能元科技股份有限公司

E-One Moli Energy Corp.

Lithium-Ion Rechargeable Product Approval Sheet

Customer: _____.

Product: ☐ **Cell** ☐ **Pack**

Model: _____.

Document No: _____ **Revision:** _____.

Issue Date: _____.

E-One Moli Energy Corp:

	Sales/Marketing (Date)	**QA** (Date)	**R&D** (Date)	**Originator** (Date)

Customer Signature: _____.

TABLE OF CONTENTS

1. SCOPE

This specification defines the characteristics of a lithium ion rechargeable cell, ICP103450CA, 2.0Ah $LiPF_6$ cobalt cell, manufactured by E-One Moli Energy Corp.

2. SAFETY STANDARDS AND REGULATIONS

2.1 UL 1642: Standards for Safety Lithium Batteries.

2.2 IEC 61960-1: 1st Edition, International Electrotechnical Commission,
Secondary Lithium Cells and Batteries for Portable Applications, Part 1

2.3 UN ST/SG/AC. 10/11/Rev 3: Transportation of Dangerous Goods

3. APPLIED PRODUCT NAME AND PRODUCT DESIGNATION

3.1 Name

Lithium ion rechargeable cell, 103450 size, $LiPF_6$ electrolyte, $LiCoO_2$ (cobalt structure) cathode.

MOLI I C P 103450 C A

a b c d e f g

a Indicates the cell manufactured by E-ONE MOLI ENERGY CORP.

b Indicates the negative electrode system.

The letter 'I' defines the lithium ion system with an intercalation electrode.

c Indicates the positive electrode system.

The letter 'C' defines a cobalt-based electrode.

d Indicates the shape of cell.

The letter 'P' defines a prismatic shaped cell.

e Indicates the dimensions of cell.

First two numerical figures define the thickness (typically, cell thickness might be larger).

100=10.5mm

Following two numerical figures define the width.

34=34mm

Following two numerical figures define the overall height.

50=50mm

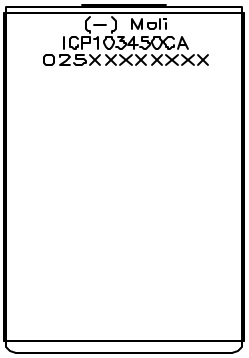
f Indicates the rated capacity of cell.

The letter 'C' defines the current product with 2.0 Ah rated capacity.

g Indicates the material of can.

The letter 'A' defines the material of can is aluminum.

3.2 Cell Marking



Legend:
(–): Indicating the negative polarity.
MOLI: Made by E-ONE MOLI Energy Corp.
ICP103450CA: Model number.
025: Product number.
xxxxxxxx: Cell lot number.

4. CONSTRUCTION

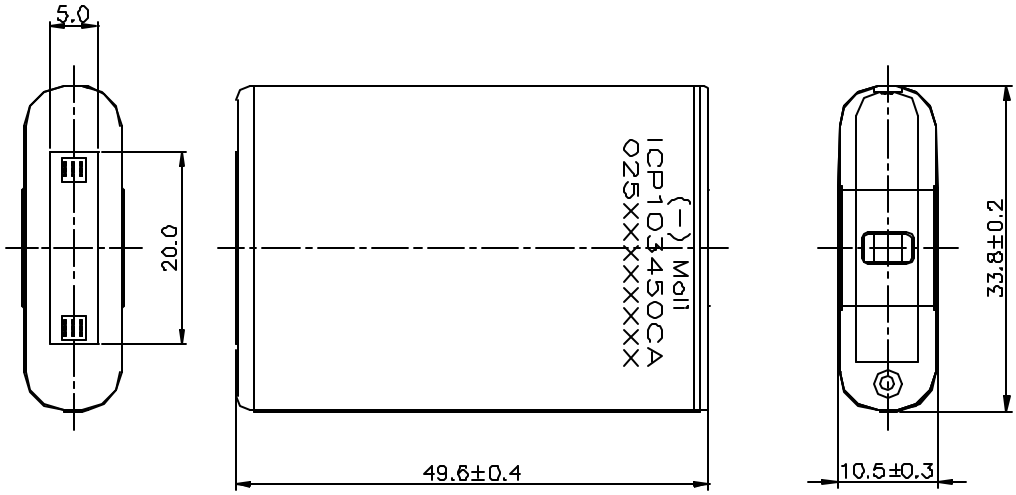
4.1 Shape: Prismatic

4.2 Dimensions:

Overall Height: 49.6 ± 0.4mm
Thickness (shipping state): 10.5 ± 0.3mm
Width: 33.8 ± 0.2mm

4.3 Weight: 41.5g (Max.)

4.4 Finished Cell Dimension (Labeled)



5. RATED SPECIFICATIONS

Definitions of items are described in accordance with IEC 61960-1, 1st Ed.

Items			Specifications		Remarks
1a	Rated charge		Limiting 1.9A and constant 4.2 ± 0.05V charge for 2.5h at 23 °C.		
1b	Recommended charge		Limiting 1.33A and constant 4.2 ± 0.05V charge for 3h at 23 °C.		
2	Rated discharge		Constant 0.38A discharge until 3.0V at 23 °C.		
3	Rated capacity		2.0 Ah (typical)		Rated discharge capacity after rated charge at cycle 2 of fresh cell.
			1.9Ah (minimum)		
4	Nominal voltage		3.70V		Mean voltage during rated discharge after rated charge.
5	Shipping voltage		3.80 ± 0.05V		Nominal. Approximate state of charge = 50%.
6	Internal resistance at shipping		35~70mΩ		By AC 1kHz within 3~4 hours after 50% charge.
7	End of charge voltage		4.20 ± 0.05V		
8	End of discharge voltage		3.0V		
9	Charging time		3h		Recommended charge.
10	Maximum continuous charging current		1.9A		Present UL approval level.
	Maximum continuous discharging current		< = 45 °C	2.5A	Maximum permitted discharge current to avoid activation of thermal fuse on the top of cell.
			< = 60 °C	2.0A	
11	Operating temperature	Charging	0~45 °C		
		Discharging	-20~60 °C		
12	Storage temperature		<35 °C		Recommended temperature for long term storage is 23 ± 2°C.
13	Shelf life		1 year		Typical value at 23 °C from ship state.
14	Cycle life @ 80%		500		0.2C rated discharge current at 23 °C.

6. SAFETY PROTECTION FUNCTIONS

6.1 Safety Valve

Relieve pressure in event of excessive internal build up.

6.2 Meltable Separator

Prevent thermal runaway due to external short.

6.3 Thermal fuse device

Not resettable, prevents sustained high current overcharge.

Prevents prolonged high current flow in the event of an external short circuit.

7. PERFORMANCE

7.1 Test Condition

7.1.1 The cells used in the tests are sampled after 3 to 7 days storage and are typically tested after 1 standard cycle.

7.1.2 All testing temperature is within ± 2 °C deviation in this specification and at a relative humidity between 45% and 85% except elsewhere noted.

7.1.3 Standard cycling, 1.33A charge and 1.9A discharge to 3.0V.

7.2 Performance

7.2.1 Electrical Performance

Items			Typical	Condition
1	Discharge capacity (Rate capability) at 23 °C	2.38A	1.80Ah	Discharge capacity to 3.0V after recommended charge.
		1.90A	1.83Ah	Discharge capacity to 3.0V after recommended charge.
		0.95A	1.90Ah	Discharge capacity to 3.0V after recommended charge.
		0.38A	2.00Ah	Discharge capacity to 3.0V after recommended charge.
2	Discharge capacity (Temp, capability) at 0.38A	60 °C	1.98Ah	Discharge capacity to 3.0V after recommended charge.
		45 °C	1.98Ah	Discharge capacity to 3.0V after recommended charge.
		0 °C	1.80Ah	Discharge capacity to 3.0V after recommended charge.
		-10 °C	1.70Ah	Discharge capacity to 3.0V after recommended charge.
		-20 °C	1.40Ah	Discharge capacity to 3.0V after recommended charge.
3	Energy density	Volumetric	403Wh/l	Calculated energy density based on the volume and weight specifications using 0.38A discharge to 3.0V at 23 °C after recommended charge.
		Gravimetric	178Wh/kg	

7.2.2 Storage Performance

Items			Typical	Conditions
		DOD		
1 Capacity retention	23 °C 30 days	0%	90%	Retained discharge capacity and energy after storage, expressed as a percentage of the "before storage" value, both at 0.38A. (Storage: after recommended charge, i.e. 0% depth of discharge)
	45 °C 30 days	0%	85%	
	60 °C 7 days	0%	87%	
2 Capacity recovery	23 °C 30 days	0%	97%	Recovered discharge capacity and energy after storage, expressed as a percentage of the "before storage" value, both at 0.38A. (Storage: after recommended charge then 0.38A discharge to stated depth of discharge)
		100%	99%	
	45 °C 30 days	0%	95%	
		100%	98%	
	60 °C 7 days	0%	95%	

7.2.3 Life

Item			Typical	Conditions
1 Cycle life	23°C 1.90A	C300	80%	1.90A discharge at 23°C on cycle 300 and 500. Ah capacity ratio to cycle 1 Ah capacity. (Cycling:1.33A charge, 1.90A discharge, at 23°C)
		C500	70%	
	23°C 0.95A	C300	80%	0.95A discharge at 23°C on cycle 300 and 500. Ah capacity ratio to cycle 1 Ah capacity. (Cycling: 1.33A charge, 0.95A discharge, at 23°C)
		C500	72%	
	23°C 0.38A	C300	85%	0.38A discharge at 23°C on cycle 300 and 500. Ah capacity ratio to cycle 1 Ah capacity. (Cycling: 1.33A charge, 0.38A discharge, at 23°C)
		C500	80%	
	45°C 1.90A	C300	75%	1.90A discharge at 45°C on cycle 300 and 500. Ah capacity ratio to cycle 1 Ah capacity. (Cycling: 1.33A charge, 1.90A discharge, at 45°C)
		C500	60%	

7.2.4 Quick Reference Guide: Typical Capacity of Fresh Cells

Discharge Temperature (°C)	Capacity (Ah) at various discharge rates			
	0.38A	0.95A	1.90A	2.38A
-20	1.40	1.15	N/A	N/A
-10	1.70	1.50	N/A	N/A
0	1.80	1.70	1.30	1.28
23	2.00	1.90	1.83	1.80
45	1.98	1.92	1.90	1.88
60	1.98	1.92	1.90	1.88

7.2.5 Safety Performance

1) Environmental Endurance Performance

	Items	Criteria	Conditions
1	-40 °C, 85 °C temperature cycle	Weight loss<20mg, average of 5 samples Weight loss<30mg, individually No fire or explosion	Weight loss after storage. (Storage: -40 °C dwell for 1h, 1h ramp to 85 °C, 85 °C dwell for 1h, 1h ramp to -40 °C. Repeat cycle 30 times.)
2	Heating 150 °C	No fire or explosion Maximum temperature<180 °C	Per UL 1642 standard.

2) Electrical Endurance Performance

	Items	Criteria	Conditions
1	Short circuit @23 °C	No fire or explosion Temp. <150 °C	External circuit impedance is <100mΩ.
2	Forced discharge	No fire or explosion	Discharge at a current of 1.9A for 2.5h.
3	Overcharge	No fire or explosion	Charging at a current of 3.5A to 4.55V from the fully discharged state for 24hrs.

3) Mechanical Endurance Performance

	Items	Criteria	Conditions
1	Crush	No fire or explosion	Crush between two flat plates on the flat surface of the cell. Applied force is about 13KN.
2	Impact	No fire or explosion	Impact by 15.8mmφ bar 9.1kg weight dropped from 61cm height on the flat surface.
3	4ft drop proof	ΔOCV loss<10% ΔACR<120mΩ No visible electrolyte leakage, no temperature rising.	Drop from a height of 4 ft onto a wooden floor 3 times for each side of the cell.(total number of drops=18)
4	Vibration proof	No leakage, weight loss, distortion or out gassing	Subject to 10~55Hz vibration at an amplitude of 1.6mm for two axes. Rate of charge of vibration: 1Hz/minute.

8. REGULATORY COMPLIANCE

8.1 UL 1642 recognized component.

8.2 Complies with UN amendments to the third revised edition of the recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria.

9. PRECAUTIONS FOR USIN G LITHIUM ION RECHARGEABLE CELL

The lithium ion rechargeable cell with high power and long life has played a significant role in the rising popularity of portable electronic products such as notebook PC, cellular phone, personal digital assistant, camcorder, etc. E-One Moli Energy Corporation, a pioneer in lithium ion cell development and manufacturing in Taiwan, is capable of providing lithium ion cells with absolute safety, small size, high power, and long life. The precautions described below are important to assure the achievements of designed performance and safety.

9.1 Handling Precautions

9.1.1 Charging

The lithium ion rechargeable cell is to be charged by "constant current/constant voltage" method. The lithium ion cell is charged at a constant current (CC Mode) until the cell voltage reaches 4.2 V, followed by a constant voltage charge (CV Mode) at 4.2 V. The charging current at this constant voltage tapers off. As long as the tapering current is down to 2% of 1C rate current or the charging time at CV Mode reaches 2.5 hours (whichever comes first); the charge process is terminated.

1) Charge voltage:

Do not exceed the specified charge voltage (4.2V per single cell). If the cells are used in cell packs, the maximum voltage is 4.2 x N (N= number of cells connected in series) V.

2) Charge current:

Charge the cell at the specified charge current 1.0CmA or less.

3) Charge temperature:

Charge the cell at the temperature range of 0°C ~ 45 °C. Due consideration should also be given to the arrangement of the cell pack so that it is in that temperature range even though it is effected by heat generated in the cell charger.

9.1.2 Reverse charging:

The cell must be prevented from the reverse-polarity charging.

9.1.3 Discharging

A lithium ion rechargeable cell starts to discharge at 4.2V and terminates at a cut off voltage of 3.0V.

1) Discharge current:

Discharge the cell at the specified discharge current 1.90A or less. In the case of a pulse discharge, set the average current to 1.0CmA or less. A peak current of higher than 2A depending on the pulse interval may reduce the cell capacity.

2) Discharge temperature:

Discharge the cell at temperature range from –20°C to 60°C. At a temperature of –20°C or less, the cell will show a significant decrease in discharge capacity.

3) Discharge termination voltage/Over discharge:

Avoid discharge to voltage less than 3.0V per single cell. A leak current to the equipment may over discharge the cell, which may damage the performance of cell.

9.1.4 Long-term Storage

1) In case of long-term storage, store the cell at temperature range of -20~+35 °C, low humidity, no corrosive gas atmosphere.
2) When storing the cell for a long period longer than one year, charge it at least once a year. And in this case, the cell is recommended to be charged to 50% SOC.
3) No condensation on the cell.

9.2 Safety Precautions

9.2.1 When using the cell

ⓘ WARNING

1) Mistreatment of a cell may cause the cell to generate heat, explode, or ignite and cause serious injury. Be sure to follow the safety rules as follows:
   (1) Do not solder directly onto the cell.
   (2) Do not place the cell in fire or heat the cell.
   (3) Do not install the cell backwards so that the polarity is reversed.
   (4) Do not expose the cell to water or salt water, or allow the cell to get wet.
   (5) Do not carry or store the cells together with necklaces, hairpins or other metal objects.
   (6) Do not place the cells in microwave ovens, high-pressure containers, or on induction cookware.
   (7) Do not connect the positive terminal and the negative terminal of the cell to each other with any metal objects such as chains, coins or wire.
   (8) Do not pierce the cell with nails, strike the cell with a hammer, step on the cell, or otherwise subject it to strong impacts or shocks.
2) Do not disassemble or modify the cell. The cell contains safety and protection devices, if damaged, may cause the cell to generate heat, explode or ignite.
3) Do not place the cell in or near fire, stoves, or other high-temperature locations. Do not place the cell in direct sunshine, or use or store the cell inside cars in hot weather. Doing so may cause the cell to generate heat, explode, or ignite. Using the cell in this manner may also result in a loss of performance and a shortened life expectancy.

ⓘ CAUTION

4) If the device is to be used by small children, the caregiver should explain the contents of the user's manual to the children. The caregiver should provide adequate supervision to

ensure that the device is being used as explained in the user 's manual.

5) When the cell is worn out, insulate the terminals with adhesive tape or similar materials before disposal.
6) Immediately discontinue use of the cell if, while using, charging, or storing the cell, the cell emits an unusual smell, feels hot, changes color, changes shape, or appears abnormal in any other way. Contact your sales location or E-One Moli Energy if any of these problems are observed.
7) In the event that the cell leaks and the fluid gets into one's eye, do not rub the eye. Rinses well with water and immediately seek medical care. If left untreated the cell fluid could cause damage to the eye.

9.2.2 When charging the cell

ⓘ WARNING

1) Be sure to follow the rules listed below while charging the cell. Failure to do so may cause the cell to become hot, explode, or ignite and cause serious injury.
   (1) Do not attach the cells to a power supply plug or directly to a car's cigarette plug.
   (2) When charging the cell, either use a specified cell charger or otherwise ensure that the cell charging conditions specified by E-One Moli Energy are met.
   (3) Do not place the cells in or near fire, or into direct sunlight. When the cell becomes hot, the built in safety equipment is activated, preventing the cell from charging further, and heating the cell can destroy the safety equipment and can cause additional heating, breaking, or ignition of the cell.
2) Do not continue charging the cell if it does not recharge within the specified charging time. Doing so may cause the cell to become hot, explode, or ignite.

ⓘ CAUTION

3) The temperature range over which the cell can be charged is 0 °C to 45 °C. Charging the cell at temperatures outside of this range may cause the cell to become hot or to break. Charging the cell outside of this temperature range may also harm the performance of the cell or reduce the cell's life expectancy.

9.2.3 When Discharging the Cell

ⓘ WARNING

1) Do not discharge the cell using any device except for the specified device. When the cell is used in devices aside from the specified device it may damage the performance of the cell or reduce its life expectancy, and if the device causes an abnormal current to flow, it may cause the cell to become hot, explode, or ignite and cause serious injury.

ⓘ **CAUTION**

2) The temperature range over which the cell can be discharged is –20°C to 60°C (Consult E-One Moli Energy if you plan to discharge the cells at temperature less than –10 °C). Use of the cell outside of this temperature range may damage the performance of the cell or may reduce its life expectancy.

Please note

E-One Moli Energy recommends that cells be assembled in a pack with protection circuit. Various protection circuit modules are available for applications of multiple series and parallel configurations. For multi-cell application, the over-current protective devices (PTC or thermal fuse) is NEEDED on each cell or between cells connected in parallel. In order to ensure safe use of cell, be sure to consult with E-One Moli Energy regarding charging and discharging specifications and contact E-One Moli Energy in advance when designing a device with this cell.

10. WARRANTY OF CELL

Warranty period is one year after factory delivery under normal conditions.

11. SHIPPING STATE OF CELL

The capacity of delivery cell is approximately at 50% of charging.

12. PACKING SPECIFICATION

The maximum quantity of the cells in a master carton is 150pcs.

13. AMENDMENT OF SPECIFICATION CONTENT

It is necessary to have mutual discussion before making any change of the specification.

Fig. 1. Charge Characteristics for ICP103450CA Cell.

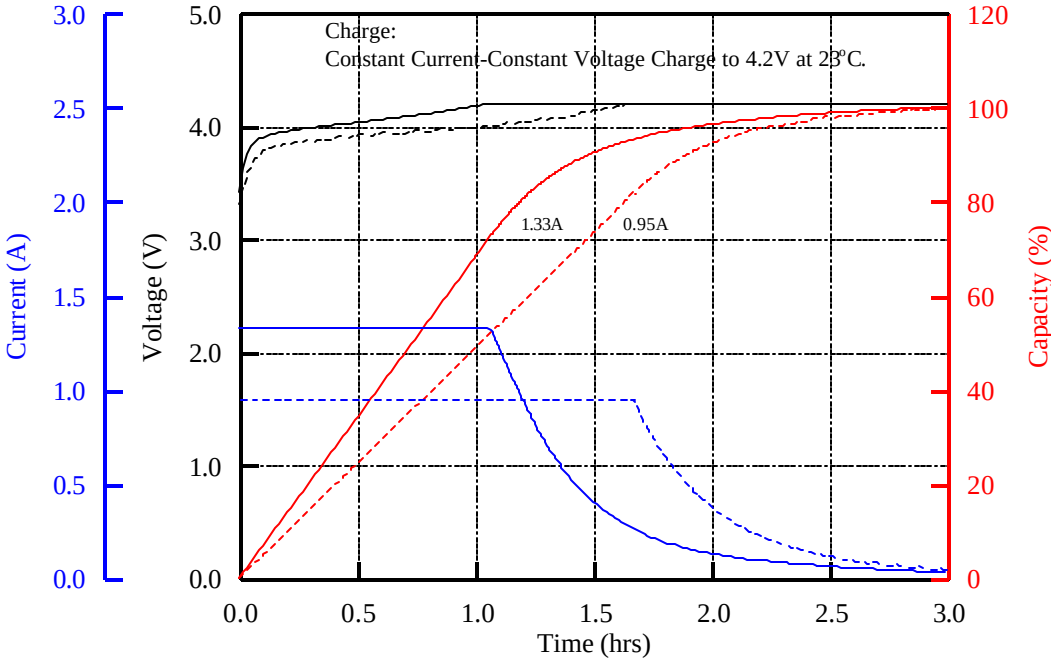


Fig. 2. Discharge Characteristics for ICP103450CA Cell.

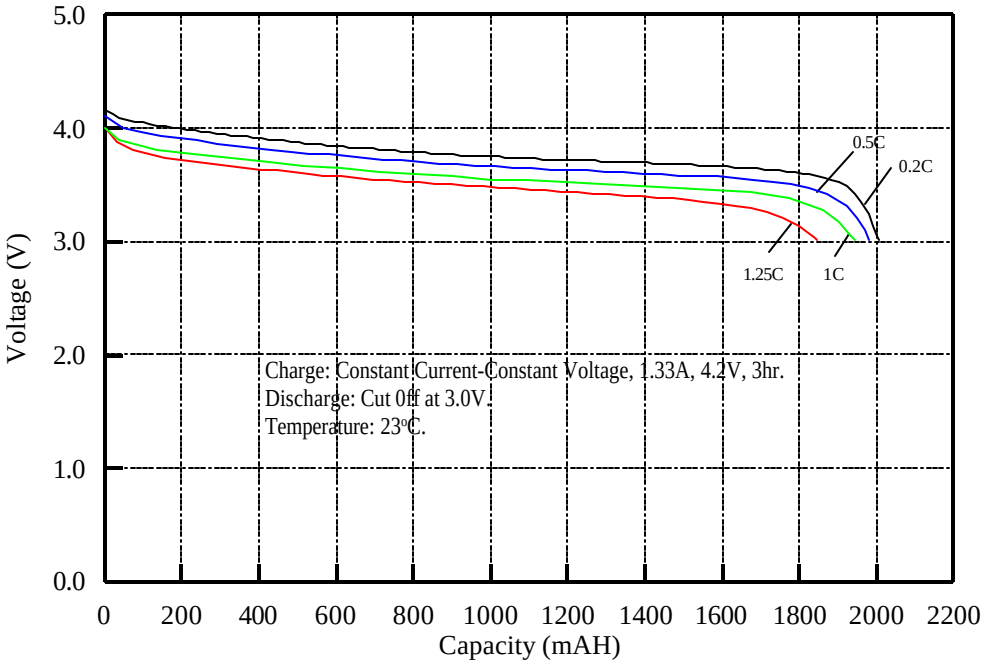


Fig. 3. Discharge Characteristics for ICP103450CA Cell.

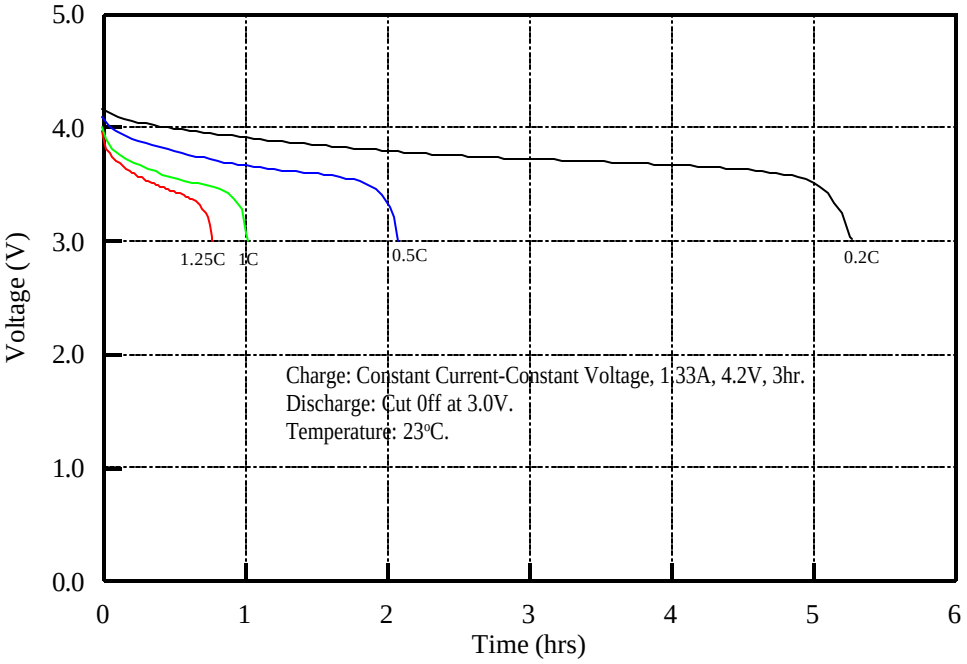


Fig. 4. Discharge Temperature Characteristics for ICP103450CA Cell.

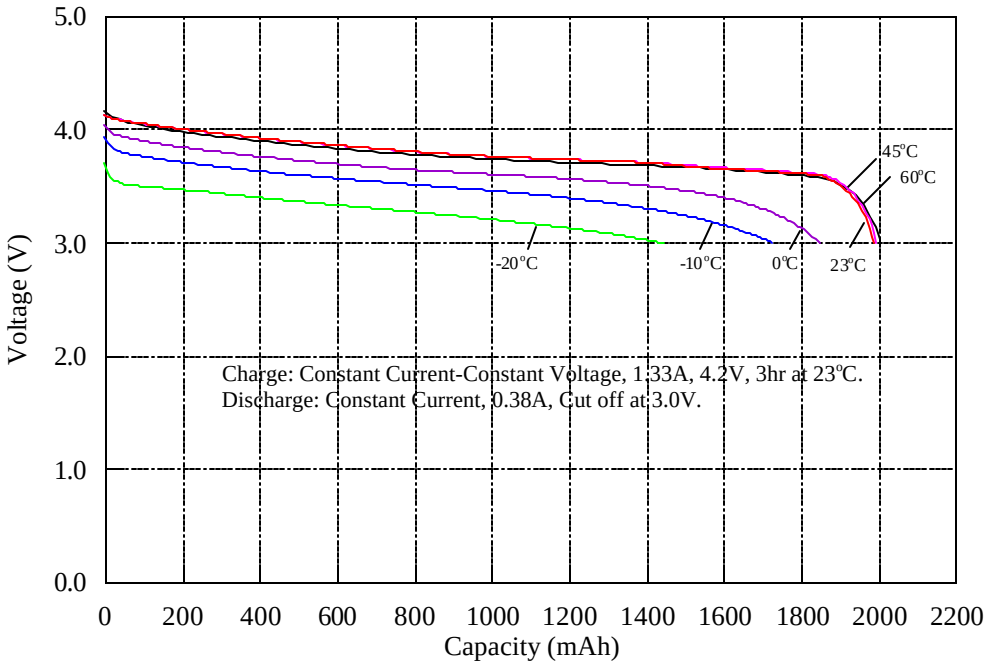


Fig. 5. Discharge Temperature Characteristics for ICP103450CA Cell.

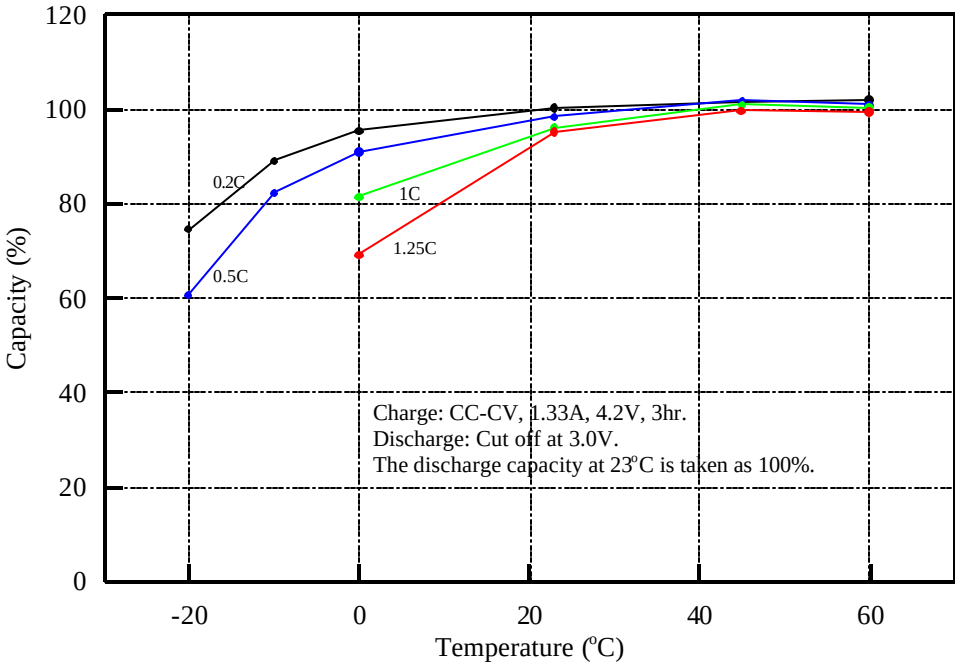


Fig. 6. Cycle Life Characteristics for ICP103450CA Cell at 23°C

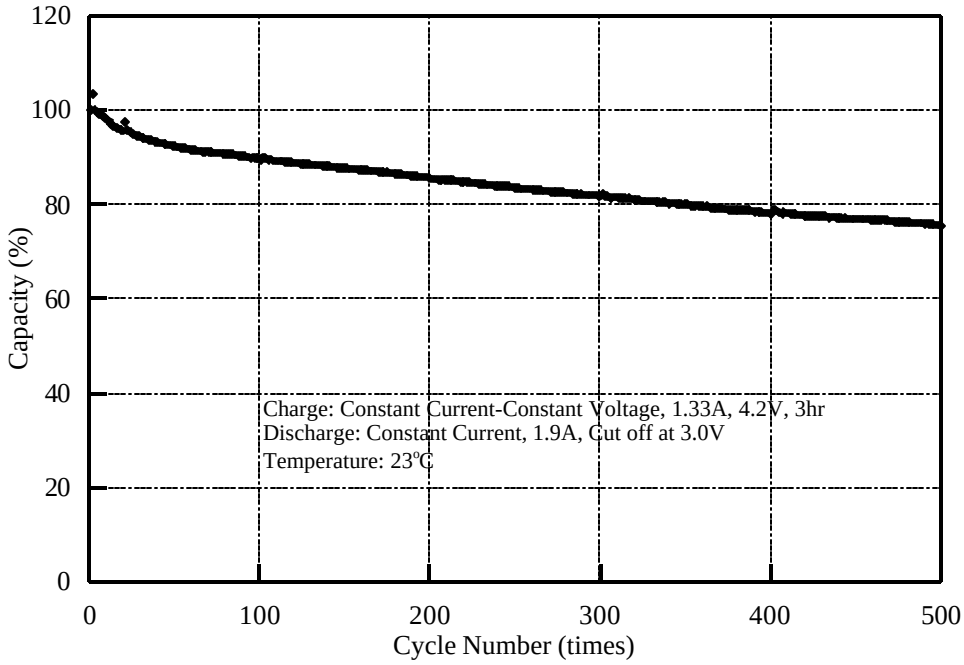


Fig. 7. Cycle Life Characteristics for ICP103450CA Cell at 45°C