FUJIFILM
Value from Innovation

Wako

Battery Materials

Rechargeable Battery Reagents

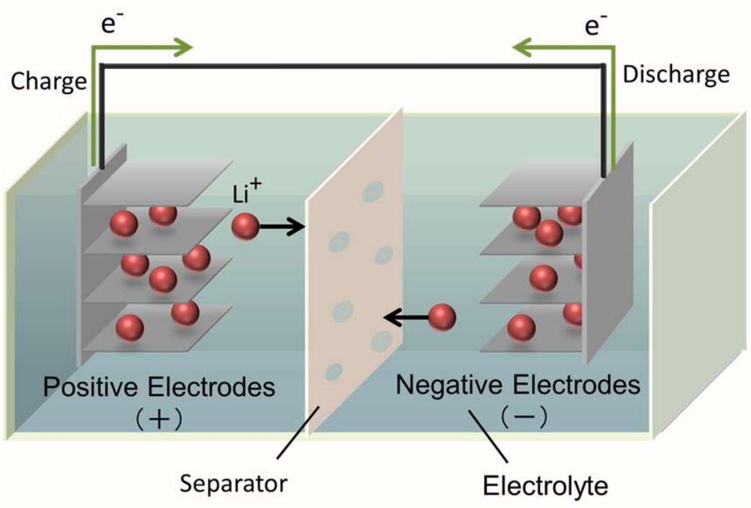
Class of Reagents

- Lithium-Ion Battery
  - Toshima Manufacturing, Ltd., Materials of Lithium-Ion Batteries
  - SHINSHU VOLTA CO., LTD., Materials of Lithium-Ion Batteries
- Magnesium-Ion Battery
- Sodium-Ion Battery
- Ionic Liquids etc.

Contents

Lithium-Ion Battery

Lithium-ion batteries are used in a wide range of products due to their high energy density and voltage. Because of the development of electric vehicles and mobile devices, the demand for high-capacity, high-voltage, and safe secondary batteries is growing. FUJIFILM Wako deals with various materials that constitute lithium-ion batteries.



Positive Electrodes(+)

(Discharge) (Charge)

$$Li_{1-x}CoO_2 + xLi^+ + xe^- \rightleftarrows LiCoO_2$$

Negative Electrodes(−)

(Discharge) (Charge)

$$Lix6C \rightleftarrows 6C + xLi^+ + xe^-$$

Mechanism of the LIB system

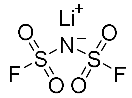
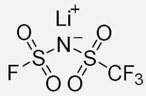
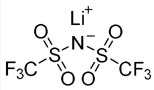
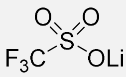
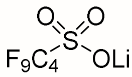
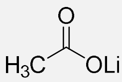
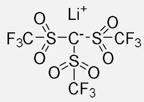
Positive Electrodes

Manufacturer	Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	125-03501	Lithium Molybdate	Li_2MoO_4	Keep at RT	100g
	127-03505			13568-40-6	500g

Negative Electrodes

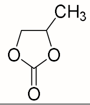
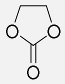
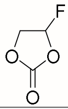
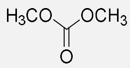
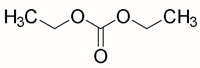
Manufacturer	Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	127-06001	Lithium, Shot	Li	Keep at RT	10g
				7439-93-2	
FUJIFILM Wako Pure Chemical	208-01602	Tin(IV) Oxide (98.0+%)	SnO_2	Keep at RT	25g
	202-01605			18282-10-5	500g
FUJIFILM Wako Pure Chemical	191-05582	Silicon, Powder, 99.9%	Si	Keep at RT	25g
				7440-21-3	
FUJIFILM Wako Pure Chemical	198-05612	Silicon Monoxide, 99.9%	SiO	Keep at RT	25g
				10097-28-6	
FUJIFILM Wako Pure Chemical	190-09072	Silicon Dioxide, 99.9%	SiO_2	Keep at RT	25g
	192-09071			7631-86-9	100g

Electrolytes

Manufacturer	Code No.	Product Name	Formula	Melting point (ref.)	Storage Condition CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	122-06632	Lithium Bis(fluorosulfonyl)imide 【Synonyms：LiFSI】		140°C	Keep at RT	25g
	124-06631				171611-11-3	100g
FUJIFILM Wako Pure Chemical	120-06851	Lithium (Fluorosulfonyl)(trifluoromethanesulfonyl)imide 【Synonyms：LiFTFSI】		100°C	Keep at RT	5g
					192998-62-2	
FUJIFILM Wako Pure Chemical	129-06642	Lithium Bis(trifluoromethanesulfonyl)imide 【Synonyms：LiTFSI】		234-238°C	Keep at RT	25g
	121-06641				90076-65-6	100g
FUJIFILM Wako Pure Chemical	128-03792	Lithium Trifluoromethanesulfonate		423°C	Keep at RT	25g
					33454-82-9	
FUJIFILM Wako Chemical	327-61481	Lithium 1,1,2,2,3,3,4,4,4-Nonafluoro-1-butanesulfonate		370-380°C	Keep at RT	5g
	325-61482				131651-65-5	25g
FUJIFILM Wako Pure Chemical	123-01542	Lithium Acetate		280-285°C	Keep at RT	25g
	127-01545				546-89-4	500g
FUJIFILM Wako Pure Chemical	121-05921	Lithium Hexafluorophosphate*1	$LiPF_6$	165-175°C	Keep at RT	10g
	127-05923				21324-40-3	50g
FUJIFILM Wako Pure Chemical	123-06042	Lithium Perchlorate*1	$LiClO_4$	236°C	Keep at RT	25g
	125-06041				7791-03-9	100g
FUJIFILM Wako Pure Chemical	128-06031	Lithium Tetrafluoroborate*1	$LiBF_4$	293°C	Keep at 2-10 °C	5g
	126-06032				14283-07-9	25g
FUJIFILM Wako Pure Chemical	121-06761	Lithium Tris(trifluoromethanesulfonyl)methide 【Synonyms：LiTFSM】		-	Keep at RT	1g
					132404-42-3	

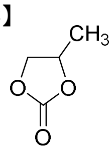
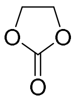
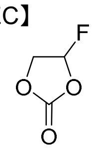
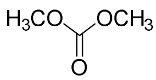
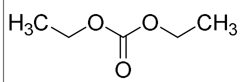
※1 Battery Grade

Solvents of the Electrolyte Solution

Manufacturer	Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	169-25201	Propylene Carbonate 【Synonyms：PC】 *1		Keep at RT	100mL
	161-25205			108-32-7	500mL
FUJIFILM Wako Pure Chemical	057-08491	Ethylene Carbonate 【Synonyms：EC】 *1		Keep below 25 °C	100g
	059-08495			96-49-1	500g
FUJIFILM Wako Pure Chemical	063-06711	Fluoro Ethylene Carbonate 【Synonyms：FEC】 *1		Keep at 2-10 °C	5g
	061-06712			114435-02-8	25g
FUJIFILM Wako Pure Chemical	044-31931	Dimethyl Carbonate 【Synonyms：DMC】 *1		Keep at RT	100mL
	046-31935			616-38-6	500mL
FUJIFILM Wako Pure Chemical	047-31921	Diethyl Carbonate 【Synonyms：DEC】 *1		Keep at RT	100mL
	049-31925			105-58-8	500mL

※1 = Battery Grade

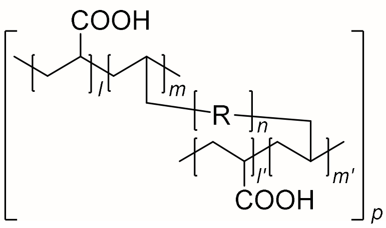
●Specification

	Specification				
	【PC】 	【EC】 	【FEC】 	【DMC】 	【DEC】 
Purity (cGC)	≧98.0%	≧98.0%	≧99.5%	≧98.0%	≧98.0%
Water Content	≦20ppm	≦50ppm	≦200ppm	≦20ppm	≦20ppm
Acid (as H_2CO_3)	-	-	-	≦0.1%	≦0.2%
Chloride	≦5ppm	≦5ppm	-	≦5ppm	≦5ppm
Ca	≦1.0ppm	≦1.0ppm	-	≦1.0ppm	≦1.0ppm
Fe	≦1.0ppm	≦1.0ppm	-	≦1.0ppm	≦1.0ppm
K	≦1.0ppm	≦1.0ppm	-	≦1.0ppm	≦1.0ppm
Na	≦1.0ppm	≦1.0ppm	-	≦1.0ppm	≦1.0ppm

■ Binder

Cross-linked Polyacrylic Acids, “CLPA Series”

The CLPA series is a water-based binder developed for the high capacity Si negative electrode for next generation lithium-ion secondary batteries.
The expansion and shrinkage of Si during charge and discharge causes isolation of Li-Si, inhibiting capacity degradation.

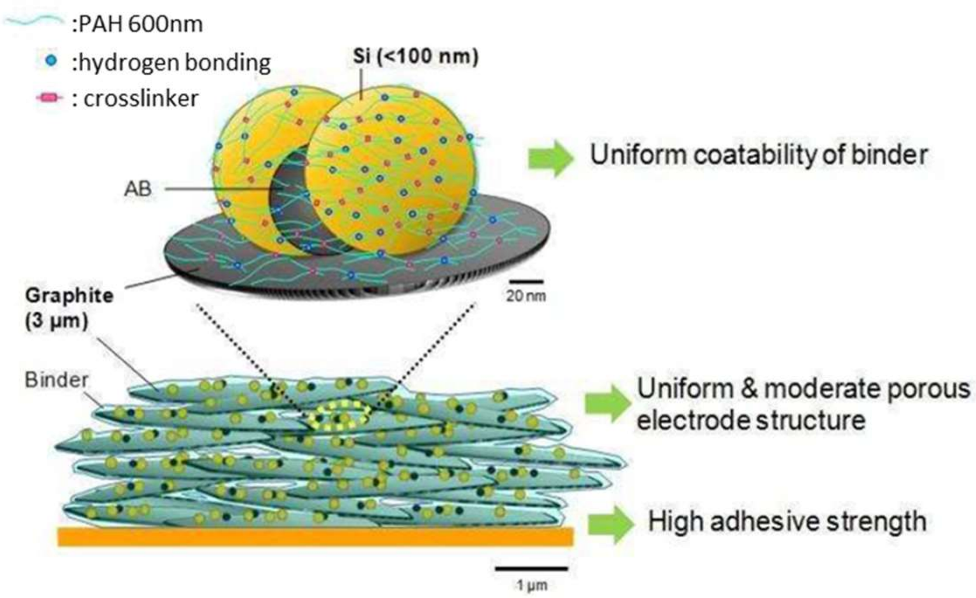


CLPA structure

Features

- The chemically cross-linked polyacrylic acid shows increased viscosity and thixotropy* when it is neutralized.
- Active materials are contained and the electrode destruction is prevented by the physical and chemical crosslinking, so that the cycle characteristic can be improved.

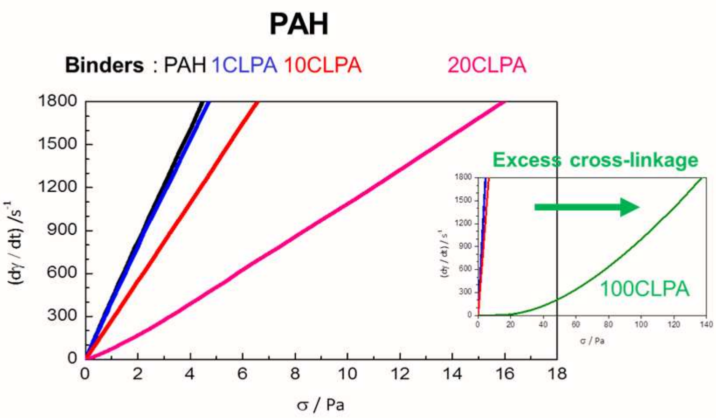
＊Thixotropy is the property that the viscosity of a material decreases with time when the material is under constant shear stress and viscosity increases with time when the stress is removed.

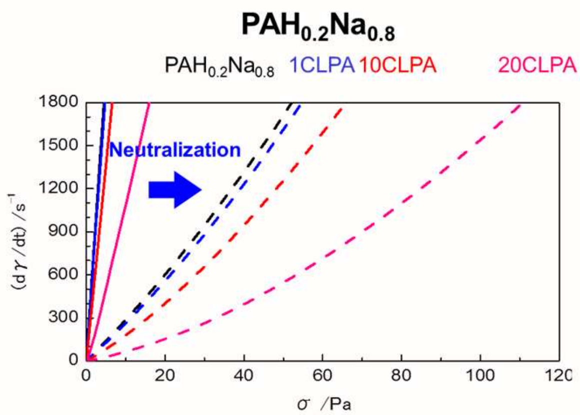


Manufacturer	Code No.	Product Name	Storage Condition	CAS RN®	Pack Size
FUJIFILM Wako Chemical	355-41122	PAH（non-crosslinked type）	Keep at RT	9003-01-4	25g
FUJIFILM Wako Chemical	352-41132	1 CLPAH	Keep at RT	9003-01-4	25g
FUJIFILM Wako Chemical	359-41142	10 CLPAH	Keep at RT	9003-01-4	25g
FUJIFILM Wako Chemical	356-41152	20 CLPAH	Keep at RT	9003-01-4	25g
FUJIFILM Wako Chemical	353-41162	100 CLPAH	Keep at RT	9003-01-4	25g

Physical and Electrochemical Properties of CLPA

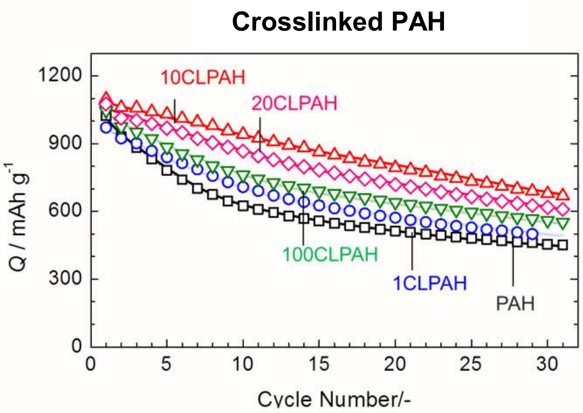
- **Viscosity of Binder Solution**



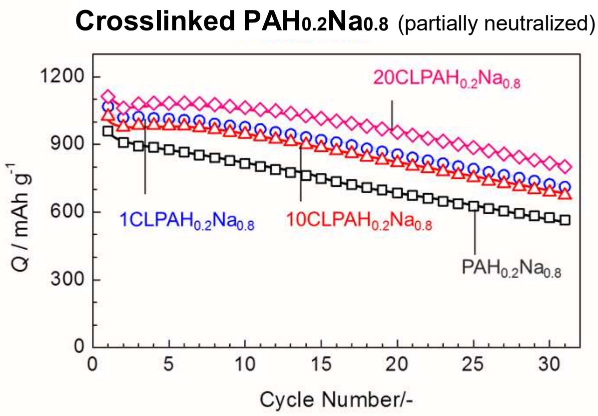


Rotational viscometer 1% (w/w) aq.

- **Capacity retention; Effect of Covalent Crosslinkage & Partial Neutralization** [a]



Cycling stability of Si/C composite electrodes is Improved by using the moderately crosslinked PAH binder



Cycling stability of Si/C composite electrodes is further improved by “neutralization” of binders.

[a] Komaba, S. *et al.* : *J. Electrochem. Soc,* **162.**, A2245 (2015).

Toshima Manufacturing Co., Ltd., Materials of Lithium-Ion Batteries

FUJIFILM Wako provides lithium-ion battery materials manufactured by Toshima Manufacturing Co., Ltd. A company engaged in the development and marketing of positive electrode materials used in lithium-ion batteries and solid electrolytes, which have been attracting public attention, can provide such materials with high purity. Materials and shapes not listed in the lineups can be provided. Please contact if the product you want is not included in the list.

Positive Electrodes

Code No.	Manufacturer Code No.	Product Name	Purity	Appearance	Size	Storage Condition / CAS RN®	Pack Size
381-04661	LiLBPW01	$LiCoO_2$	3N*2	Powder	0.5～1μm	Keep at RT / 12190-79-3	100g
389-04601	LiLBPW03	$LiNiO_2$	3N	Powder	5～15μm	Keep at RT / 12031-65-1	100g
382-04831	LiLBPW05	$LiFeO_2$	3N	Powder	5～15μm	Keep at RT / 12022-46-7	100g
385-04681	LiLBPW07	Li_2MnO_3	3N	Powder	5～15μm	Keep at RT / -	100g
386-04611	LiLBPW09	$LiMn_2O_4$	3N	Powder	5～15μm	Keep at RT / 12057-17-9	100g
385-04701	LiLBPW13	$LiNi_{0.5}Mn_{1.5}O_4$	3N	Powder	30～50μm	Keep at RT / -	100g
-	LiLBPW16	$LiCo_{1/3}Ni_{1/3}Mn_{1/3}O_2$	3N	Powder	5～15μm	Keep at RT / 346417-97-8	100g
383-04621	LiLBPW18	$LiFePO_4$	3N	Powder	5～15μm	Keep at RT / 15365-14-7	100g
380-04631	LiLBPW20	$LiCoPO_4$	3N	Powder	1～10μm	Keep at RT / 13824-63-0	100g
388-04671	LiLBPW22	$LiNiPO_4$	3N	Powder	1～10μm	Keep at RT / 13977-83-8	100g
382-04691	LiLBPW24	$LiMnPO_4$	3N	Powder	1～10μm	Keep at RT / 13826-59-0	100g
382-19221	-	$Li_3V_2(PO_4)_3$	3N	Powder	5～15μm	Keep at RT / -	100g
389-04841	-	$LiCo_{0.2}Ni_{0.4}Mn_{0.4}O_2$	3N	Powder	1～10μm*3	Keep at RT / -	100g

※2 3N=99.9%
※3 Estimation

Code No.	Manufacturer Code No.	Product Name	Purity	Appearance	Size	Storage Condition CAS RN®	Pack Size
-	-	NCM523 ($LiNi_{0.5}Co_{0.2}Mn_{0.3}O_2$)	3N*2	Powder	5～15μm	Keep at RT -	100g
-	-	NCM622($LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$)	2N5*4	Powder	5～15μm	Keep at RT -	100g
-	-	NCM811($LiNi_{0.8}Co_{0.1}Mn_{0.1}O_2$)	2N5	Powder	5～15μm	Keep at RT -	100g
-	-	1.15C+$LiFePO_4$	3N	Powder	1～10μm	Keep at RT -	100g
-	-	2C+$LiMn_{0.6}Fe_{0.4}PO_4$	3N	Powder	1～10μm	Keep at RT -	100g

※4 2N5=99.5%

Negative Electrodes

Code No.	Manufacturer Code No.	Product Name	Purity	Appearance	Size	Storage Condition CAS RN®	Pack Size
385-04561	LiLBPW56	$Li_4Ti_5O_{12}$	3N	Powder	1～10μm	Keep at RT -	100g
-	-	C (Spherical graphite：C-Dm10)	4N*5	Powder	9～11μm	Keep at RT -	100g
-	-	C (Spherical graphite：C-Dm15)		Powder	14～16μm	Keep at RT -	100g
-	-	C (Spherical graphite：C-Dm22)		Powder	21～23μm	Keep at RT -	100g

※5 4N=99.99%

All solid Electrolytes for all solid-state Batteries

All solid-state lithium-ion batteries that use no organic solvent are the subject of active research to develop an incombustible and safer next-generation battery. Toshima Manufacturing Co., Ltd. offers various materials, such as NASICON or perovskite type materials, representative solid electrolyte materials and garnet type materials with excellent oxidation/reduction stability and large potential window.

Code No.	Manufacturer Code No.	Product Name	Purity	Appearance	Size	Storage Condition / CAS RN®	Pack Size
381-13152	LiLBPW26	$Li_{6.25}La_3Zr_2Al_{0.25}O_{12}$ (cubic)	3N	Powder	5～10μm	Keep at RT / -	25g
388-13162	LiLBPW28	$Li_{6.6}La_3Zr_{1.6}Ta_{0.4}O_{12}$ (cubic)	3N	Powder	5～10μm	Keep at RT / -	25g
389-04802	LiLBPW32	$Li_7La_3Zr_2O_{12}$ (tetra)	3N	Powder	5～15μm	Keep at RT / -	25g
387-04722	LiLBPW36	$Li_{0.33}La_{0.55}TiO_3$ (tetra)	3N	Powder	5～10μm	Keep at RT / -	25g
388-04752	LiLBPW42	$Li_{1.5}Al_{0.5}Ge_{1.5}P_3O_{12}$ (amorphous)	3N	Powder	5～15μm	Keep at RT / -	25g
381-04742	LiLBPW44	$Li_{1.5}Al_{0.5}Ge_{1.5}P_3O_{12}$ (rhomb)	3N	Powder	5～15μm	Keep at RT / -	25g
385-13172	LiLBPW46	$Li_{1.3}Al_{0.3}Ti_{1.7}P_3O_{12}$	3N	Powder	5～15μm	Keep at RT / -	25g
387-04641	LiLBPW48	Li_3PO_4	3N	Powder	1～5μm	Keep at RT / 10377-52-3	100g
385-04821	LiLBPW54	Li_3BO_3	3N	Powder	10～30μm	Keep at RT / 13774-56-6	100g

Others

Code No.	Manufacturer Code No.	Product Name	Purity	Appearance	Size	Storage Condition / CAS RN®	Pack Size
386-04655	NaNBPW01	Na_3PO_4	3N	Powder	5～15μm	Keep at RT / 7601-54-9	500g
386-04851	NaNBPW03	$Na_3Zr_2Si_2PO_{12}$	2N*6	Powder	5～15μm	Keep at RT / -	100g

※6 2N5 =99%

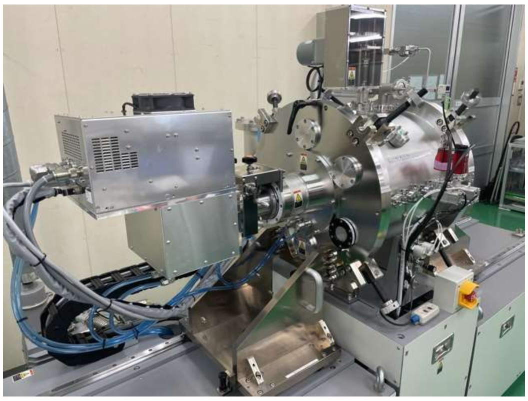
Introduction of the Barrel Sputtering Technique

The barrel sputtering is a coating technique for powders and the sputter deposition is used to deposit films primarily on substrates (flat surfaces). Feeding the base material powder into a polyhedral barrel and rotating it to form a film enables a surface to be coated homogeneously and efficiently with the powder. This powder coating used for various purposes such as catalysts, raw materials of cosmetics, decoration, and raw materials of ceramics has drawn attention in recent years as a manufacturing technique for lithium-ion batteries.
Through a joint research collaboration with Professor Abe of the University of Toyama, Toshima Manufacturing Co., Ltd. is engaged in the contract manufacturing of powder coating films (sputter/surface modification).

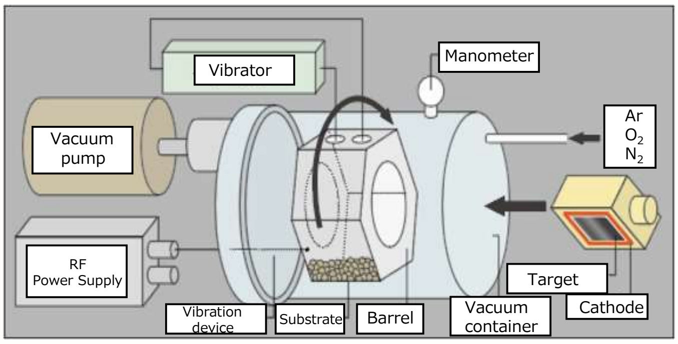
○Intended Purposes

- Positive Electrodes of Li Batteries
- Catalyst-related Applications
- Decoration

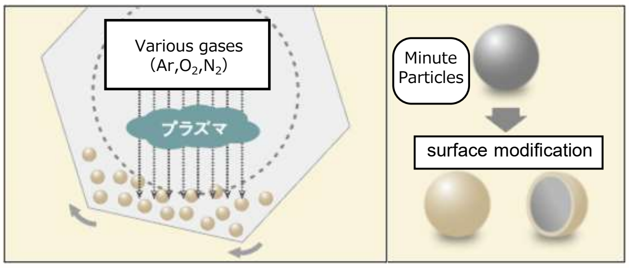
○ Equipment appearance



○ Composition Image

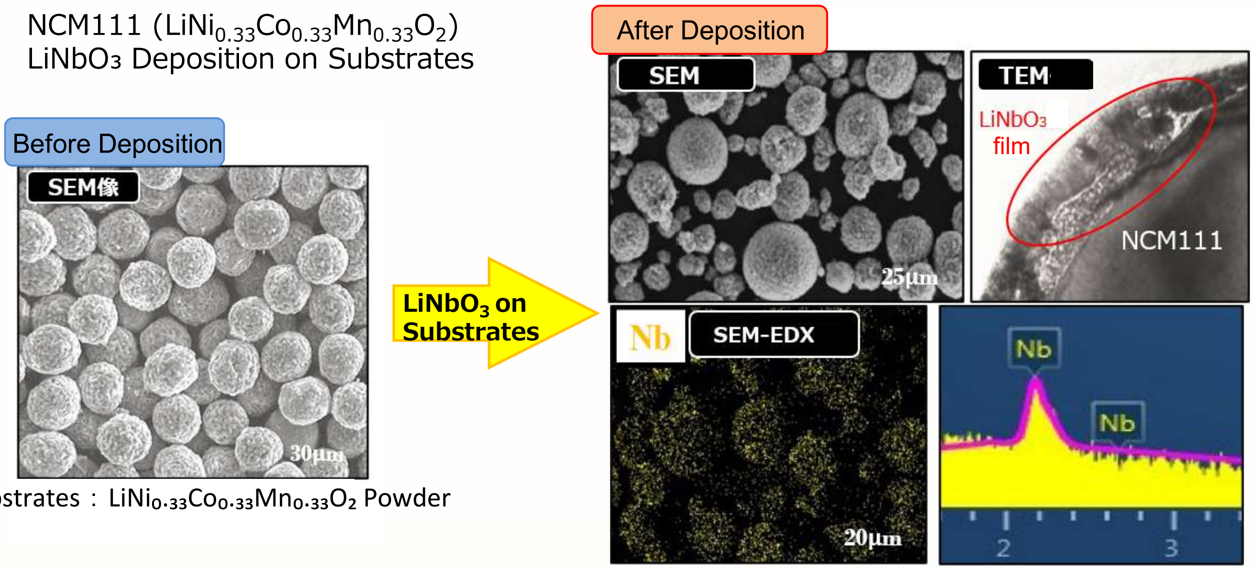


○ Deposition Image



<Example of a Past Successful Result>

NCM111 ($LiNi_{0.33}Co_{0.33}Mn_{0.33}O_2$)
$LiNbO_3$ Deposition on Substrates



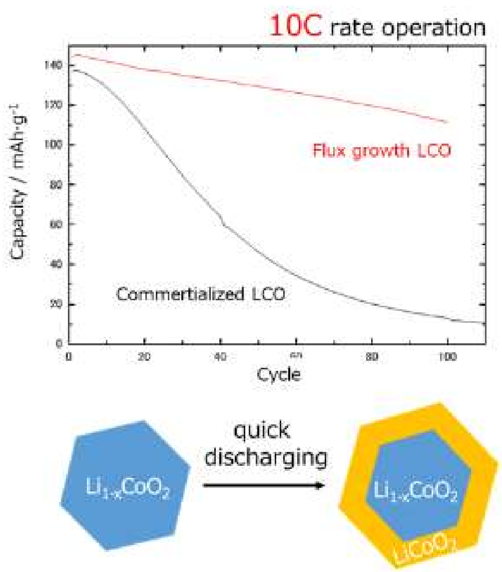
Substrates：$LiNi_{0.33}Co_{0.33}Mn_{0.33}O_2$ Powder

SHINSHU VOLTA CO.,LTD. established in May 2021 (Representative: Takeshi Hashimoto, MEIJO NANO CARBON Co., Ltd.) is a venture company originating from Shinshu University. The company develops lithium-ion batteries based on the research results that were obtained in the development of lithium-ion battery materials, which has been promoted by the leading researcher, Professor Nobuyuki Zettsu in Faculty of Engineering/Director of ELab² Center, Next-generation Research Center Cluster, Interdisciplinary Cluster for Cutting Edge Research (ICCER) of Shinshu University, and were licensed in part to MEIJO NANO CARBON Co., Ltd.

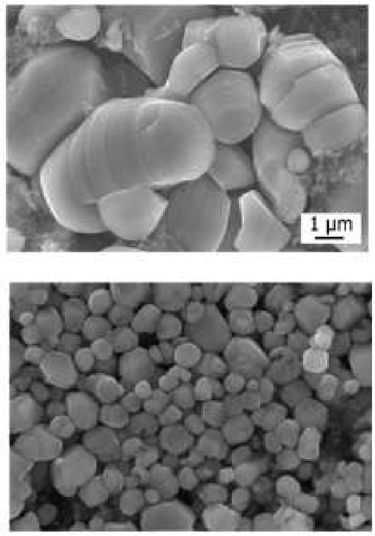
Monocrystal"$LiCoO_2$(LCO)”

"The world’s first commercialization of a battery material grown by the flux method”

Using the flux method (a crystal growth method of recrystallizing inorganic material crystals using a fused salt as a solvent) to grow monocrystalline LCO particles, which are widely used for the positive electrodes of lithium ion batteries to be installed to small consumer electronics and drones, has made it possible to achieve a smaller average size (conventional product) and more excellent 10C rate property (can be fully discharged in 6 minutes) than those of existing products, and significantly improve the capacity decrease in charge and discharge cycles at 10C rate compared with the conventional products. By using the flux method, which is the advantage of Shinshu University, monocrystalline particles with a structure widely covered with a {104} face advantageous to lithium-ion diffusion can be obtained, whereas the LCO particles of the conventional products are amorphous and polycrystalline.



conventional product：high-output LCO



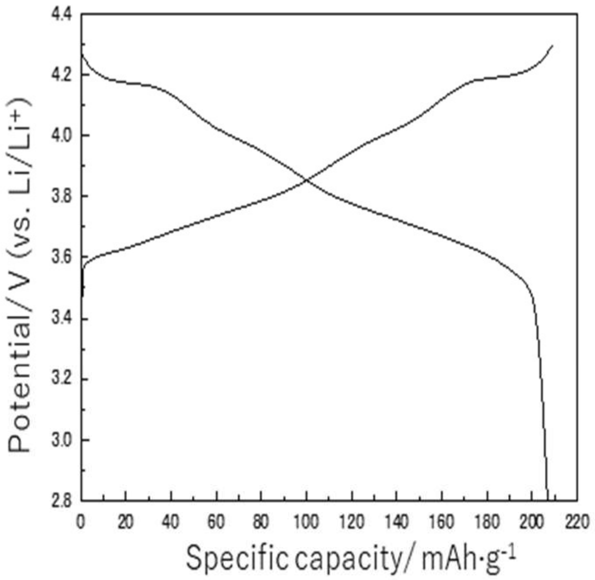
Shindai Crystal LCO

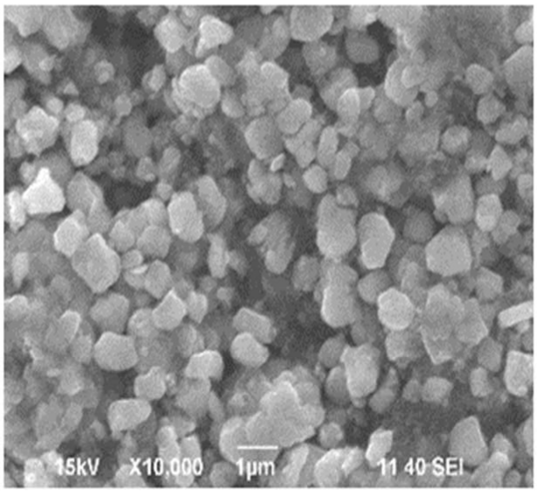
Data resulting from the discharge test of the cell with the monocrystalline LCO grown by the flux method and FE-SEM images of the electrode surfaces after the cycle test. Shindai Crystal hardly deteriorates even after the high-rate discharge test at 10C rate.

Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
636-53211	Lithium Cobalt Oxide	$LiCoO_2$	Keep at RT / 12190-79-3	10g

$LiNi_{0.9}Co_{0.05}Mn_{0.05}O_2$ (NCM91) Electrode with Bimodal Average Particle Size Distribution

As a next-generation positive electrode for high-capacity lithium-ion batteries used in the electric vehicles, a high nickel layered tertiary positive electrode material whose basic composition is $LiNi_xCo_yMn_{1-x-y}O_2$ has been gathering attention. An increased nickel content results in an increase in specific capacity of the positive electrode material but it makes the manufacturing process far more difficult. Through the combination of the precursor manufacturing technique of Tsukishima Kikai Co., Ltd. and the synthesis technique of Shinshu University, a NCM91 positive electrode with bimodal average particle size distribution has been developed. This increases the packing density of the NCM91 particles in the electrode and makes the resulting potential distribution uniform, leading to an extended battery life. A specific capacity of at least 200 mAh/g, which is higher than those of the positive electrode materials used in the conventional electric vehicles, can also be obtained.



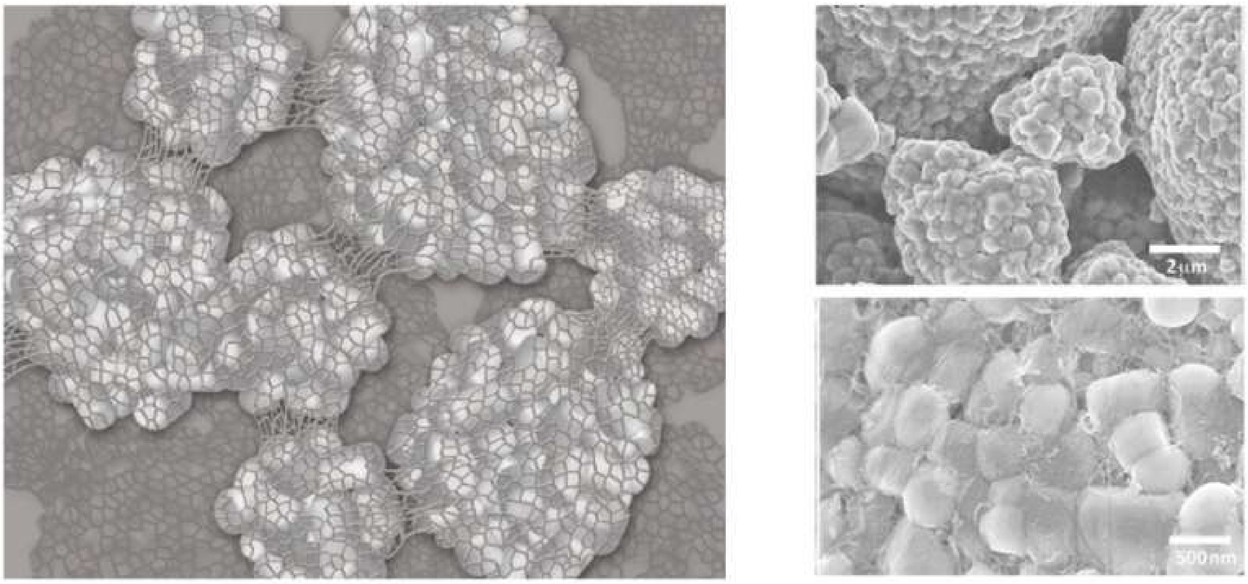


Charge/discharge curves and FE-SEM image of the $LiNi_{0.9}Co_{0.05}Mn_{0.05}O_2$ (NCM91) positive electrode with bimodal average particle size distribution. A specific capacity of about 210 mAh/g can be obtained in the cut-off voltage range of 2.8-4.3 V (vs.Li/Li^+).

Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
633-53221	Lithium Nickel Manganese Cobalt Oxide 【NCM91】	$LiNi_{0.9}Co_{0.05}Mn_{0.05}O_2$	Keep at RT / 346417-97-8	10g

Carbon Nanotube Dispersion Liquid [high output]

The world's first conductive binder has been developed by the creation of a hybrid of single-walled and multi-walled carbon nanotubes. This brings a success in significantly reducing the amount of a conductive aid or binder to be used, which does not contribute to the battery capacity, and enables a high-energy density electrode with high concentrations of active materials. The carbon nanotube forms an electronic conduction network that spreads three-dimensionally and uniformly in the electrode, making it possible to significantly reduce conventional electrode resistance. It has been shown clear that the reticulately spreading electronic conduction network serves as a binder to bind the adjacent active material particles existing in the electrode.

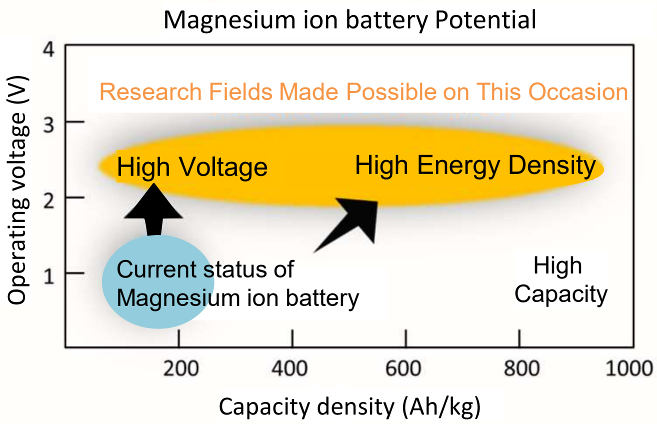


Diagrammatic illustration of low-modulus carbon nanotube binder and FE-SEM images of an NCM electrode with high concentrations of active space: materials (NCM : CNT = 99.5 : 0.5 (wt%)). The company provides electrodes with input-output characteristics, high energy density, and cycle characteristic.

Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
632-53235	Carbon Nanotube Dispersion Liquid [high output]	C	Keep at RT / -	500mL

Magnesium-Ion Battery

As a successor to lithium-ion batteries, for which there is concern about resource depletion, magnesium batteries have been gathering attention. Although magnesium is a promising material for secondary batteries because it is more abundant and safer than lithium, magnesium batteries have room for improvement compared to lithium-ion batteries in terms of energy density and cycle characteristics. Therefore, the development of advanced electrodes and electrolytes is expected for magnesium batteries.



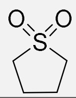
Positive Electrodes

Manufacturer	Code No.	Product Name	Formula	Storage Condition CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	222-00122	Vanadium(V) Oxide	V_2O_5	Keep at RT	25g
	226-00125			1314-62-1	500g

Negative Electrodes

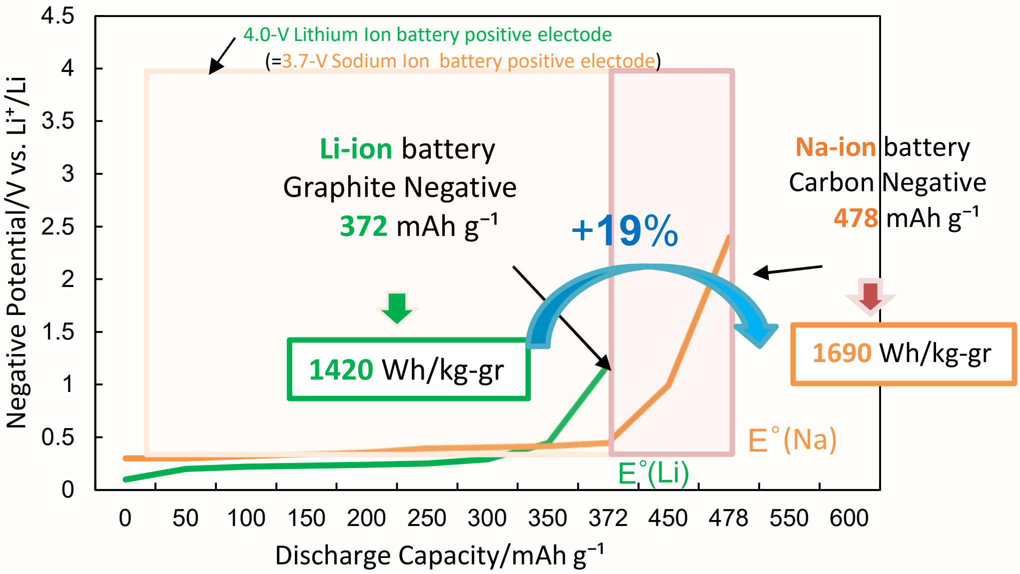
Manufacturer	Code No.	Product Name	Formula	Storage Condition CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	201-15301	Tin, Powder, -45μm, 99.5%	Sn	Keep at RT 7440-31-5	100g

Electrolytes

Manufacturer	Code No.	Product Name	Formula	Storage Condition CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	133-07981	Magnesium Perchlorate 300～850μm(20～48mesh)	$Mg(ClO_4)_2$	Protect from light	50g
	139-07983			10034-81-8	400g
FUJIFILM Wako Pure Chemical	195-05703	Sulfolane		Keep at RT	25mL
	199-05706			126-33-0	500mL

Sodium-Ion Battery

Sodium secondary batteries are made from raw materials that are more abundant than those for lithium-ion batteries, so they can be produced at a lower cost than lithium-ion batteries. Although sodium secondary batteries were considered to have lower energy density than lithium-ion batteries in the past, it is expected that with a newly developed negative electrode material, they will achieve energy density equivalent to that of lithium-ion batteries[b].

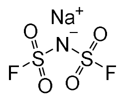
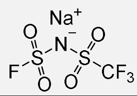


[b] Azusa. Kamiyama. *et al.* : *Angew. Chem. Int. Ed.*, **60**, 5114 (2021).

Negative Electrodes

Manufacturer	Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	201-15301	Tin, Powder, -45μm, 99.5%	Sn	Keep at RT / 7440-31-5	100g
FUJIFILM Wako Pure Chemical	204-09862	Tin(II) Oxide, 99.9%	SnO	Keep at RT / 21651-19-4	25g

Electrolytes

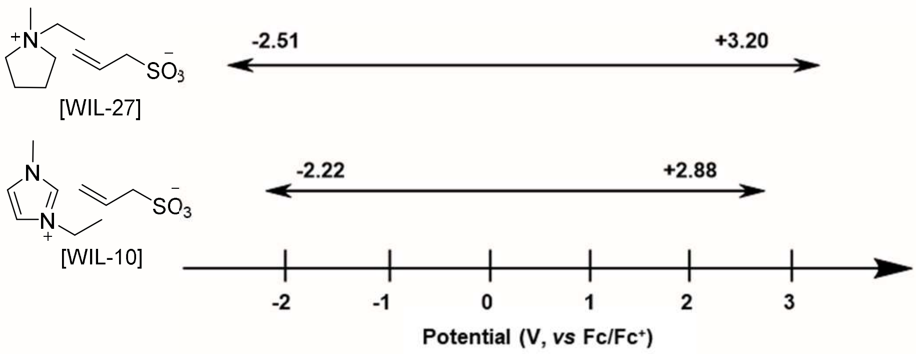
Manufacturer	Code No.	Product Name	Formula	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	195-01462 199-01465	Sodium Tetrafluoroborate	$NaBF_4$	Keep at RT / 13755-29-8	25g 100g
FUJIFILM Wako Pure Chemical	198-09252 192-09255	Sodium Perchlorate	$NaClO_4$	Keep at RT / 7601-89-0	25g 500g
FUJIFILM Wako Pure Chemical	190-18801	Sodium Bis(fluorosulfonyl)imide【Synonyms：NaFSI】		Keep at RT / 100669-96-3	5g
FUJIFILM Wako Pure Chemical	197-18811	Sodium (Fluorosulfonyl)(trifluoromethanesulfonyl)imide【Synonyms：NaFTFSI】		Keep at RT / 1233836-95-7	5g

Battery Grade『WIL Series』

Ionic liquids, which are refractory, flame-retardant, and heat-resistant and safer than organic solvents, have been receiving attention as a flame-retardant material. Research and development of ionic liquids as electrolytes and electrolyte solutions for lithium-ion secondary batteries have been widely proceeded with from the viewpoint of enhanced safety, in particular, such as preventing ignition and explosion of batteries, and they are expected to be put into practical use as a material for secondary batteries.

FUJIFILM Wako has developed the WIL series, original ionic liquids suitable for research of batteries. The series has the advantage of having a larger potential window than the existing ionic liquids.

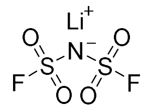
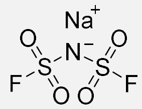
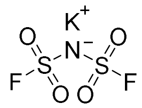
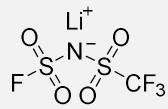
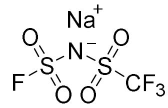
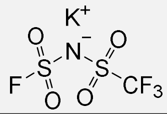
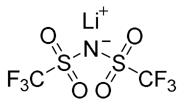
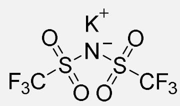
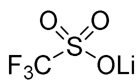
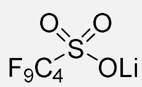
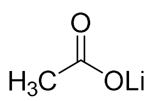
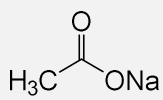
What is a Potential Window?
Potential window is defined as an electrolyte range where current does not flow in the electrolyte solution, that is, a range that an oxidation-reduction reaction does not take place on the electrodes and is used as an indicator of electrochemical properties.

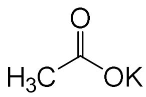


Code No.	Product Name	Pack Size	Storage Condition / CAS RN®	Viscosity (mPa・s, 25℃)	Melting Point (℃)	Conductivity (mS/cm, 25℃)	Electric Potential Area (V)	Electric Potential Width (V)
052-08561	WIL-27	1g	Keep at RT	312	-83	1.2	-2.51 ~ +3.20 (Fc)	5.71
058-08563		5g	1268622-88-3					
056-08581	WIL-10	1g	Keep at RT	210	-68	1.0	-2.22 ~ +2.88 (Fc)	5.10
052-08583		5g	1268622-81-6					

Ionic Liquids as Precursors

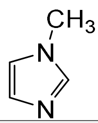
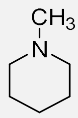
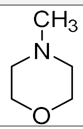
The anion exchange method is one of the synthesis methods of ionic liquids. An ionic liquid can be prepared by the reaction of a desired cationic haloid salt with a desired anionic lithium salt. Potassium salt and sodium salt are also offered. Consider the use of the products for the synthesis of ionic liquids.

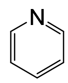
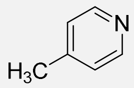
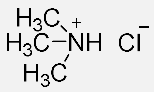
Manufacturer	Code No.	Product Name	Formula	Melting Point (ref.)	Storage Condition CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	122-06632 124-06631	Lithium Bis(fluorosulfonyl)imide 【Synonyms：LiFSI】		140°C	Keep at RT 171611-11-3	25g 100g
FUJIFILM Wako Pure Chemical	190-18801	Sodium Bis(fluorosulfonyl)imide 【Synonyms：NaFSI】		112°C	Keep at RT 100669-96-3	5g
FUJIFILM Wako Pure Chemical	167-28742 169-28741	Potassium Bis(fluorosulfonyl)imide 【Synonyms：KFSI】		101°C	Keep at RT 14984-76-0	25g 100g
FUJIFILM Wako Pure Chemical	120-06851	Lithium (Fluorosulfonyl)(trifluoromethanesulfonyl)imide 【Synonyms：LiFTFSI】		100°C	Keep at RT 192998-62-2	5g
FUJIFILM Wako Pure Chemical	197-18811	Sodium (Fluorosulfonyl)(trifluoromethanesulfonyl)imide 【Synonyms：NaFTFSI】		-	Keep at RT 1233836-95-7	5g
FUJIFILM Wako Pure Chemical	166-28751	Potassium (Fluorosulfonyl)(trifluoromethanesulfonyl)imide 【Synonyms：KFTFSI】		101°C	Keep at RT 860653-59-4	5g
FUJIFILM Wako Pure Chemical	129-06642 121-06641	Lithium Bis(trifluoromethanesulfonyl)imide (Synonyms：LiTFSI)		234-238°C	Keep at RT 90076-65-6	25g 100g
FUJIFILM Wako Pure Chemical	167-28002 169-28001	Potassium Bis(trifluoromethanesulfonyl)imide (Synonyms：KTFSI)		200°C	Keep at RT 90076-67-8	25g 100g
FUJIFILM Wako Pure Chemical	128-03792	Lithium Trifluoromethanesulfonate		423°C	Keep at RT 33454-82-9	25g
FUJIFILM Wako Chemical	327-61481 325-61482	Lithium 1,1,2,2,3,3,4,4,4-Nonafluoro-1-butanesulfonate		370-380°C	Keep at RT 131651-65-5	5g 25g
FUJIFILM Wako Pure Chemical	123-01542 127-01545	Lithium Acetate		280-285°C	Keep at RT 546-89-4	25g 500g
FUJIFILM Wako Pure Chemical	198-01072 190-01071 192-01075	Sodium Acetate		>300°C	Keep at RT 127-09-3	25g 100g 500g

Manufacturer	Code No.	Product Name	**Formula**	**Melting Point (ref.)**	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	166-03172	Potassium Acetate		292°C	Keep at RT	25g
	160-03175				127-08-2	500g
FUJIFILM Wako Pure Chemical	121-05921	Lithium Hexafluorophosphate*1	$LiPF_6$	165-175°C	Keep at RT	10g
	127-05923				21324-40-3	50g
FUJIFILM Wako Pure Chemical	128-06031	Lithium Tetrafluoroborate*1	$LiBF_4$	293°C	Keep at 2-10 °C	5g
	126-06032				14283-07-9	25g
FUJIFILM Wako Pure Chemical	195-01462	Sodium Tetrafluoroborate	$NaBF_4$	384°C	Keep at RT	25g
	199-01465				13755-29-8	500g
FUJIFILM Wako Pure Chemical	161-16792	Potassium Tetrafluoroborate	KBF_4	530°C	Keep at RT	25g
	165-16795				14075-53-7	500g

※1 Battery Grade

Cation Precursors

Manufacturer	Code No.	Product Name	Formula	Melting Point (ref.)	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	134-12801	1-Methylimidazole		-60°C	Protect from light	100mL
	136-12805				616-47-7	500mL
FUJIFILM Wako Pure Chemical	133-08042	1-Methylpiperidine		-18°C	Keep at RT	25mL
	137-08045				626-67-5	500mL
FUJIFILM Wako Pure Chemical	132-06873	4-Methylmorpholine		-66°C	Keep at RT	25mL
	136-06876				109-02-4	500mL

Manufacturer	Code No.	Product Name	Formula	Melting Point (ref.)	Storage Condition / CAS RN®	Pack Size
FUJIFILM Wako Pure Chemical	164-05312 162-05313 166-05316	Pyridine		-42℃	Keep at RT 110-86-1	25mL 100mL 500mL
FUJIFILM Wako Pure Chemical	161-02603 165-02606	4-Methylpyridine		2.4℃	Keep at RT 108-89-4	25mL 500mL
FUJIFILM Wako Pure Chemical	200-07723 204-07726	Tributyl Phosphine	$P(n\text{-}C_4H_9)_3$	-	Keep at RT 998-40-3	25mL 500mL
FUJIFILM Wako Pure Chemical	208-03662	Trimethylammonium Chloride		277℃	Keep at RT 593-81-7	25g
FUJIFILM Wako Pure Chemical	204-02363 208-02366	Tributylamine	$N(n\text{-}C_4H_9)_3$	-70℃	Keep at RT 102-82-9	25mL 500mL
FUJIFILM Wako Pure Chemical	205-09272 209-09275	Trioctylamine	$N(n\text{-}C_8H_{17})_3$	-	Keep at RT 1116-76-3	25mL 500mL

FUJIFILM Wako Laboratory Chemicals site
https://labchem-wako.fujifilm.com

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