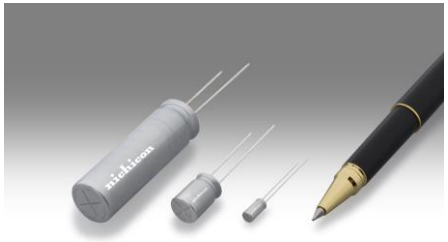
Small Lithium Ion Rechargeable Battery

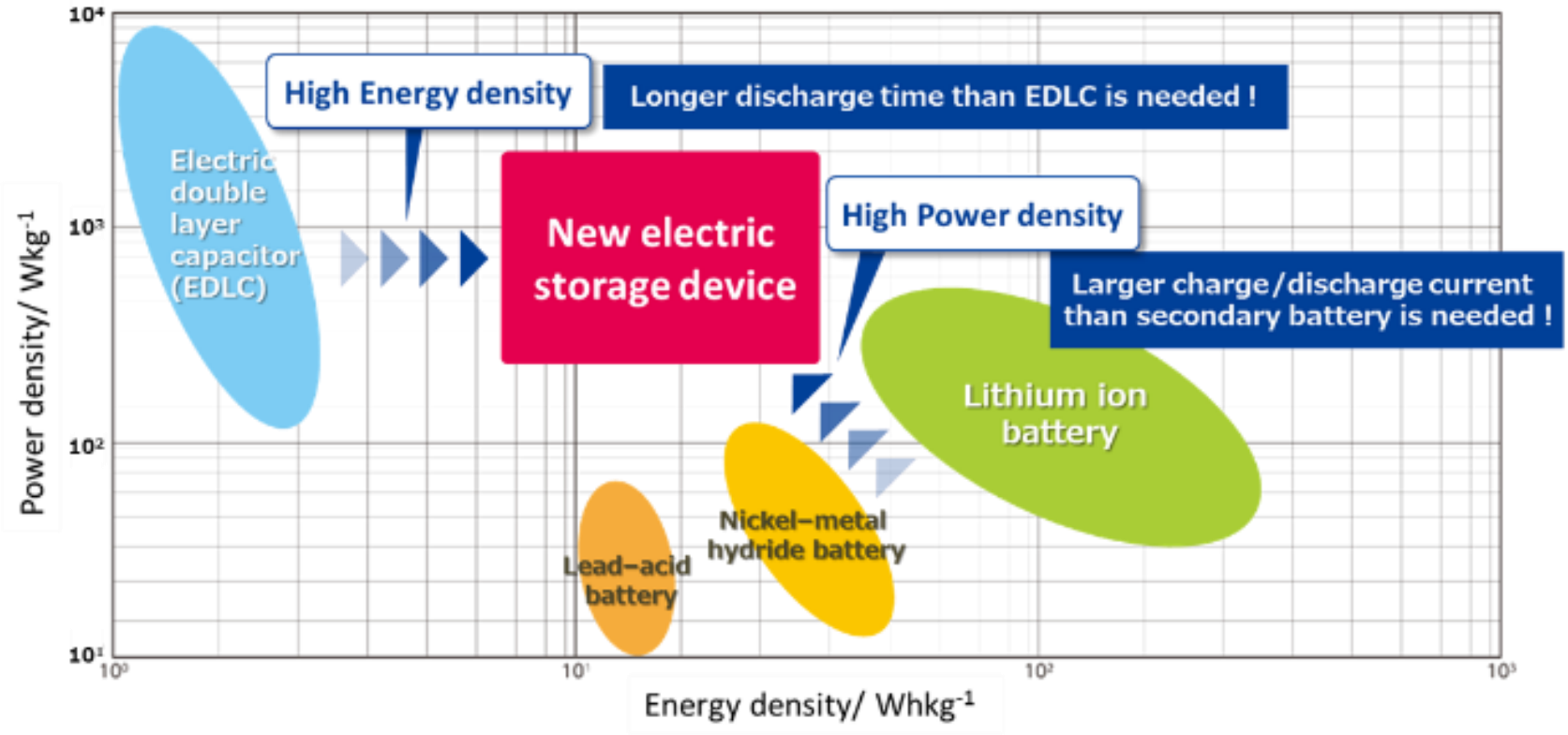
nichicon

June 2020

Nichicon's Small Lithium Ion Rechargeable Battery

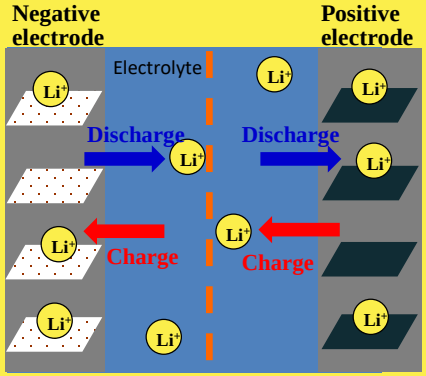
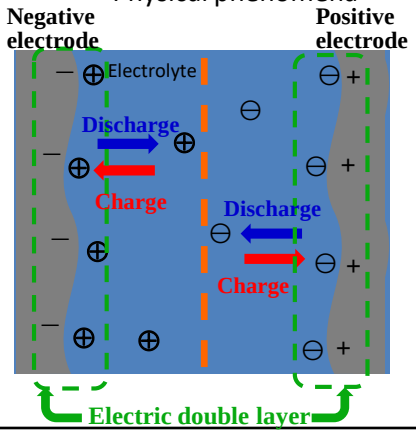
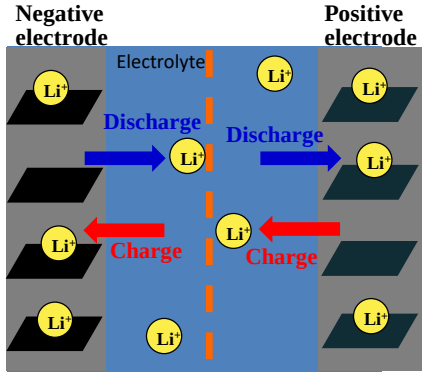


Development background



Electric storage device having high output and large capacity is demanded.

Difference of Electric storage devices

Name	Small Lithium Ion Rechargeable Battery	Electric double layer capacitor	Lithium ion battery
mechanism	Chemical reaction 	Physical phenomena 	Chemical reaction 
Voltage	To 2.8V	To 2.7V	To 4V
Energy density	To 40Wh/kg Advantage over EDLC	To 7Wh/kg	To 300Wh/kg
Power density	3kW/kg Advantage over battery	To 10kW/kg	To 1kW/kg
Operating temperature range	−30 to +60℃ Advantage over battery	−40 to +85℃	−20 to +60℃
Cycle life	25,000 times over Advantage over battery	1,000,000 times over	To 3,000 times
Discharge range	There is a lower limit voltage	Discharge to 0 V	There is a lower limit voltage
Safety	No rupture or ignition Advantage over battery	No rupture or ignition	Rupture or ignition
Merit	High power, Long life, safety	High power, Long life, safety	High energy density
Demerit	Low energy density	Low energy density	Short life time

New electric storage device have long life and excellent safety.

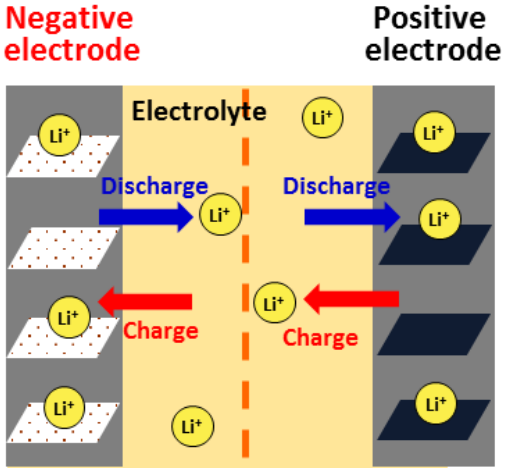
Special “Negative electrode” of Small Lithium Ion Rechargeable Battery

What is the difference between
“Small Lithium Ion Rechargeable Battery” and “Conventional Lithium Ion Rechargeable Battery” ?

→ **Negative electrode**

Negative electrode : Conventional Lithium Ion Rechargeable Battery → Small Lithium Ion Rechargeable Battery

LiC_6 → **LTO**



Advantages of LTO (Lithium Titanate):

- Material with thermal stability that does not burn.
- Low reactivity with electrolyte → Low heat generation
- Material with low electron conductivity
  → Only little current and heat will generate when short occurs between positive and negative electrode
  Only a small current and heat are generated.

High safety and reliability

Specifications of Small Lithium Ion Rechargeable Battery

■ Features ・・・ Cylindrical compact storage device with high power and long life

Specification	
Rated voltage	2.4V
Maximum charge voltage	2.8V
Discharge cutoff voltage	1.8V
Operating temperature range	-30 to 60°C

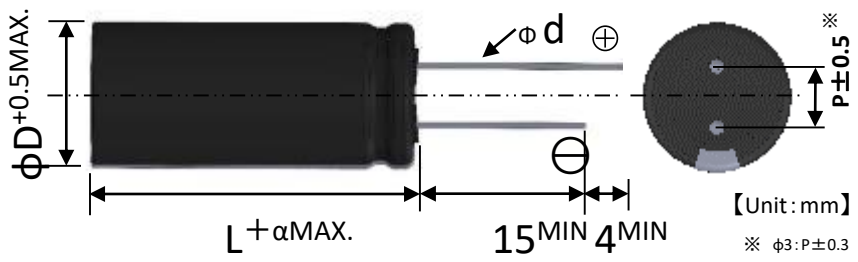
Size (Lead type)	Capacity (mAh)	Energy density(Wh/L)	Weight (g)
Φ3 × 7L	0.35	17	0.2
Φ8 × 11.5L	14	58	1.5
Φ12.5 × 40L	150	73	9.2

*ϕ4x25.5L(5mAh),ϕ8x20L(25mAh), ϕ10x31.5L(60mAh) is under consideration.

※When compared with EDLC Please use 1mAh ≒ 10F

■ Drawing

Lead type



ϕD	3	4	8	10	12.5
P	1.0	1.5	3.5	5.0	5.0

ϕD	3	4	8	10	12.5
ϕd	0.4	0.45	0.6	0.8	0.8

ϕD	3	4	8	10	12.5
α	1	1.5	1.5	2.0	2.0

Main Advantages

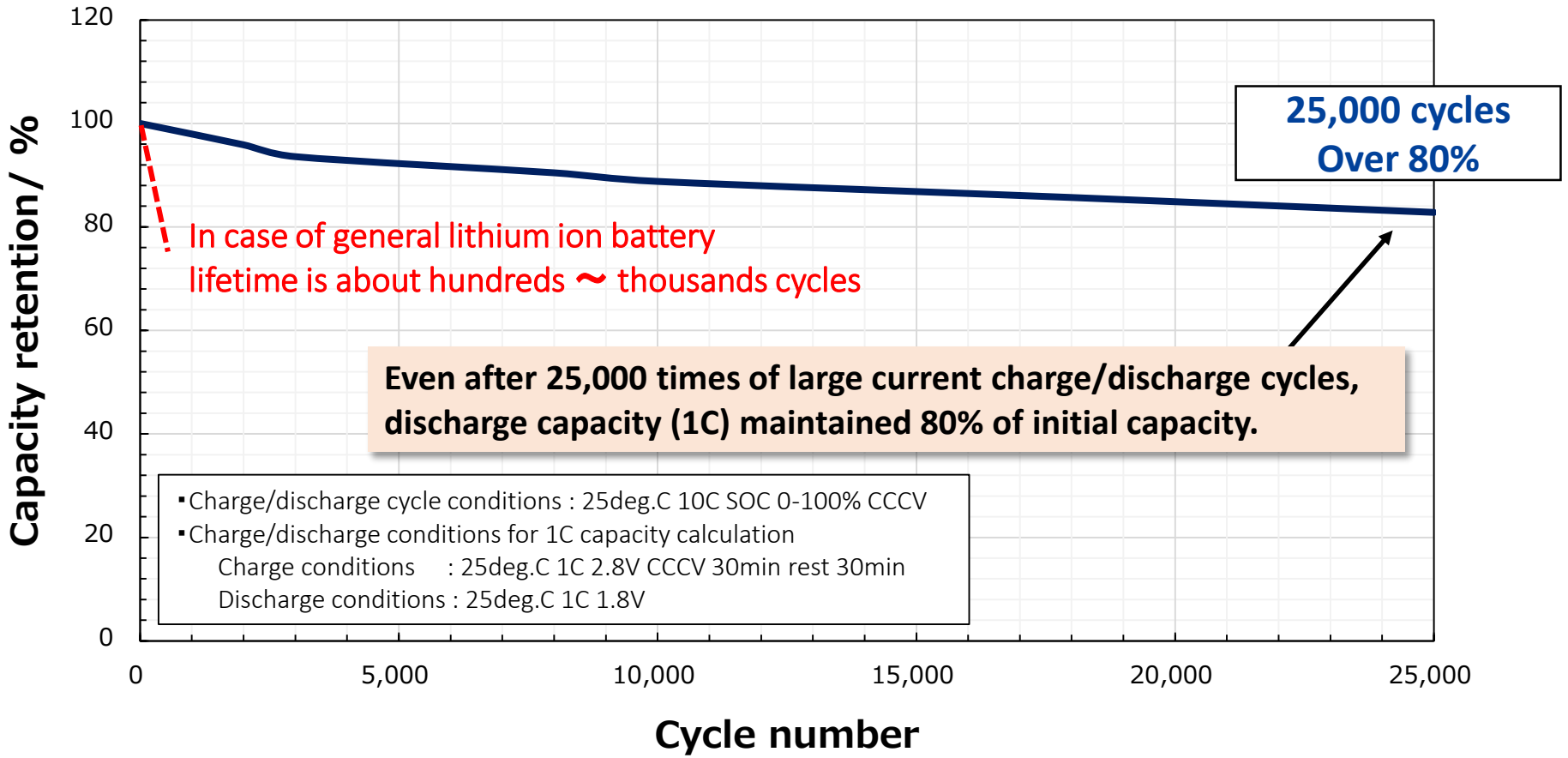
1	Long life	Over 25,000 cycles life time
2	Rapid Charge/discharge	Charge/discharge at large current rate (20C Max.)
3	Low-temperature operation	Can be used at temperatures as low as -30deg.C
4	Safety	Uses highly safe lithium titanium oxide (LTO)

Cycle characteristics

1 **Long life：Over 80% of the capacity is maintained after 25,000 cycles of charge/discharge.**

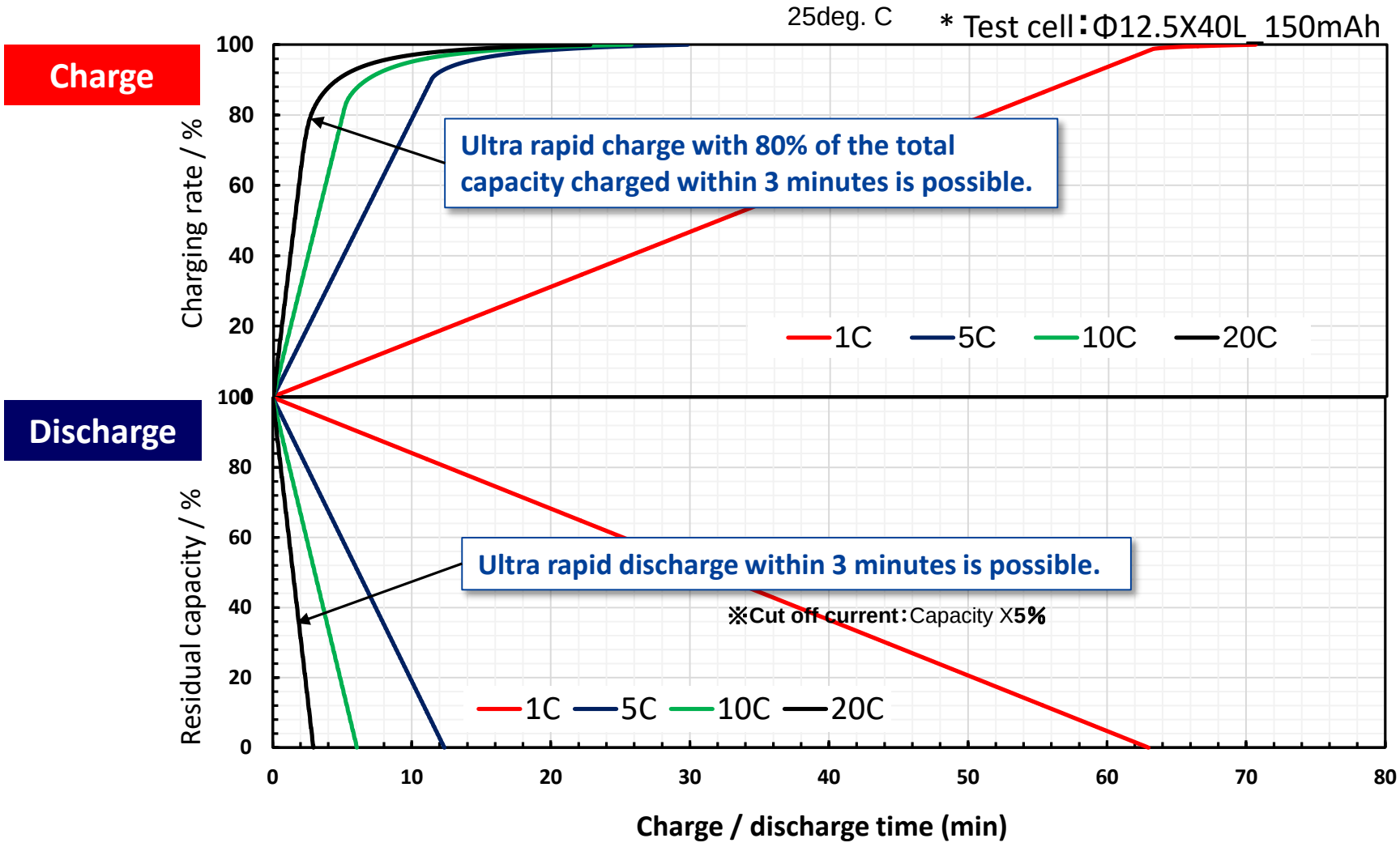
1C discharge capacitance change in 10C rate charge/discharge cycle

*** Test cell：Φ12.5X40L_150mAh**



Charge/discharge characteristics

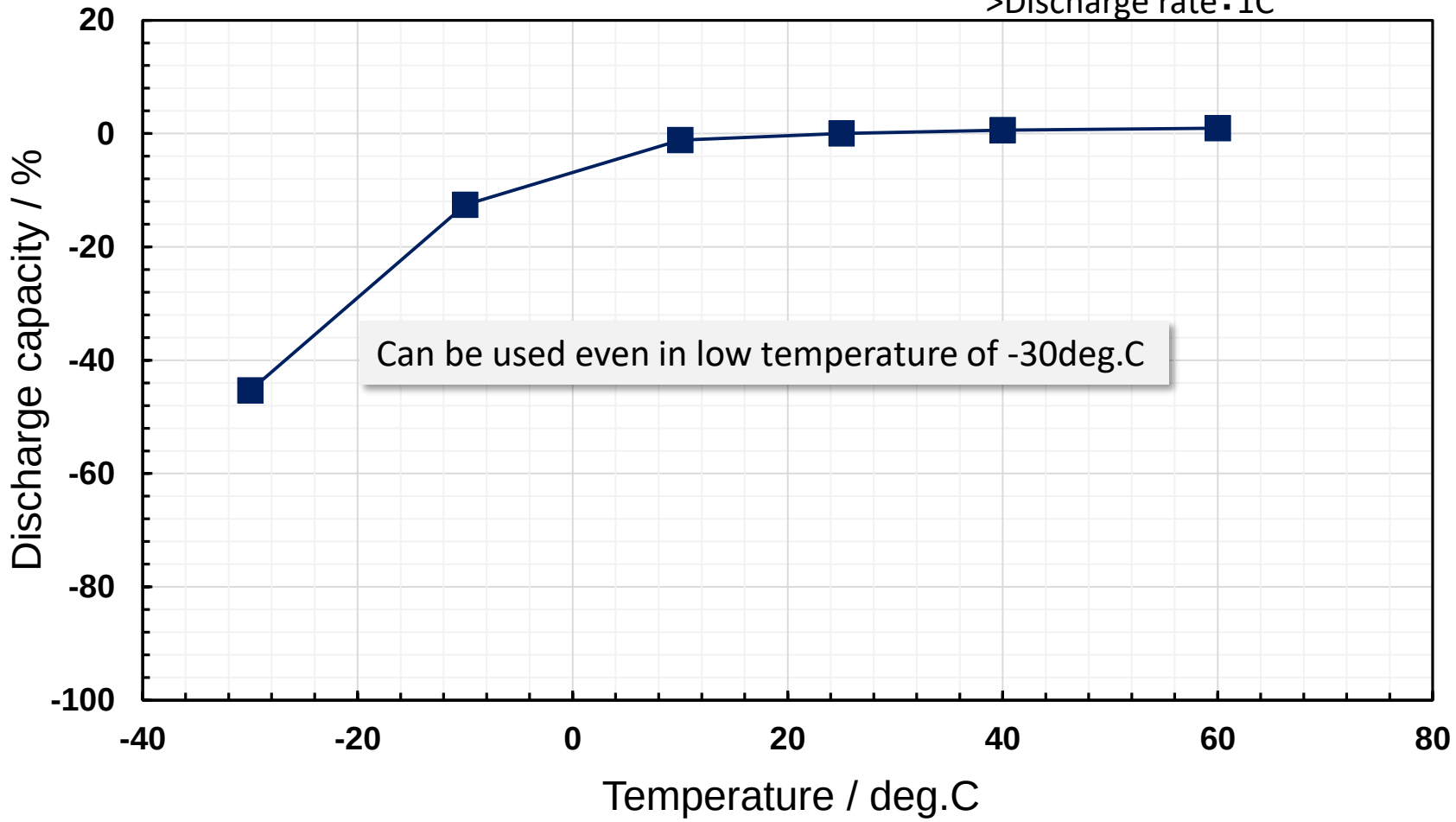
2 Rapid charge/discharge is possible：Power density similar to EDLC.



Temperature characteristics

3 Low-temperature operation：Can be used at low temperatures (-30deg.C)

>Test cell：Φ12.5X40L_150mAh
>Discharge rate：1C



Safety

4 Safety: There is a very low risk of fire or explosion from internal short circuit.

No.	Test Item	Judgement Criteria	Result
1	Crushing by pressure	No Rupture or ignition	No Rupture or ignition
2	Nail penetration test	No Rupture or ignition	No Rupture or ignition
3	Blunt Nail Test	No Rupture or ignition	No Rupture or ignition
4	External short circuit	No Rupture or ignition	No Rupture or ignition
5	Over charge	No Rupture or ignition	No Rupture or ignition
6	Forced discharge	No Rupture or ignition	No Rupture or ignition

Lithium ion Rechargeable battery

There is a device with very low risk of fire or explosion and high safety.

Safe

Crushing by pressure

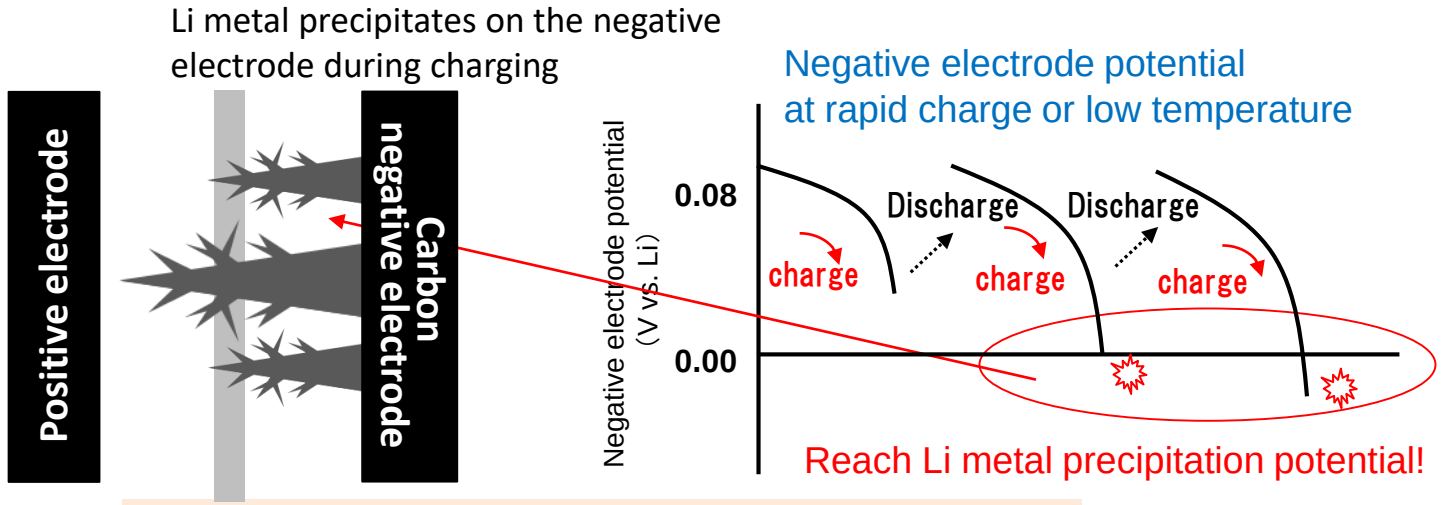
Nail penetration

High safety due to materials used

Materials / Technology	This development product	Conventional LIB
Negative electrode material	**LTO** (using incombustible materials) → Thermally stable	**Carbon material** (Graphite)
Internal short circuit current	**Small** (When short-circuited, the resistance of the LTO surface is increased due to phase change)	**Large**
Li metal deposition	**None** (During fast charge, low temperature, It does not reach the Li deposition potential even in the long cycle)	**Occur** (During fast charge, low temperature, the Li deposition potential is reached at long cycle)

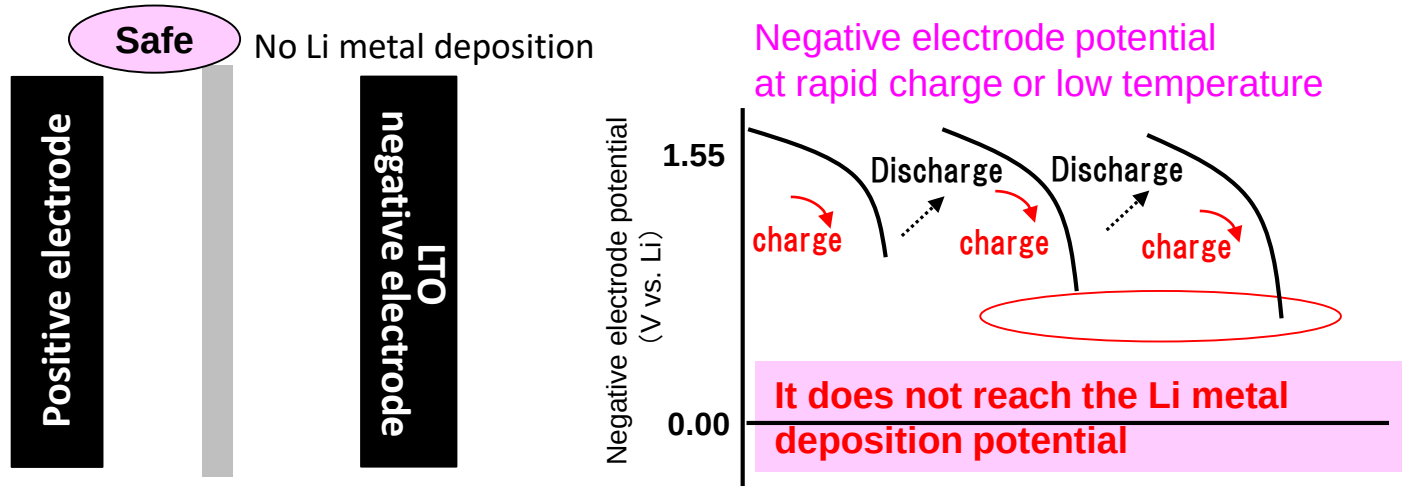
No short circuit due to lithium deposition

In case of general LIB



In addition to breakage of separator during charging, short circuit due to Li metal deposition may occur.

In case of this new product



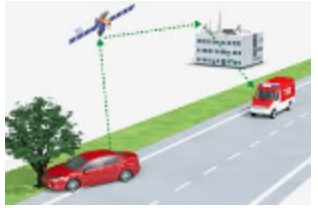
Target Market

■ Target product of new electric storage device

Stylus pen

Wireless earphone

Drive recorder



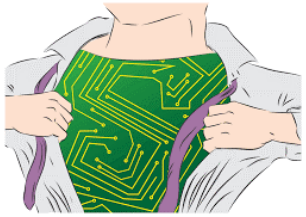
Automotive auxiliary power supply
（EPS , Door unlock , E-call , ADAS etc)

Rechargeable toy

Electric tool

Electronic Cigarette

IoT device
（Fixed point observation ,
Condition monitoring）



Wearable terminal

Smart meter

Memory backup
(Home appliances,
industrial machines etc.)

Notebook PC
(CMOS backup)

Remote
controller

Handling of Small Lithium-ion Secondary Batteries

- Hazardous
  - Since chemical components are sealed in a new electric storage device, the hazards are extremely low.
  - However, if you mistakenly use it, the new electric storage device may cause deformation, leakage, rupture, heat generation, or irritating gas or corrosive gas, so please be extremely careful in handling.

- Stability and reactivity
  - When two or more devices are randomly mixed without insulation treatment on the terminals, there is a possibility of bursting and rapid heat generation by short-circuiting.
  - When overcharged, heated, or dropped in a fire, electrolyte or other substances may burst out rapidly.
  - When disassembling the device, there is a possibility of rapid heat generation due to a short circuit.

Handling precautions and Conditions

- **Do not short circuit the battery**
  Overheating of the cell may cause leakage, overheating, or explosion.
- **Do not apply current via reversed polarity**
  An abnormal reaction may occur internally, causing leakage, overheating, or explosion.
- **Do not apply physical load.**
  If excessive force is applied, the parts will be damaged, causing electric shock, short circuit, or liquid leakage.
- **Do not conduct the tests listed below**
  Overcharge test, overdischarge test, nail penetration test, crushing test, drop test, chemical resistance test, high temperature exposure test.

Treatment when electrolyte leaks

The electrolyte is flammable and is a liquid with irritation to the eyes, skin and mucosa. If leakage occurs, please take below measures.

- **When adhering to the skin**
  Immediately wash the adhering part with water or tepid water by using soap. If there is a change in your skin or pain continues, please consult your doctor immediately.
- **When gets into eyes**
  Wash your eye with clean water for 15 minutes and submit to medical treatment.
- **Smoke or fire**
  Please extinguish with carbon dioxide, powder fire extinguisher, or a lot of water.

Storage of Small Lithium-ion Secondary Batteries

○ Storage condition

・Please do not let the terminals contact with each other or contact with the conductors.

・Please avoid storage under the following circumstances.

(a) Being exposed to water, high temperature & high humidity atmosphere, or condensation of moisture.

(b) Being exposed to oil or an atmosphere that is filled with particles of oil.

(c) Being exposed to salty water or an atmosphere that is filled with particles of salt.

(d) In an atmosphere filled with toxic gasses (such as hydrogen sulfide, sulfurous acid, nitrous acid , chlorine, bromine, methyl bromide, ammonia, etc.)

(e) Being exposed to direct sunlight, ozone , ultraviolet ray, or radiation.

(f) Being exposed to acidic or alkaline solutions

・Long term storage performance is being confirmed.

nichicon

SINCE1950