



# Products for Battery Applications

Lithium-Ion Batteries, Next-Generation Batteries, and Other Related Materials

TOAGOSEI  
TECHNOLOGY



## Toagosei's Proprietary Technologies

### Polymers and Oligomers

- Polymer Structure Design and Control Technology**  
We can manufacture polymer and oligomer products with diverse functions through polymer structure design and control technology.  
A wide range of polymer structures can be designed.  
A variety of functionalities can be controlled through structural design.

Block Copolymers    Telechelic Polymers    Star Polymers    Graft Polymers

**Polyacrylates**

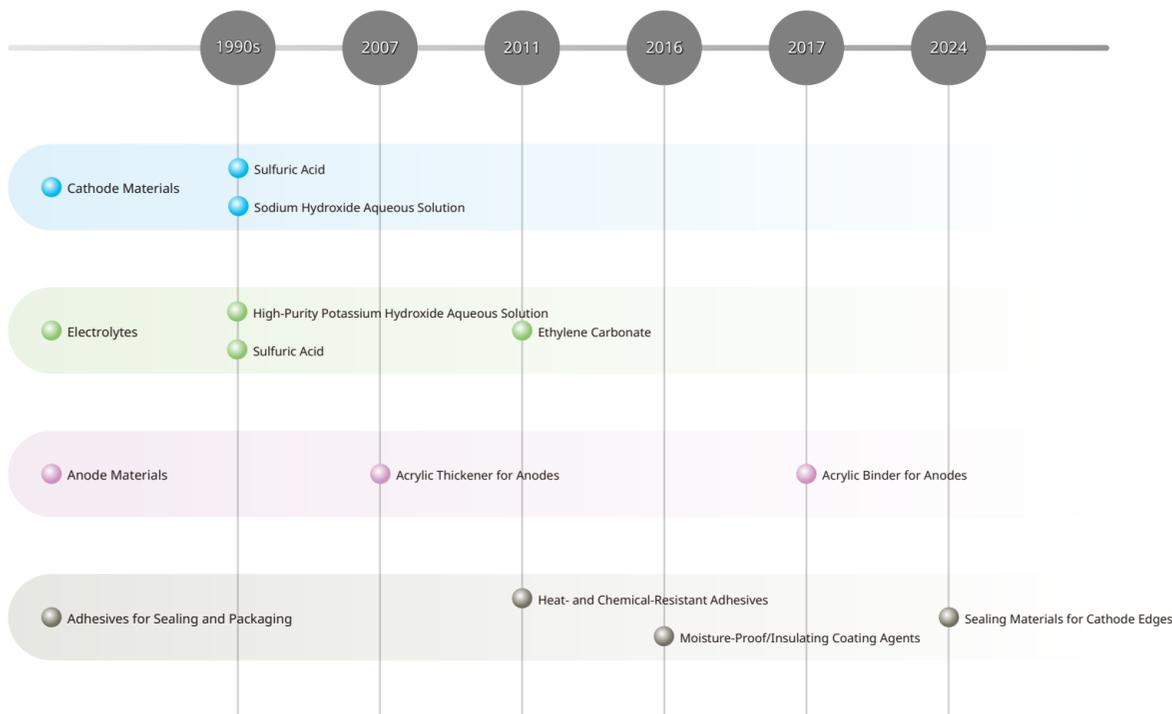
- Highly Cross-linked: Superabsorbent Polymers, Water-Absorbing Microparticles
- Slightly Cross-linked: Water-Retaining Agents, Thickeners, Gelling Agents
- Non-cross-linked: Dispersants, Detergent Builders, Scale-Control Agents

- Particle Size Control Technology**  
By utilizing various polymerization methods, we can synthesize polymer microparticles with a range of particle sizes.

[Particle Size]

- 100µm: Suspension Polymerization
  - [Normal-Phase Suspension Polymerization]: Acrylic Beads, Cosmetic Additives
  - [Inverse-Phase Suspension Polymerization]: Water-Absorbing Microparticles, Pore-Forming Agents, Cosmetic Additives
- 10µm: Dispersion Polymerization: Monodisperse Microparticles, Light-Diffusing Agents, Anti-Blocking Agents
- 1µm: Emulsion Polymerization
- 0.1µm: Microemulsion Polymerization: Ultrafine Particle Emulsions, Coating Agents, Binders
- 0.01µm: (No specific method listed)

## Chronology of Toagosei's Battery Materials



## High-Performance Inorganic Materials

- Particle Shape and Size Control Technology**  
We can synthesize inorganic particles with various shapes and sizes.

Zirconium Compounds

- Lattice-like
- Cotton Candy-like
- Flake-like

- Functionality Control Technology**  
We can impart diverse functionalities to inorganic materials.

- Inorganic Ion Scavengers:** Capture corrosive ions and protect wiring.
- Anti-Allergen Agents:** Over 99% inactivated allergen activity.
- Ion Exchange Technology:** Significant reduction in bacterial proliferation.
- Hybridization Technology / Intercalation Technology:** Sustained release of antifungal agents prevents mold growth.

## Adhesive Materials

- Molecular Design and Formulation Technology**  
We offer a wide range of functional adhesives through our advanced molecular design and synthesis technologies. Furthermore, our proprietary formulation technology enables the development of high-value-added products.
- Extensive Product Lineup**

- Reactive Adhesives
- UV-Curing Adhesives
- Hot-Melt Adhesives
- Cyanoacrylate Adhesives

- Curing Time Control via Light**
- Balancing Instant Adhesion with Flexibility**

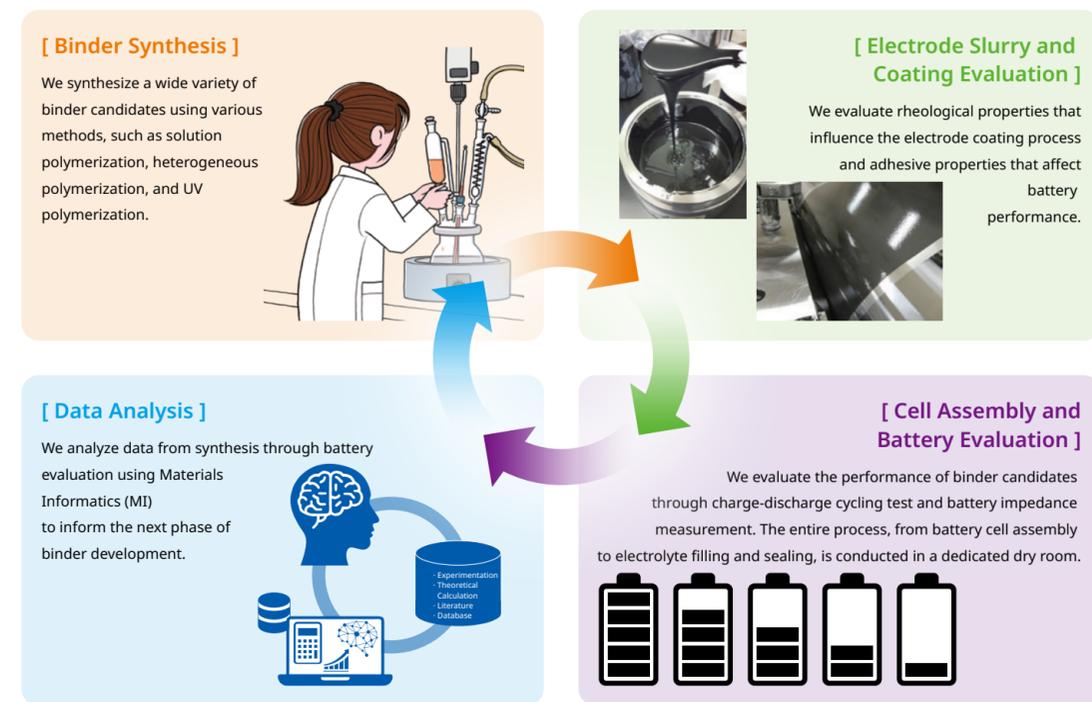
Adhesion Speed: Fast to Slow  
Flexibility: Low to High

Hybrid adhesive (Cyanoacrylate + Silicone)

Holds the Guinness World Record for the "longest-running instant adhesive brand"

## Battery Material Development Cycle

Example: Development Cycle for an Anode Binder



# Toagosei's Battery-Related Products and Development Pipeline

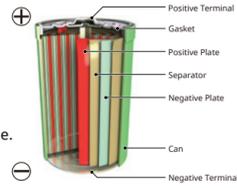
## Secondary Batteries

### Nickel-Cadmium and Nickel-Metal Hydride Batteries

#### Electrolyte

##### < High-Purity Potassium Hydroxide Aqueous Solution >

Hydroxide ions (OH<sup>-</sup>) source. OH<sup>-</sup> generates free electrons (e<sup>-</sup>) by oxidation reactions at the cathode.



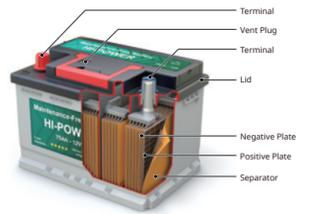
	General Liquid KOH	Low-Chloride Liquid KOH	Low-Sodium Liquid KOH
Form	Liquid	Liquid	Liquid
Purity [%]	48.0<	48.0<	48.0<
Cl [ppm]	<50	<8	<8
Na [ppm]	<5,000	<3,000	<200

### Lead-Acid Batteries (for Automotive Applications)

#### Electrolyte

##### < Sulfuric Acid >

Dissolves (oxidizes) the lead anodes and promotes free electrons (e<sup>-</sup>) generation. Furthermore, captures the generate lead ions to precipitate as lead sulfata at the cathode.



	Concentrated Sulfuric Acid	Dilute Sulfuric Acid
Form	Liquid	Liquid
Purity [%]	98 or 95	78 or 70
Fe [%]	<0.01	<0.03

\*Quality is controlled according to the standards of the Sulfuric Acid Association of Japan.

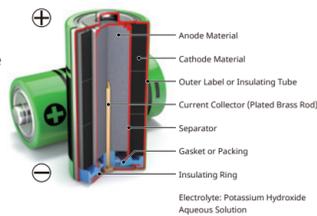
## Primary Batteries

### Alkaline Batteries

#### Anode Materials

##### < Acrylic Thickener for Anodes >

Maintains the dispersion of the anode active material by rheology control of electrolyte and offers excellent handling properties without stringiness.

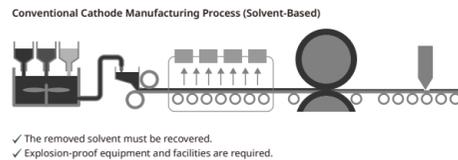


	Cross-linked Type	Cross-linked Type (Neutralized)
Form	Powder	Powder
Viscosity [mPa·s]	25,000-45,000 (0.2%, neutralized)	500-700 (0.2%)
pH	3.0-4.0 (0.2%)	6.5-7.5 (0.2%)

#### Cathode Materials

**< Binder for Cathodes >** IDP  
Water-soluble binder. Applicable to the aqueous manufacturing process of cathodes.

**[Cathode Development Trends]**  
Due to environmental impact and manufacturing costs of conventional cathode manufacturing process with organic solvent, aqueous process come into the spotlight as an effective solution.



##### < Sulfuric Acid >

Dissolves and extracts metals from raw ore.

	Concentrated Sulfuric Acid	Dilute Sulfuric Acid
Form	Liquid	Liquid
Purity [%]	98 or 95	78 or 70
Fe [%]	< 0.01	< 0.03

##### < Sodium Hydroxide Aqueous Solution >

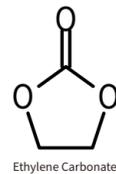
Bonds with specific metal ions to remove insoluble precipitates.

	48% Liquid NaOH	33% Liquid NaOH	25% Liquid NaOH
Form	Aqueous Solution	Aqueous Solution	Aqueous Solution
Na <sub>2</sub> CO <sub>3</sub> [%]	< 0.1	< 0.07	< 0.1
NaCl [%]	< 0.01	< 0.007	< 0.05
Fe <sub>2</sub> O <sub>3</sub> [ppm]	< 0.002	< 0.014	< 0.002

#### Electrolyte Additives

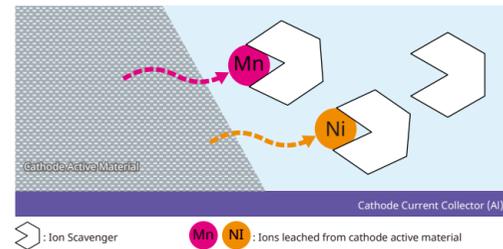
##### < Highly Polar Solvent >

Ionize lithium salts to maximize battery performance. High-purity and high-dielectric ethylene carbonate(EC).

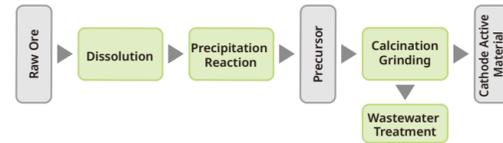


	General-Purpose EC	Purified EC
Form	Liquid or Solid	Liquid
Purity [%]	99.0<	99.99<
Color [APHA]	<30	<10
Moisture [ppm]	<1,000	<20

**< Ion Scavenger >** IDP  
Captures metal ions leached from cathode active material to suppress Mn/Ni deposition in anode.



##### [ Cathode Active Material Manufacturing Process ]



##### Dissolution Process

A high-purity metal sulfate solution is obtained by selectively dissolving the metal components from the ore in sulfuric acid and removing insoluble residues.

##### Precipitation Reaction Process

By adding a sodium hydroxide aqueous solution, specific metal ions are precipitated and recovered as hydroxides.

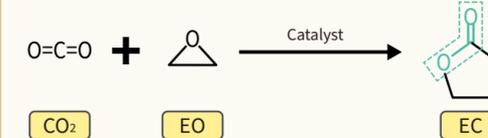
##### Wastewater Treatment Process

Sulfuric acid and sodium hydroxide aqueous solution are also used for pH adjustment and removal of dissolved metal ions from astewater.

#### Key Point! Toagosei's Ethylene Carbonate

[1] Our EC manufacturing process adopts eco-friendly technology that uses CO<sub>2</sub> as a raw material.

##### Ethylene Carbonate Manufacturing Process



CO<sub>2</sub> accounts for 50% of the ethylene carbonate molecule by mass.

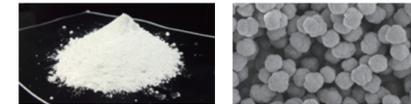
## Lithium-Ion Batteries

#### Anode Materials

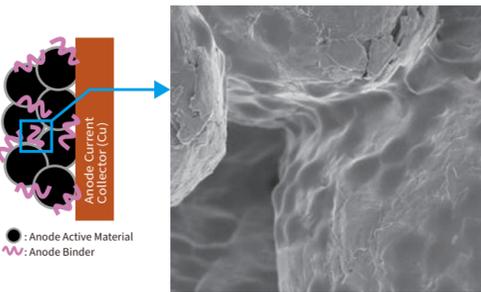
**[Anode Development Trends]**  
For higher battery capacity, additive ratio of silicon-based anodes are increasing. Silicon-based anodes undergo significant expansion and contraction during charge-discharge cycling test. Accordingly, high-adhesive binder is required.

##### < Acrylic Binder for Anodes >

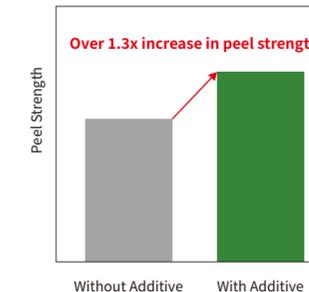
Strongly binds active material particles to each other and to the current collector, maintaining conductive pathways after repeated cycling.



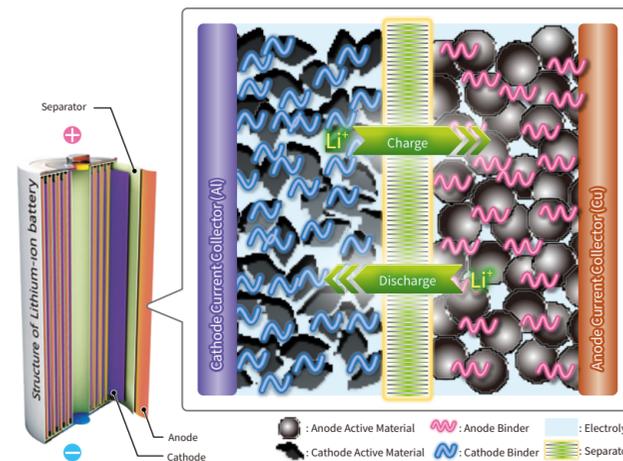
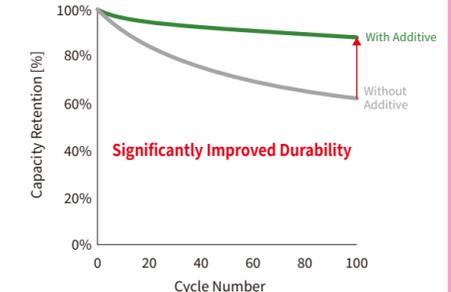
##### Strong Adhesion Between Active Material Particles



##### Improved Peel Strength



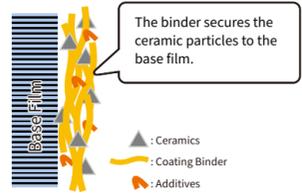
##### High Capacity Retention



#### Separator

##### [Trends in Separator Development]

To ensure the safety of lithium-ion batteries, multilayer structures with ceramic coatings are being developed to enhance thermal resistance. Additionally, adhesive layers made from acrylic or PVDF resins are being implemented to improve adhesion to electrodes, thereby boosting cell productivity and extending cycle life.



##### < Cellulose-Based Binder and Dispersant for Coatings >

 IDP

Maintains low viscosity even at high concentrations and provides excellent dispersion of ceramic particles.



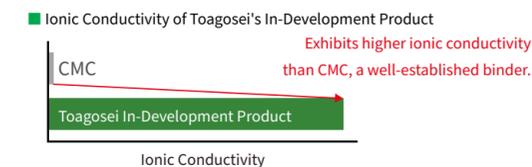
##### Ceramic Dispersion



##### < Acrylic Binder for Coatings >

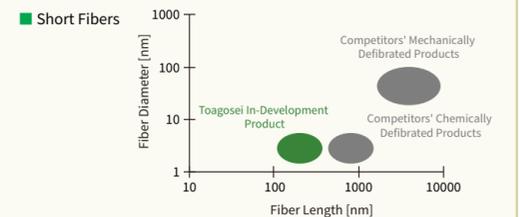
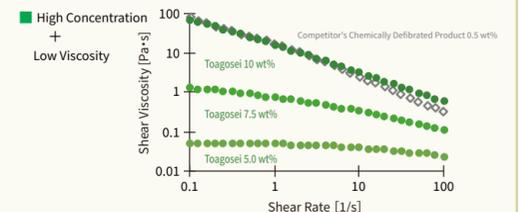
 IDP

Reduces the Li<sup>+</sup> conduction resistance of the coating layer. Offers excellent processability, enabling thinner and more uniform coatings.



#### Key Point! Toagosei's Cellulose-Based Binder and Dispersant

- Achieves excellent handling with high-concentration, low-viscosity formulations.
- Disperses easily without the need for specialized equipment.



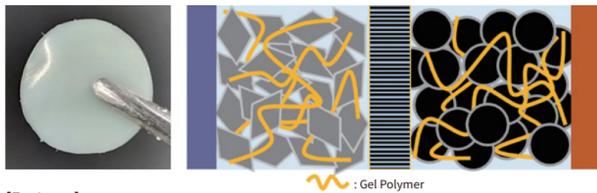
## Next-Generation Secondary Batteries

### Gel Polymer Batteries

#### Electrolyte

##### < Gel Polymer >

Prevent electrolyte leakage and improve battery safety. As gelation occurs after cell assembly, the conventional lithium-ion battery manufacturing process can be utilized.



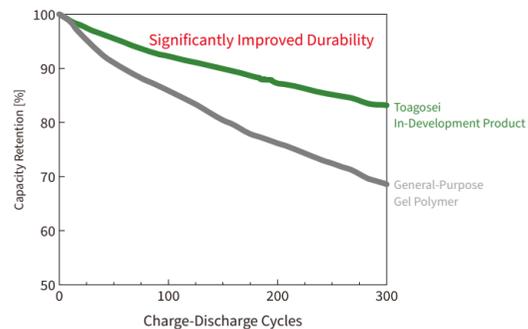
#### [Features]

- Low temperature dependence of ionic conductivity.
- High battery capacity retention after repeated charge-discharge cycles.

#### Ionic Conductivity of Gel Polymer Electrolyte

	Toagosei In-Development Product	General-Purpose Gel Polymer
25°C	7.5	5.0
-10°C	2.5	1.2

#### High Capacity Retention

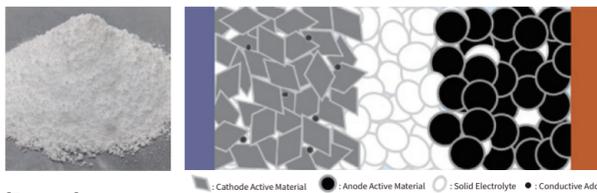


### All-Solid-State Batteries

#### Electrolyte

##### < Oxide-Based Inorganic Solid Electrolyte >

High ionic conductivity at elevated temperatures. Also, highly stable against moisture and does not generate toxic gases, ensuring reliable operation even in hot and humid environments.



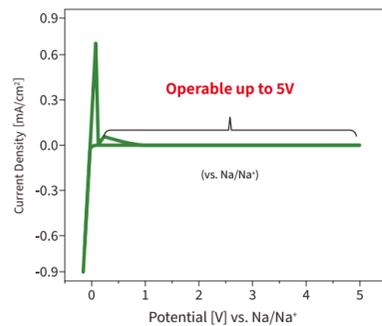
#### [Features]

- Developed for both LIB and SIB applications.
- Can be handled in ambient air.
- Operating potential: Stable up to 5V.

#### Ionic Conductivity of Sintered Pellet

	for LIBs	for SIBs
25°C	0.1	6.7
100°C	2.0	55

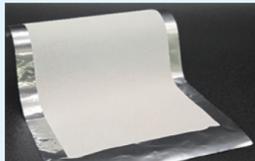
#### Wide Potential Window



#### Toagosei's Development Topics

To enhance electrolyte performance, we are developing hybrid electrolytes that combine dissimilar materials.

#### Organic Material × Organic Material Inorganic Material × Organic Material



#### [Concept]

To fabricate electrolyte films with excellent handling properties by combining high-ionic-conductivity organic or inorganic materials with highly flexible organic materials.

## Other Battery Materials

### Coating Agents

#### < Cathode Edge Coating Agent >

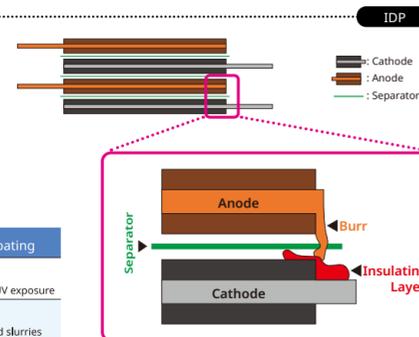
Coating the cathode edge with an insulating UV-curable resin reduces the risk of short circuits, even if burrs (generated during electrode plate cutting process) penetrate the separator.

#### [Features]

- Expected improvement of productivity (vs conventional methods)
- Equivalent resistance to electrolyte (vs conventional materials)
- Rheology control for various application methods (100-1,000 mPa·s)

#### Comparison of Methods and Materials

	Tape Application	Solvent-Based Slurry Coating	UV-Curable Resin Coating
Productivity	✗ Low positional accuracy	△ Solvent drying is time-consuming	◎ Cures with a few seconds of UV exposure
Electrolyte Resistance	△ Adhesion is reduced by the electrolyte	○ Proven conventional technology	○ Equivalent to solvent-based slurries



#### < Moisture-Proof and Insulating Coating Agent >

Coating safety devices and electronic circuit boards inside the battery cells of electric vehicles (HEV, PHV, EV, etc.) helps prevent malfunctions.

#### [Features]

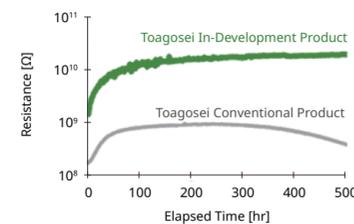
- Excellent moisture-proof and insulation properties
- High adhesion to polyimide



#### Performance Comparison

	Toagosei Conventional Product	Toagosei In-Development Product
Water Absorption (23°C, 24 hr)	1.5% (Water Resistance: △)	0.4% (Water Resistance: ◎)
Adhesion (to PI)	○ (Peel Strength)	○ (Peel Strength)

#### Insulation Resistance



### Packaging Adhesives

#### < Heat- and Chemical-Resistant Adhesive >

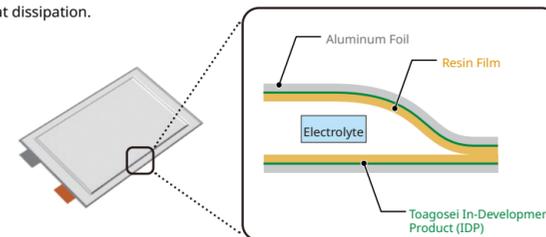
By laminating aluminum foil with high thermal conductivity to a resin film with high electrolyte resistance, this adhesive enables thinner, lighter batteries and more efficient heat dissipation.

#### [Features]

- Heat resistance suitable for automotive applications
- Excellent electrolyte resistance for safety

#### Performance Comparison

	Toagosei Conventional Product	Toagosei In-Development Product
Heat Resistance (120°C)	△ Hot Peel Strength	◎ Hot Peel Strength
Electrolyte Resistance (7-day immersion)	○ Peel Strength	○ Peel Strength



The information in this technical document introduces applications for our products and is based on currently available materials and data; however, it does not constitute a guarantee of any kind. For safety information regarding the storage, use, or disposal of this product, please contact your sales representative.

**TOAGOSEI CO., LTD.** URL: <https://www.toagosei.co.jp>

**Head Office** 1-14-1 Nishi-Shinbashi, Minato-ku, Tokyo 105-8419, Japan  
TEL: +81-3-3597-7215 FAX: +81-3-3597-7217

**Osaka Branch** Nakanoshima Mitsui Bldg. 11F, 3-3-3 Nakanoshima, Kita-ku, Osaka 530-0005, Japan  
TEL: +81-6-6446-6551 FAX: +81-6-6446-6571

**Nagoya Branch** Taiju Life Nagoya Bldg. 6F, 1-4-6 Nishiki, Naka-ku, Nagoya, Aichi 460-0003, Japan  
TEL: +81-52-209-8591 FAX: +81-52-209-8671

**Shikoku Sales Office** 2-4-1 Showacho, Sakaiide, Kagawa 762-0004, Japan  
TEL: +81-877-46-3300 FAX: +81-877-46-3200

**Fukuoka Sales Office** 7th Myojo Bldg. 6F, 4-1-1 Tenjin, Chuo-ku, Fukuoka 810-0001, Japan  
TEL: +81-92-721-1902 FAX: +81-92-721-1914