

PERFORMANCE TEST REPORT SUMMARY

- ▣ APPARATUS : Lithium primary battery(Li/SOCL2)
- ▣ VOLTAGE RATINGS : 3.65V
- ▣ APPLIED STANDARD : IEC62281(Edition 4.0)/UN 38.3 6th Edition
- ▣ TYPE OF BATTERY : LITHIUM METAL BATTERY
- ▣ MASS : 21.0g
- ▣ LITHIUM METAL CONTENT PER CELL : 0.98g
- ▣ PHYSICAL DESCRIPTION OF CELL(BATTERY) : CYLINDRICAL BATTERY
- ▣ MODLE NAME : SB-A01(P)
- ▣ MANUFACTURER INFO.: Name of the company : VITZROCELL
 ADDRESS : 70, Indusparkro, Hapdeok-eup, Dangjin-si, Chung-Nam, S.KOREA
 TEL : 82 02 2024 3244,
 Web : www.vitzrocell.com / Email : overseas@vitzrocell.com
- ▣ DATE OF TESTS : August 16st. 2015 ~ September 07th. 2015
- ▣ DATE OF ISSUE : November 18th. 2019
- ▣ TEST HOUSE INFO : VITZROCELL RELIABILITY TEST CENTER (Address, Tel, Web, Email are the same with Manufacturer Info)

▣ TEST SUMMARY : VITZROCELL Batteries have been successfully tested and comply with UN model Regulation UN Manual of Tests and Criteria, PartIII Subsection 38.3(6th EDTION)

| List of Tests Conducted | Result |
|---------------------------------|--------|
| 38.3.4.1 T1 Altitude simulation | Pass |
| 38.3.4.1 T2 Thermal | Pass |
| 38.3.4.3 T3 Vibration | Pass |
| 38.3.4.4 T4 Shock | Pass |
| 38.3.4.5 T5 External short | Pass |
| 38.3.4.6 T6 Impact | Pass |
| 38.3.4.7 T7 Overcharge | N.A. |
| 38.3.4.8 T8 Forced discharge | Pass |

- Tests T1 through T5 shall be conducted in sequence on the same cell or battery
- * T7 is evaluates the ability of a rechargeable battery to withstand overcharge



Approved

S.I Jung

(quality department chef)



Verified

N.H Kim

(testcenter management)



Prepared

S.H Jung

(testcenter staff)



Vitzrocell Reliability Test Center

List of the tests

| Description of tests | Test circuit | Sheet NO. |
|--------------------------|--------------|-----------|
| Altitude simulation test | – | 4/9 |
| Thermal test | – | 5/9 |
| Vibration test | – | 6/9 |
| Shock test | – | 7/9 |
| External short test | – | 8/9 |
| Impact test | – | 9/9 |
| Forced discharge test | – | 9/9 |

1. Altitude simulation test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|---|-------|------------|-------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Test cells were stored at a pressure of 11.6kPa for 6hours at ambient temperature (20±5℃) [Requirement] -NM / NL / NV / NC / NE / NR / NF -Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.671 | 3.671 | 21.47 | 21.47 | * NM NL NV NC NE NR NF (PASS) | Ph.01 |
| #02 | | | 3.670 | 3.670 | 21.51 | 21.51 | | Ph.01 |
| #03 | | | 3.671 | 3.671 | 21.41 | 21.41 | | Ph.01 |
| #04 | | | 3.672 | 3.672 | 21.61 | 21.61 | | Ph.01 |
| #05 | | | 3.671 | 3.671 | 21.50 | 21.50 | | Ph.01 |
| #06 | | | 3.670 | 3.670 | 21.48 | 21.48 | | Ph.01 |
| #07 | | | 3.670 | 3.670 | 21.39 | 21.39 | | Ph.01 |
| #08 | | | 3.671 | 3.671 | 21.51 | 21.51 | | Ph.01 |
| #09 | | | 3.672 | 3.672 | 21.53 | 21.53 | | Ph.01 |
| #10 | | | 3.670 | 3.670 | 21.46 | 21.46 | | Ph.01 |
| #11 | Fully Discharged Cells | [Test Procedure] Test cells were stored at a pressure of 11.6kPa for 6hours at ambient temperature (20±5℃) [Requirement] -NM / NL / NV / NC / NE / NR / NF | - | - | 21.59 | 21.59 | * NM NL NV NC NE NR NF (PASS) | Ph.02 |
| #12 | | | - | - | 21.60 | 21.60 | | Ph.02 |
| #13 | | | - | - | 21.71 | 21.71 | | Ph.02 |
| #14 | | | - | - | 21.61 | 21.61 | | Ph.02 |
| #15 | | | - | - | 21.55 | 21.55 | | Ph.02 |
| #16 | | | - | - | 21.53 | 21.53 | | Ph.02 |
| #17 | | | - | - | 21.57 | 21.57 | | Ph.02 |
| #18 | | | - | - | 21.61 | 21.61 | | Ph.02 |
| #19 | | | - | - | 21.49 | 21.49 | | Ph.02 |
| #20 | | | - | - | 21.55 | 21.55 | | Ph.02 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

2. Thermal test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|---|--|-------|------------|-------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | [Test Procedure] Test cells were stored for 6hours at 75±2°C, followed by storage for 6hours at -40 ±2°C. The maximum time interval between test temperature extreme was 30minutes. This procedure was repeated 10times, after which all test cells were stored for 24hours at ambient temperature (20±5°C) [Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test | 3.671 | 3.671 | 21.47 | 21.47 | * NM NL NV NC NE NR NF (PASS) | Ph.03 |
| #02 | | | 3.670 | 3.670 | 21.51 | 21.51 | | Ph.03 |
| #03 | | | 3.671 | 3.671 | 21.41 | 21.41 | | Ph.03 |
| #04 | | | 3.672 | 3.672 | 21.61 | 21.61 | | Ph.03 |
| #05 | | | 3.671 | 3.671 | 21.50 | 21.50 | | Ph.03 |
| #06 | | | 3.670 | 3.670 | 21.48 | 21.48 | | Ph.03 |
| #07 | | | 3.670 | 3.670 | 21.39 | 21.39 | | Ph.03 |
| #08 | | | 3.671 | 3.671 | 21.51 | 21.51 | | Ph.03 |
| #09 | | | 3.672 | 3.672 | 21.53 | 21.53 | | Ph.03 |
| #10 | | | 3.670 | 3.670 | 21.46 | 21.46 | | Ph.03 |
| #11 | Fully Discharged Cells | [Test Procedure] Test cells were stored for 6hours at 75±2°C, followed by storage for 6hours at -40 ±2°C. The maximum time interval between test temperature extreme was 30minutes. This procedure was repeated 10times, after which all test cells were stored for 24hours at ambient temperature (20±5°C) [Requirement] -NM / NL / NV / NC / NE / NR / NF | - | - | 21.59 | 21.59 | * NM NL NV NC NE NR NF (PASS) | Ph.04 |
| #12 | | | - | - | 21.60 | 21.60 | | Ph.04 |
| #13 | | | - | - | 21.71 | 21.71 | | Ph.04 |
| #14 | | | - | - | 21.61 | 21.61 | | Ph.04 |
| #15 | | | - | - | 21.55 | 21.55 | | Ph.04 |
| #16 | | | - | - | 21.53 | 21.53 | | Ph.04 |
| #17 | | | - | - | 21.57 | 21.57 | | Ph.04 |
| #18 | | | - | - | 21.61 | 21.61 | | Ph.04 |
| #19 | | | - | - | 21.49 | 21.49 | | Ph.04 |
| #20 | | | - | - | 21.55 | 21.55 | | Ph.04 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
 NE : No explosion, NR : No Rupture, NF : No Fire

3. Vibration test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|---|--|-------|------------|-------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | <p>[Test Procedure] Cells were firmly secured to the platform of the vibration machine. The vibration was a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15minutes. This cycle was repeated 12times for a total of 3hours for each of 3mutua-ly perpendicular mounting positions of the cells.</p> <p>•Frequency,Acceleration and amplitude - 7~18Hz : 1G - 18~50Hz : 1~8G(1.6mm p-p) - 50~200Hz : 8G</p> <p>[Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test</p> | 3.671 | 3.671 | 21.47 | 21.47 | * NM NL NV NC NE NR NF (PASS) | Ph.05 |
| #02 | | | 3.670 | 3.670 | 21.51 | 21.51 | | Ph.05 |
| #03 | | | 3.671 | 3.671 | 21.41 | 21.41 | | Ph.05 |
| #04 | | | 3.672 | 3.672 | 21.61 | 21.61 | | Ph.05 |
| #05 | | | 3.671 | 3.671 | 21.50 | 21.50 | | Ph.05 |
| #06 | | | 3.670 | 3.670 | 21.48 | 21.48 | | Ph.05 |
| #07 | | | 3.670 | 3.670 | 21.39 | 21.39 | | Ph.05 |
| #08 | | | 3.671 | 3.671 | 21.51 | 21.51 | | Ph.05 |
| #09 | | | 3.672 | 3.672 | 21.53 | 21.53 | | Ph.05 |
| #10 | | | 3.670 | 3.670 | 21.46 | 21.46 | | Ph.05 |
| #11 | Fully Discharged Cells | <p>[Test Procedure] Cells were firmly secured to the platform of the vibration machine. The vibration was a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15minutes. This cycle was repeated 12times for a total of 3hours for each of 3mutua-ly perpendicular mounting positions of the cells.</p> <p>•Frequency,Acceleration and amplitude - 7~18Hz : 1G - 18~50Hz : 1~8G(1.6mm p-p) - 50~200Hz : 8G</p> <p>[Requirement] - NM / NL / NV / NC / NE / NR / NF</p> | - | - | 21.59 | 21.59 | * NM NL NV NC NE NR NF (PASS) | Ph.06 |
| #12 | | | - | - | 21.60 | 21.60 | | Ph.06 |
| #13 | | | - | - | 21.71 | 21.71 | | Ph.06 |
| #14 | | | - | - | 21.61 | 21.61 | | Ph.06 |
| #15 | | | - | - | 21.55 | 21.55 | | Ph.06 |
| #16 | | | - | - | 21.53 | 21.53 | | Ph.06 |
| #17 | | | - | - | 21.57 | 21.57 | | Ph.06 |
| #18 | | | - | - | 21.61 | 21.61 | | Ph.06 |
| #19 | | | - | - | 21.49 | 21.49 | | Ph.06 |
| #20 | | | - | - | 21.55 | 21.55 | | Ph.06 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit

NE : No explosion, NR : No Rupture, NF : No Fire

4. Shock test

| Specimen No. | State of charge | Test procedure & requirement | Voltage and weight of cells Before and after test | | | | Result | Photo |
|--------------|------------------------|--|--|-------|------------|-------|---|-------|
| | | | Voltage (V) | | Weight (g) | | | |
| | | | Before | After | Before | After | | |
| #01 | Un-Discharged Cells | <p>[Test Procedure] Each test cell was subjected to a halfsine shock of peak acceleration of 150g_n and pulse duration of 6ms. Each cell was subjected to 3shocks in the positive direction followed by 3 shocks in the negative direction of 3mutually perpendicular mounting positions of the cell for a total of 18 shock.</p> <p>[Requirement] - NM / NL / NV / NC / NE / NR / NF - Open circuit voltage of the test cell after test : not less than 90% of its voltage prior to this test</p> | 3.671 | 3.671 | 21.47 | 21.47 | * NM NL NV NC NE NR NF (PASS) | Ph.07 |
| #02 | | | 3.670 | 3.670 | 21.51 | 21.51 | | Ph.07 |
| #03 | | | 3.671 | 3.671 | 21.41 | 21.41 | | Ph.07 |
| #04 | | | 3.672 | 3.672 | 21.61 | 21.61 | | Ph.07 |
| #05 | | | 3.671 | 3.671 | 21.50 | 21.50 | | Ph.07 |
| #06 | | | 3.670 | 3.670 | 21.48 | 21.48 | | Ph.07 |
| #07 | | | 3.670 | 3.670 | 21.39 | 21.39 | | Ph.07 |
| #08 | | | 3.671 | 3.671 | 21.51 | 21.51 | | Ph.07 |
| #09 | | | 3.672 | 3.672 | 21.53 | 21.53 | | Ph.07 |
| #10 | | | 3.670 | 3.670 | 21.46 | 21.46 | | Ph.07 |
| #11 | Fully Discharged Cells | <p>[Test Procedure] Each test cell was subjected to a halfsine shock of peak acceleration of 150g_n and pulse duration of 6ms. Each cell was subjected to 3shocks in the positive direction followed by 3 shocks in the negative direction of 3mutually perpendicular mounting positions of the cell for a total of 18 shock.</p> <p>[Requirement] - NM / NL / NV / NC / NE / NR / NF</p> | - | - | 21.59 | 21.59 | * NM NL NV NC NE NR NF (PASS) | Ph.08 |
| #12 | | | - | - | 21.60 | 21.60 | | Ph.08 |
| #13 | | | - | - | 21.71 | 21.71 | | Ph.08 |
| #14 | | | - | - | 21.61 | 21.61 | | Ph.08 |
| #15 | | | - | - | 21.55 | 21.55 | | Ph.08 |
| #16 | | | - | - | 21.53 | 21.53 | | Ph.08 |
| #17 | | | - | - | 21.57 | 21.57 | | Ph.08 |
| #18 | | | - | - | 21.61 | 21.61 | | Ph.08 |
| #19 | | | - | - | 21.49 | 21.49 | | Ph.08 |
| #20 | | | - | - | 21.55 | 21.55 | | Ph.08 |

* NM : No Mass Loss, NL : No Leakage, NV : No Venting, NC : No short-circuit
NE : No explosion, NR : No Rupture, NF : No Fire

5. External short circuit test

| Specimen No. | State of charge | Test procedure & requirement | Max. Temperature of during test(°C) | Result | Photo |
|--------------|------------------------|--|-------------------------------------|---|-------|
| #01 | Un-Discharged Cells | <p>[Test Procedure] Test cells were subjected to a short circuit condition with a total external resistance of less than 0.1Ω at 55±2°C. The test has been continued for 1hour after the cell external case temperature has returned to 55±2°C. Test cell was observed for a further 6hours.</p> <p>[Requirement] - NE / NR / NF - External temperature of the cell ≤ 170°C (NT)</p> | 82.1 | * NT NE NR NF (PASS) | Ph.09 |
| #02 | | | 85.3 | | Ph.09 |
| #03 | | | 84.1 | | Ph.09 |
| #04 | | | 84.7 | | Ph.09 |
| #05 | | | 80.9 | | Ph.09 |
| #06 | | | 79.4 | | Ph.09 |
| #07 | | | 74.2 | | Ph.09 |
| #08 | | | 81.5 | | Ph.09 |
| #09 | | | 83.1 | | Ph.09 |
| #10 | | | 84.6 | | Ph.09 |
| #11 | Fully Discharged Cells | <p>[Test Procedure] Test cells were subjected to a short circuit condition with a total external resistance of less than 0.1Ω at 55±2°C. The test has been continued for 1hour after the cell external case temperature has returned to 55±2°C. Test cell was observed for a further 6hours.</p> <p>[Requirement] - NE / NR / NF - External temperature of the cell ≤ 170°C (NT)</p> | 65.2 | * NT NE NR NF (PASS) | Ph.10 |
| #12 | | | 63.1 | | Ph.10 |
| #13 | | | 59.2 | | Ph.10 |
| #14 | | | 59.5 | | Ph.10 |
| #15 | | | 59.1 | | Ph.10 |
| #16 | | | 60.1 | | Ph.10 |
| #17 | | | 63.1 | | Ph.10 |
| #18 | | | 64.1 | | Ph.10 |
| #19 | | | 60.2 | | Ph.10 |
| #20 | | | 60.9 | | Ph.10 |

* NT : No excessive temperature rise, NE : No explosion, NR : No Rupture, NF : No Fire

6. Impact test

| Specimen No. | State of charge | Test procedure & requirement | Max. Temperature of during test(°C) | Result | Photo |
|--------------|------------------------|--|-------------------------------------|-----------------------------------|-------|
| #21 | Un-Discharged Cells | [Test Procedure] A 15.8mm diameter bar was placed across the center of the fully charged cells. Then 9.1kg weight was dropped from a height of 61cm onto cells. [Requirement] - NE / NF - External temperature of the cell ≤ 170°C (NT) | 25.6 | * NT NE NF (PASS) | Ph.11 |
| #22 | | | 24.4 | | Ph.11 |
| #23 | | | 25.6 | | Ph.11 |
| #24 | | | 26.3 | | Ph.11 |
| #25 | | | 25.1 | | Ph.11 |
| #26 | Fully Discharged Cells | [Test Procedure] A 15.8mm diameter bar was placed across the center of the fully discharged cells. Then 9.1kg weight was dropped from a height of 61cm onto cells. [Requirement] - NE / NF - External temperature of the cell ≤ 170°C (NT) | 25.1 | * NT NE NF (PASS) | Ph.12 |
| #27 | | | 25.2 | | Ph.12 |
| #28 | | | 26.3 | | Ph.12 |
| #29 | | | 26.1 | | Ph.12 |
| #30 | | | 25.7 | | Ph.12 |

7. Forced discharge test

| Specimen No. | State of charge | Test procedure & requirement | Result | Reference |
|--------------|------------------------|---|-----------------------------|--------------|
| #31 | Fully Discharged Cells | [Test Procedure] Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12V direct current power supply at an initial current equal to the maximum continuous discharge current specified by the manufacturer [Requirement] - NE / NF | * NE NF (PASS) | Ph.13/Graph1 |
| #32 | | | | Ph.13/Graph1 |
| #33 | | | | Ph.13/Graph1 |
| #34 | | | | Ph.13/Graph1 |
| #35 | | | | Ph.13/Graph1 |
| #36 | | | | Ph.13/Graph1 |
| #37 | | | | Ph.13/Graph1 |
| #38 | | | | Ph.13/Graph1 |
| #39 | | | | Ph.13/Graph1 |
| #40 | | | | Ph.13/Graph1 |

* NT : No excessive temperature rise, NE : No explosion, NF : No Fire

Photographs



#01 ~ #10

Photographs of specimen before test



#01 ~ #10

Photographs of specimen after test



Photo.01 – Photographs of specimen before & after Altitude simulation test (Undischarged cells)

Photographs



#11 ~ #20

Photographs of specimen before test



#11 ~ #20

Photographs of specimen after test



Photo.02 – Photographs of specimen before & after Altitude simulation test (Fully discharged cells)

Photographs



#01 ~ #10

Photographs of specimen before test



#01 ~ #10

Photographs of specimen after test

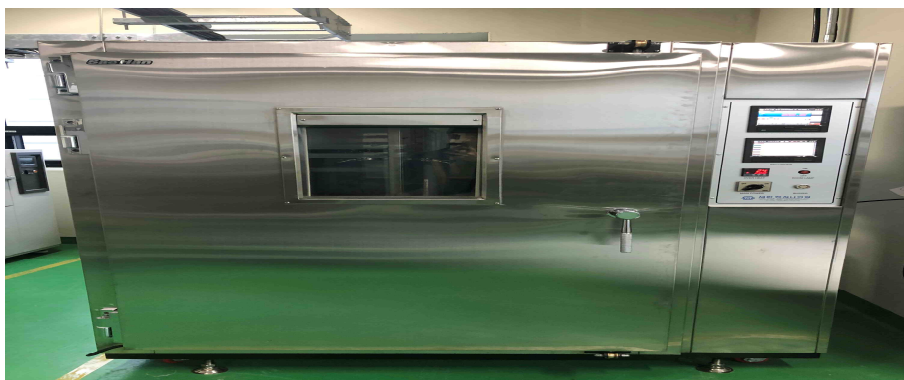


Photo.03 – Photographs of specimen before & after Thermal test (Undischarged cells)

Photographs



#11 ~ #20

Photographs of specimen before test



#11 ~ #20

Photographs of specimen after test



Photo.04 – Photographs of specimen before & after Thermal test (Fully discharged cells)

Photographs



#01 ~ #10

Photographs of specimen before test



#01 ~ #10

Photographs of specimen after test

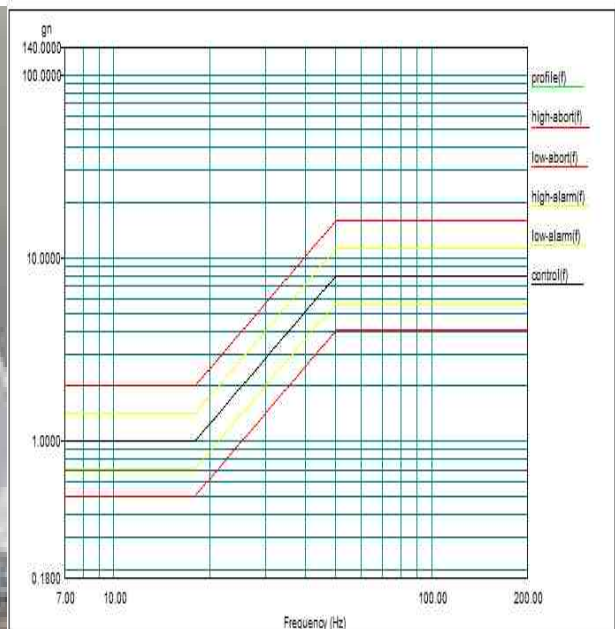


Photo.05 – Photographs of specimen before & after Vibration test (Undischarged cells)

Photographs



#11 ~ #20

Photographs of specimen before test



#11 ~ #20

Photographs of specimen after test

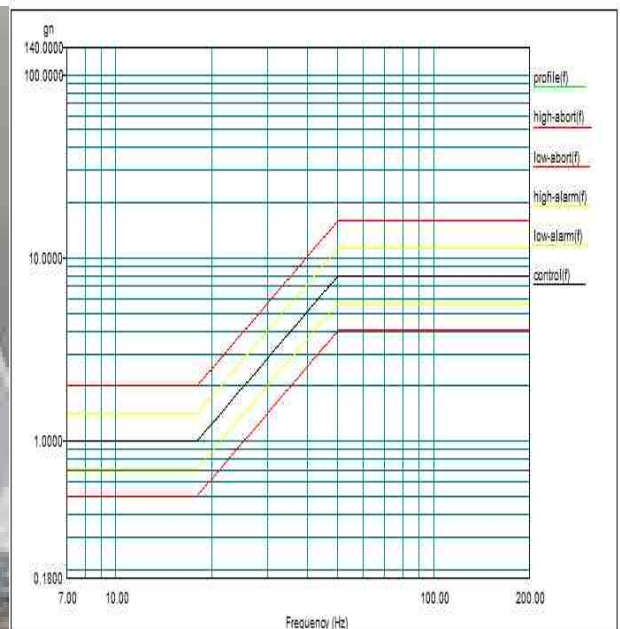


Photo.06 – Photographs of specimen before & after Vibration test (Fully discharged cells)

Photographs



#01 ~ #10

Photographs of specimen before test



#01 ~ #10

Photographs of specimen after test

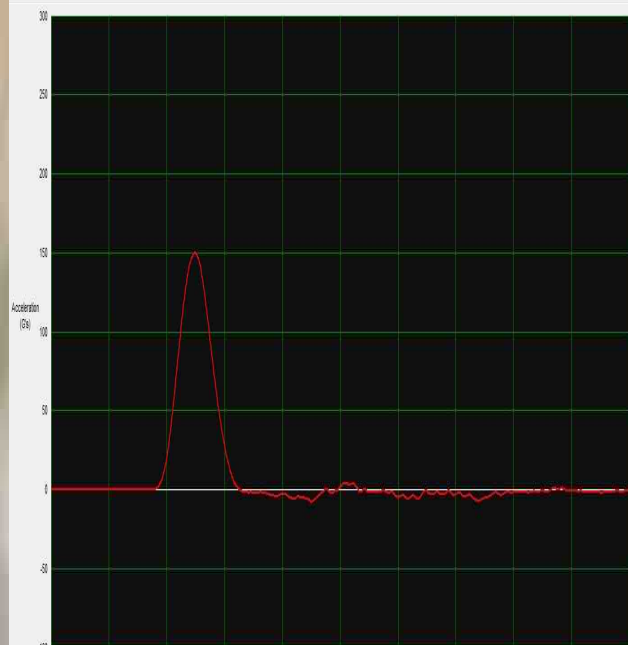


Photo.07 – Photographs of specimen before & after Shock test (Undischarged cells)

Photographs



#11 ~ #20

Photographs of specimen before test



#11 ~ #20

Photographs of specimen after test



Photo.08 – Photographs of specimen before & after Shock test (Fully discharged cells)

Photographs



#01 ~ #10

Photographs of specimen before test



#01 ~ #10

Photographs of specimen after test



Photo.09 – Photographs of specimen before & after External short circuit test (Undischarged cells)

Photographs



#11 ~ #20

Photographs of specimen before test



#11 ~ #20

Photographs of specimen after test



Photo.10 – Photographs of specimen before & after External short circuit test (Fully discharged cells)

Photographs



#21 ~ #25

Photographs of specimen before test



#21 ~ #25

Photographs of specimen after test



Photo.11 – Photographs of specimen before & after Impact test (Undischarged cells)

Photographs



#26 ~ #30

Photographs of specimen before test



#26 ~ #30

Photographs of specimen after test



Photo.12 – Photographs of specimen before & after Impact test (Fully discharged cells)

Photographs



#31 ~ #40

Photographs of specimen before test

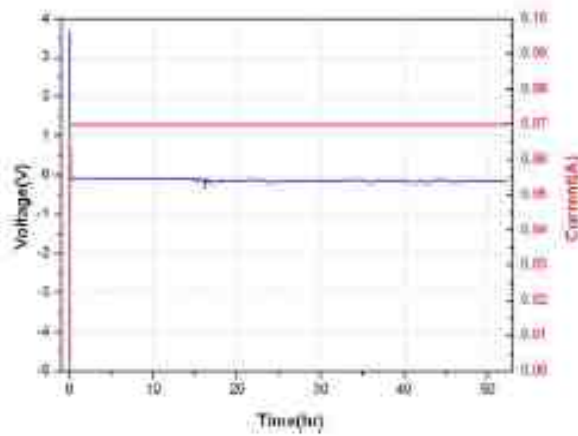


#31 ~ #40

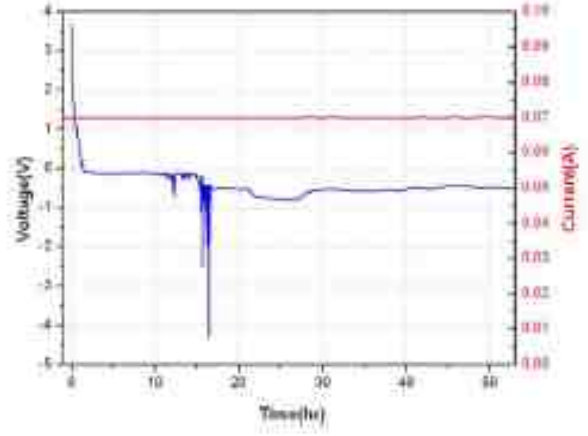
Photographs of specimen after test

Photo.13 – Photographs of specimen before & after Forced discharge test (Fully discharged cells)

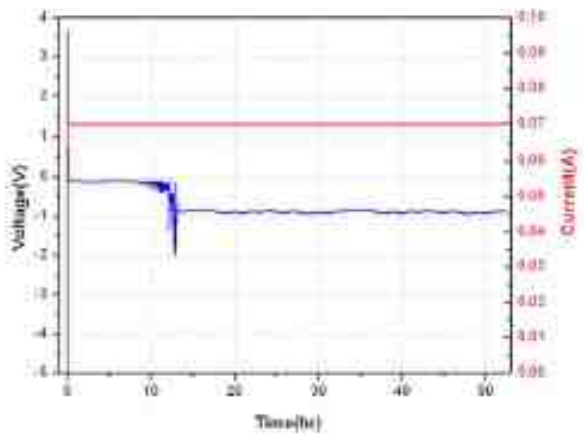
Discharge graph- Voltage and Current profile during Forced Discharge test(#31~#40)



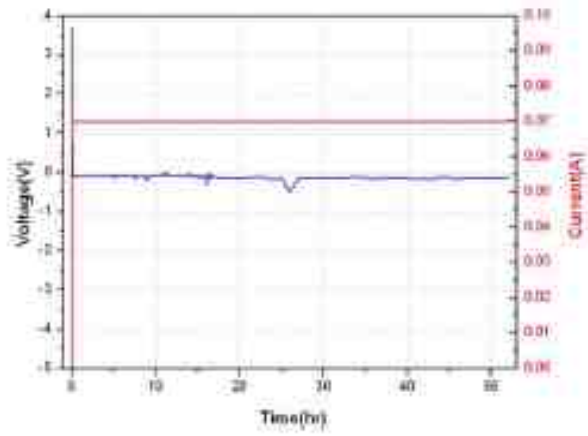
#31



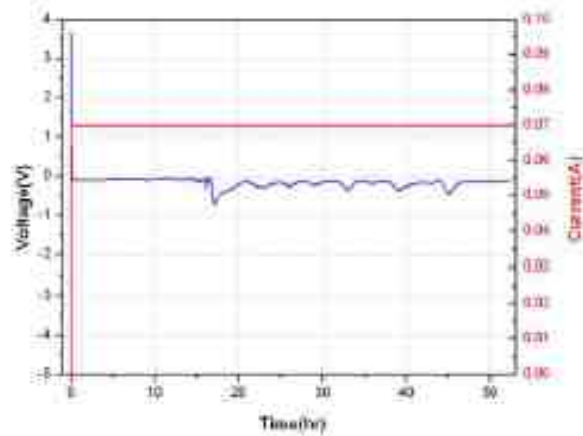
#32



#33



#34

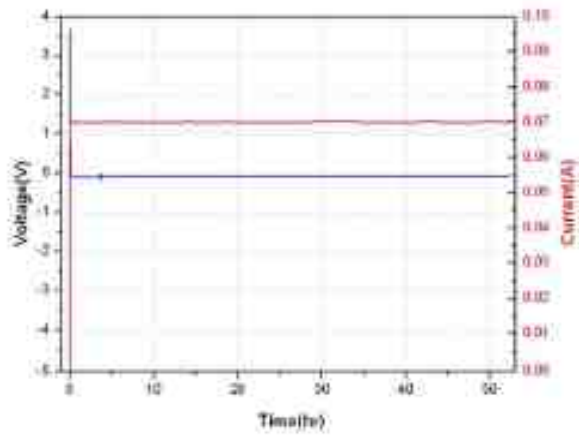


#35

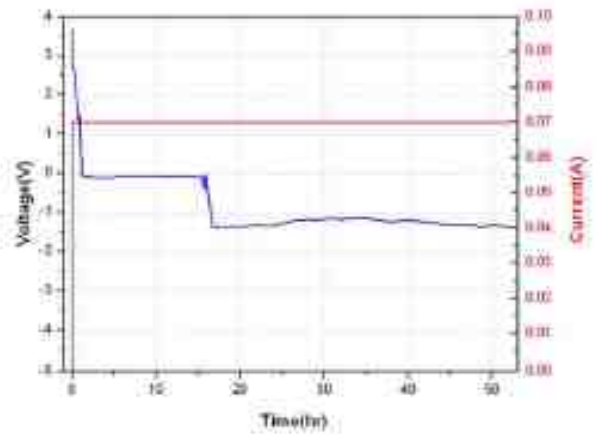
[Discharge condition : 70mA/52.2hr]

Photo.13 – Photographs of specimen before & after Forced discharge test (Fully discharged cells)

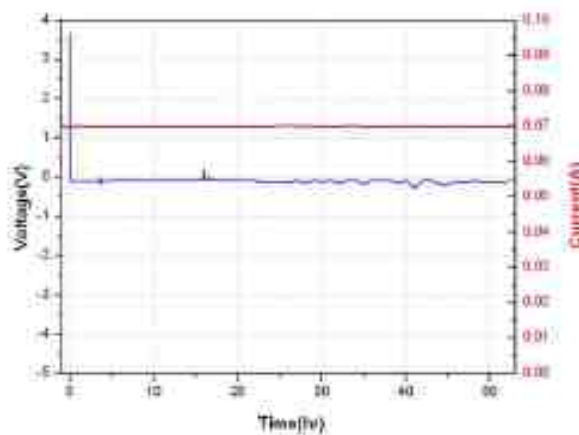
Discharge graph- Voltage and Current profile during Forced Discharge test(#31~#40)



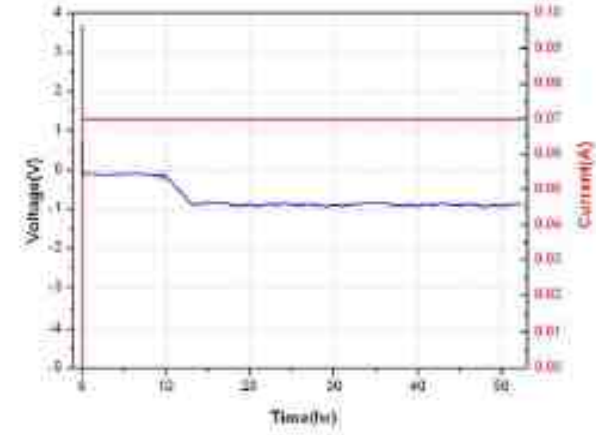
#36



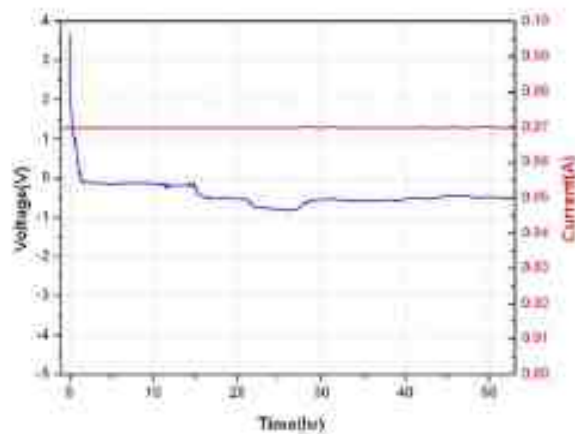
#37



#38



#39



#40

[Discharge condition : 70mA/52.2hr)

Photo.13 – Photographs of specimen before & after Forced discharge test (Fully discharged cells)