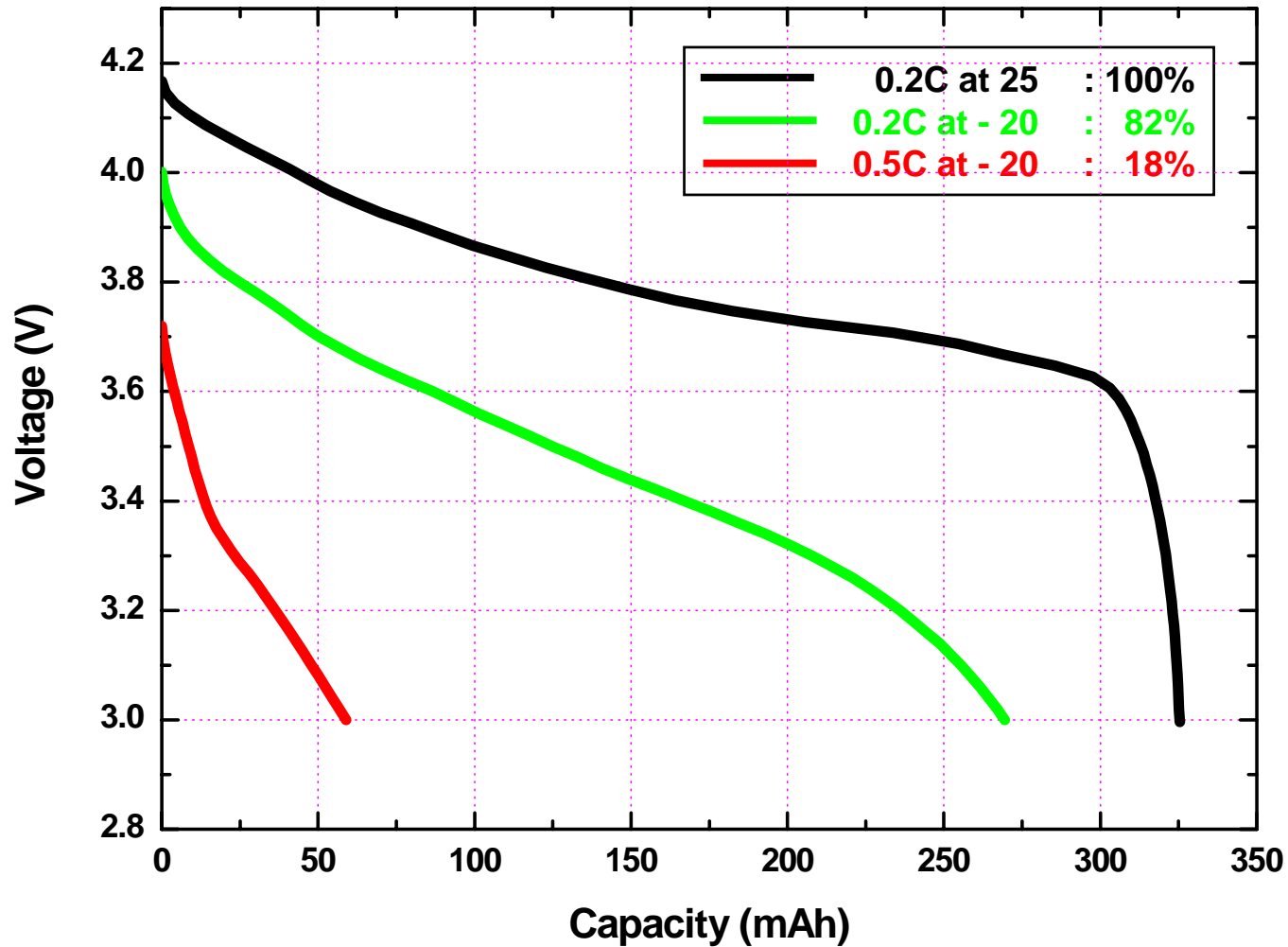
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3.2. Discharge Characteristics at -10



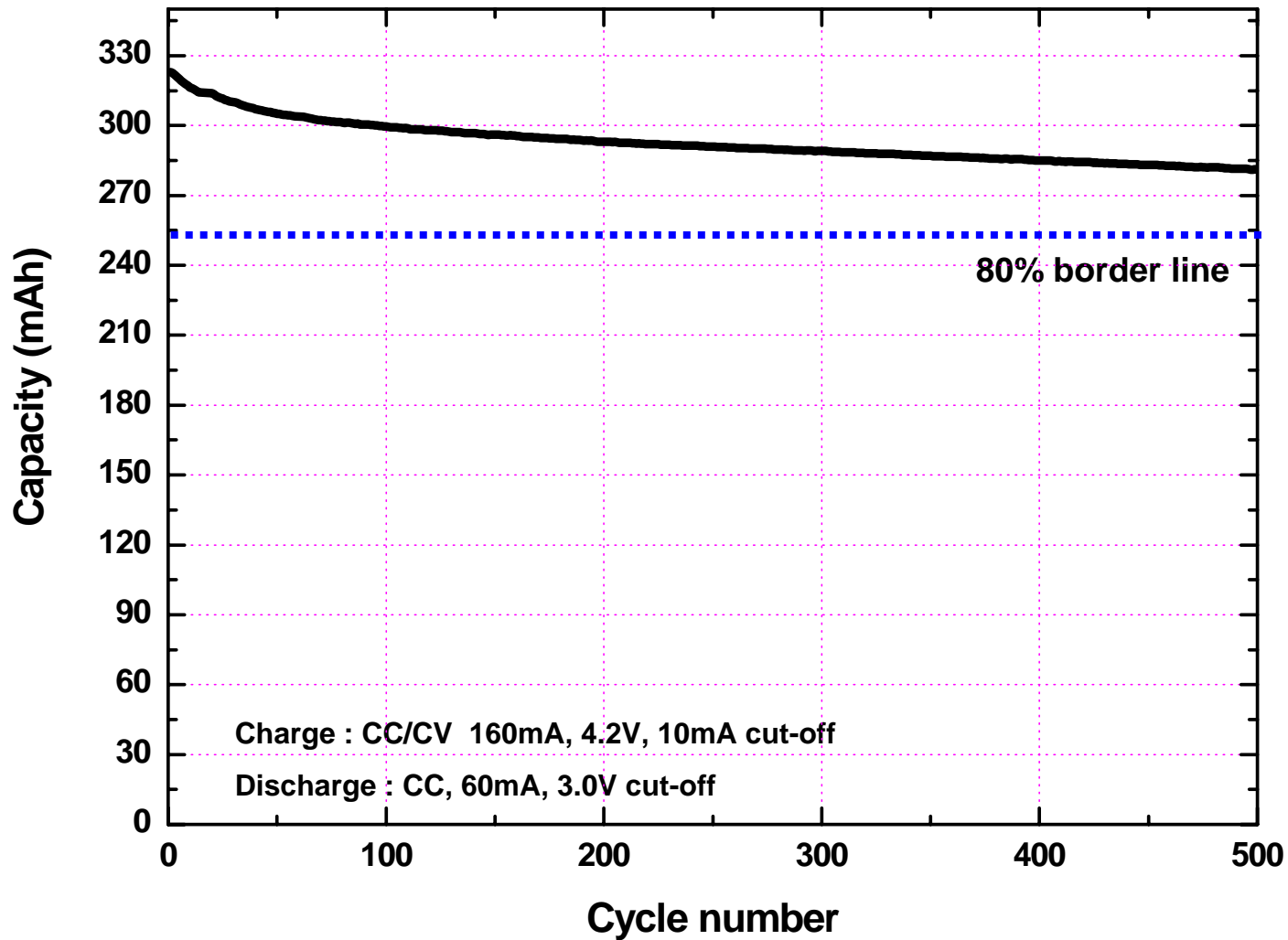
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3.3. Discharge Characteristics at -20



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4. Cycle life – 0.5C charge/ 0.2C discharge



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5. High temperature storage Test (90 , 4hrs)

** Average of 10 samples.*

| | Before storage | After storage | Δ |
|----------------------------|----------------|---------------|----------|
| Weight, g | 10.604 | 10.603 | 0.01% |
| Thickness, mm (at 90°C) | 3.64 | 3.75 | 2.94% |
| Thickness, mm (at RT) | 3.64 | 3.69 | 1.46% |
| Residual capacity, mAh | 321 | 284 | 89% |
| Recovery capacity, mAh | 321 | 301 | 94% |

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6-1. Humidity test (60 , 90% RH, 1 week)

** Average of 10 samples.*

| | Before storage | After storage | Δ |
|---------------------------|----------------|---------------|----------|
| Weight, g | 10.660 | 10.656 | 0.04% |
| Thickness, mm (at RT) | 3.64 | 3.67 | 0.90% |
| Residual capacity, mAh | 322 | 280 | 87% |
| Recovery capacity, mAh | 322 | 303 | 94% |

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6-2. Humidity test (65 , 90% RH, 96 hrs)

** Average of 10 samples.*

| | Before storage | After storage | Δ |
|---------------------------|----------------|---------------|----------|
| Weight, g | 10.602 | 10.599 | 0.03% |
| Thickness, mm (at RT) | 3.64 | 3.67 | 0.85% |
| Residual capacity, mAh | 322 | 283 | 88% |
| Recovery capacity, mAh | 322 | 306 | 95% |

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7. Thermal shock test (-40 / 60 , 10 cycles)

** Average of 10 samples.*

| | Before storage | After storage | Δ |
|---------------------------|----------------|---------------|----------|
| Weight, g | 10.622 | 10.621 | 0.01% |
| Thickness, mm (at RT) | 3.64 | 3.68 | 1.07% |
| Residual capacity, mAh | 321 | 308 | 96% |
| Recovery capacity, mAh | 321 | 314 | 98% |

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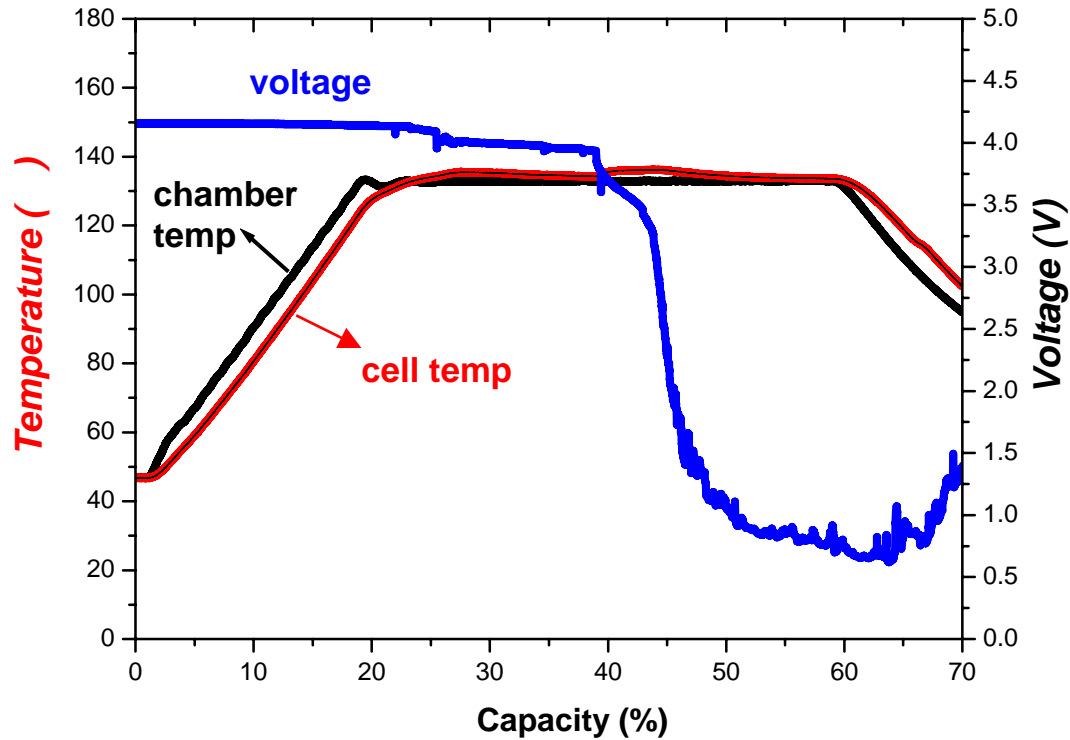
8. Satefy test

| Test | comment |
|-------------------------------------|--------------|
| Hot box test (130 , 30min) | NF, NE, NV |
| Nail test (4.0mm nail) | NF, NE, NV |
| Short circuit test | NF, NE, NV |
| Overcharge test (1.5C, 250% charge) | NF, NE, Vent |

** NF= no fire, NE= no explosion, NV=no vent*

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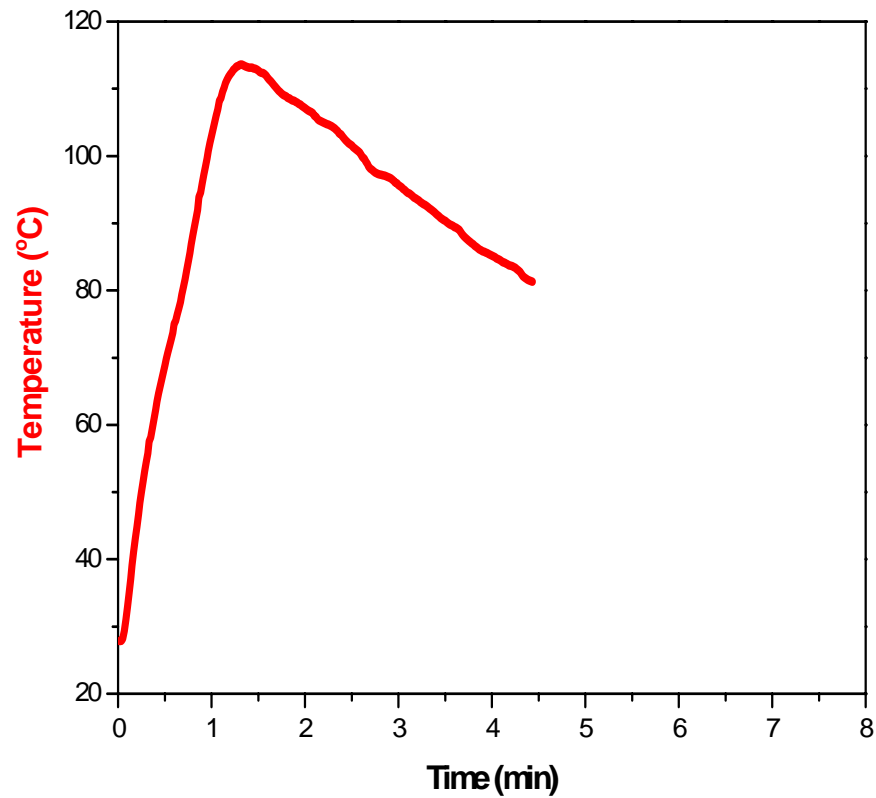
8-1. Hot-Box Test (130 , 30 min)



<after test>

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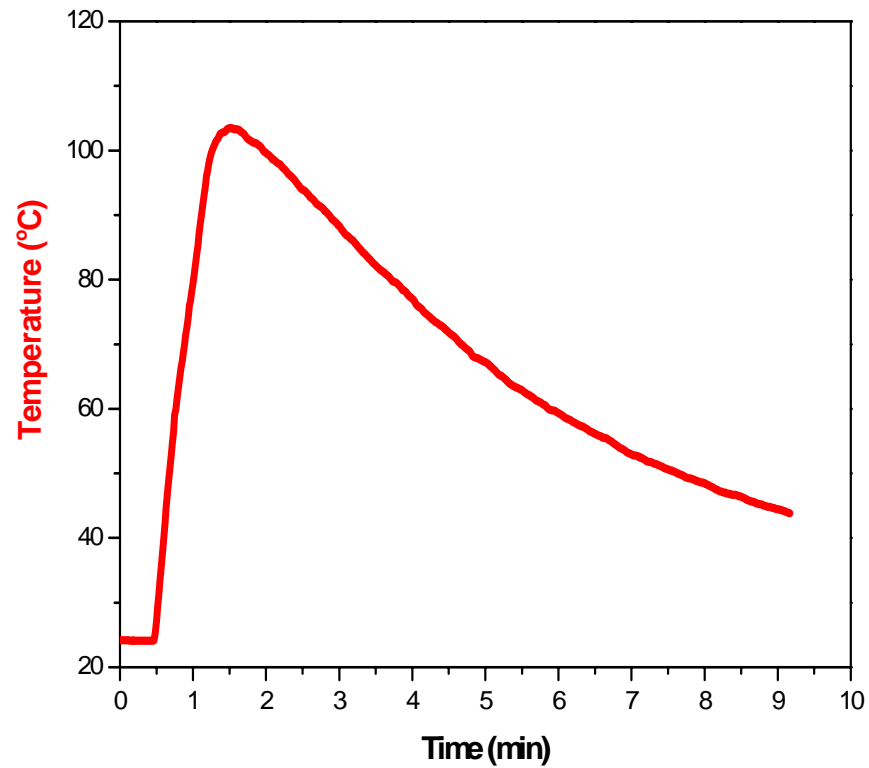
8-2. Nail Penetration Test



<after test>

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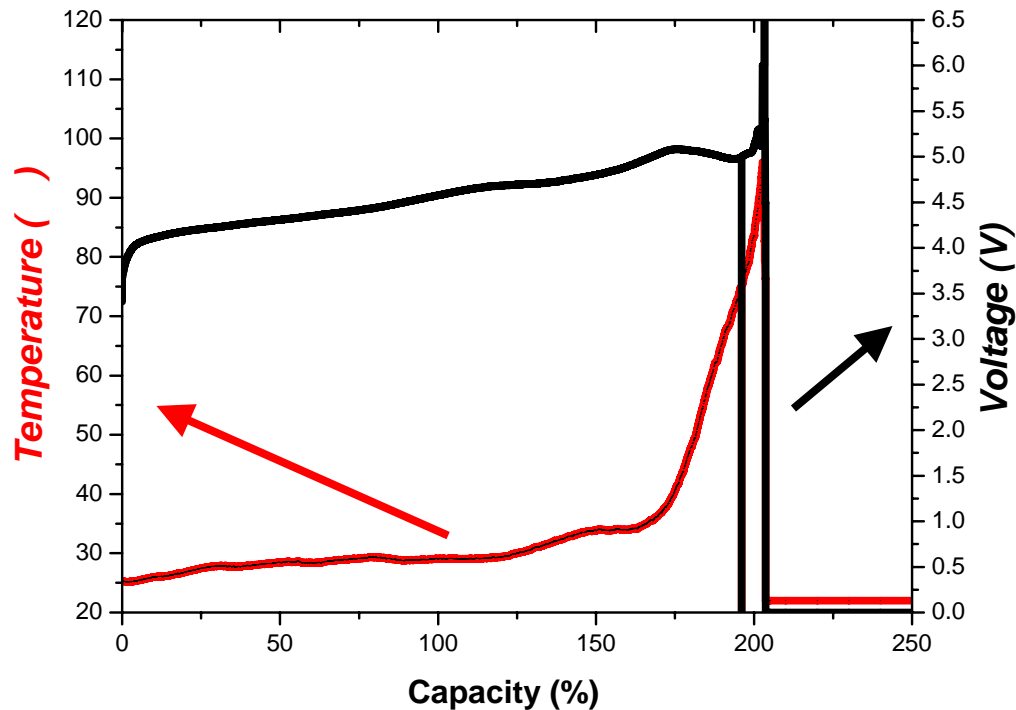
8-3. Short circuit Test



<after test>

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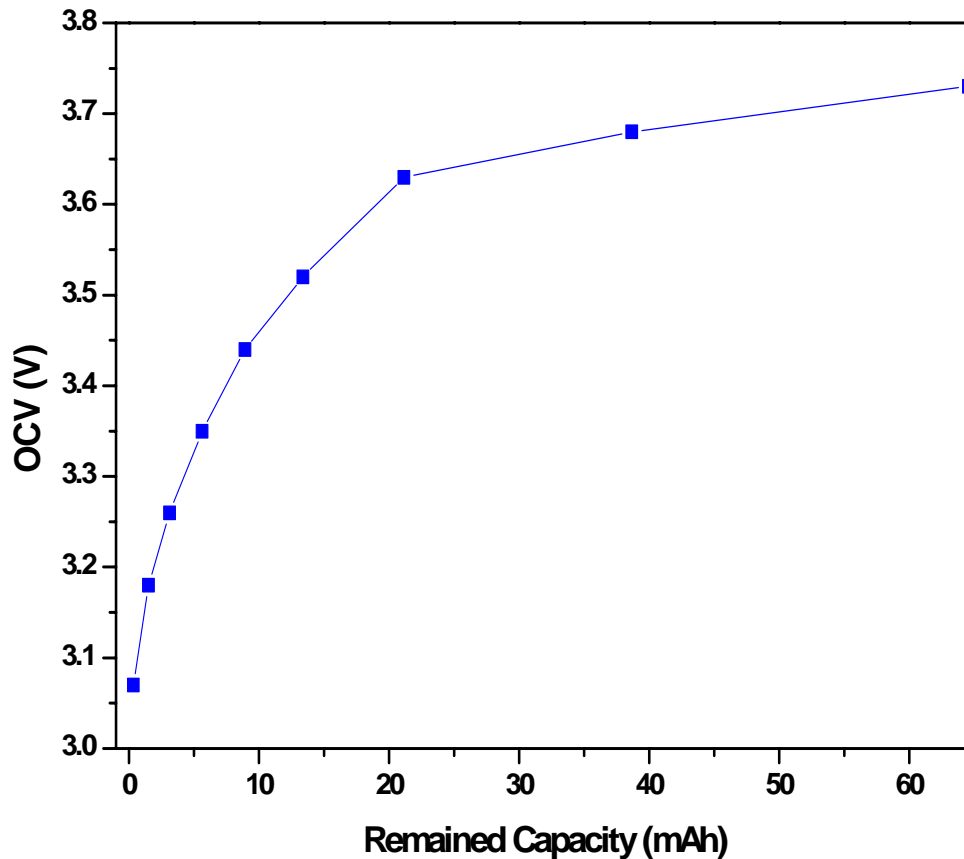
8-4. Overcharge test (1.5C continuous overcharge)



<after test>

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Appendix. Capacity vs. OCV



| Remained Capacity | OCV |
|-------------------|------|
| (mAh) | (V) |
| 64.55 | 3.73 |
| 38.65 | 3.68 |
| 21.12 | 3.63 |
| 13.39 | 3.52 |
| 8.92 | 3.44 |
| 5.63 | 3.35 |
| 3.13 | 3.26 |
| 1.50 | 3.18 |
| 0.34 | 3.07 |

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