

# **Carbon Nanotube Dispersions Business for Lithium ion Battery Business Briefing**

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Toyocolor Co.,Ltd**

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- History of evolution with dispersion as the core technology
- Advantages of using CNT dispersions
- Trends in the EV and LiB markets
- Outlook of CNT dispersions for LiBs
- Our Competitive Advantages

# Today's Key Points

1) The change point of our CNT dispersions business for automotive applications in the Medium-Term Management Plan and future forecast.

2) Continue activities to have new customers begin to use our products, invest capital and ensure stable production at five bases in four regions: Europe, the US, China, and Japan.

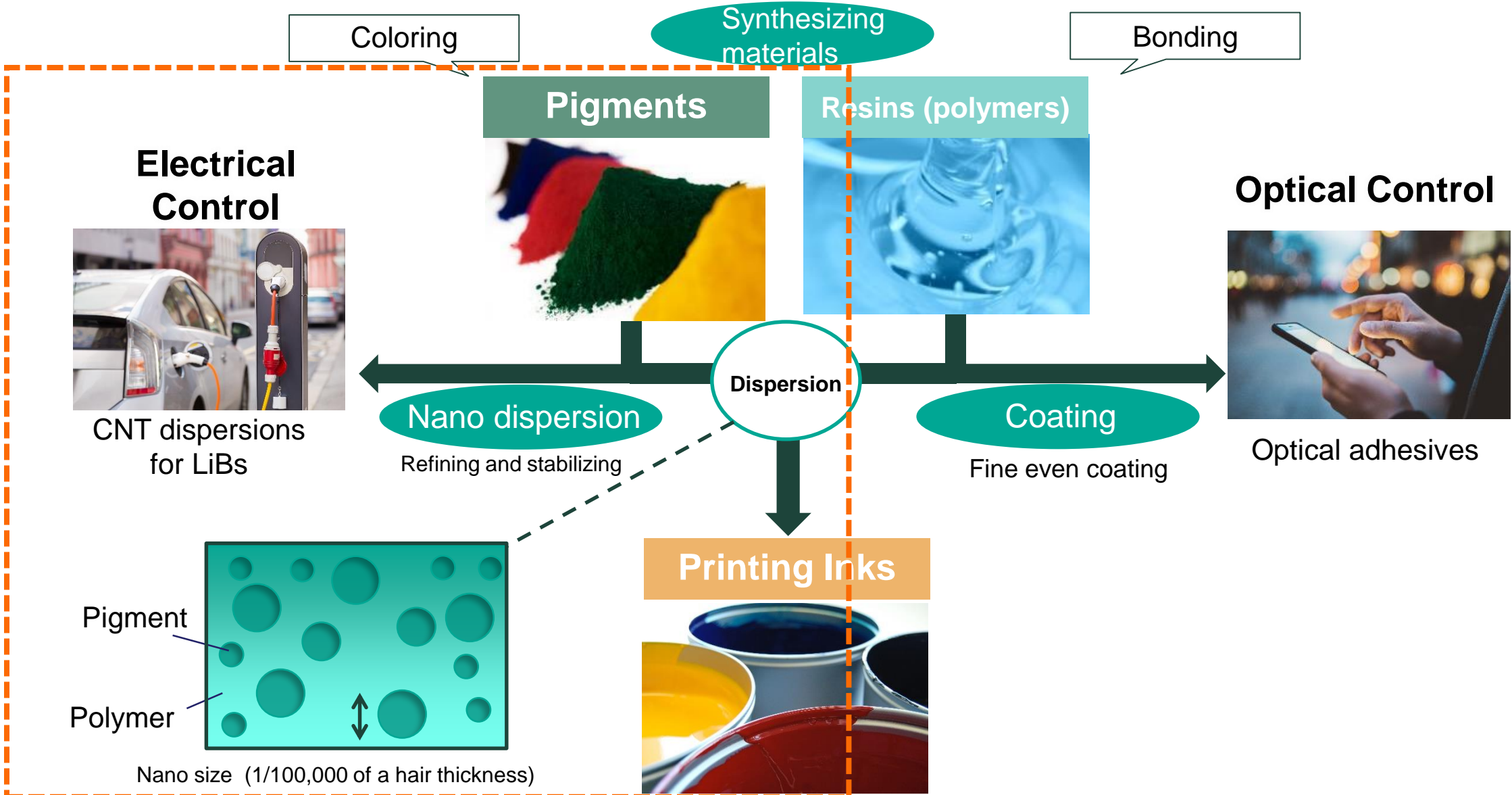
3) Focus efforts on the development of products for LMFP, for anode materials and for all-solid-state batteries in anticipation of future technology trends.

\*Demand forecasts are based on the end of July 2024.

\*In this presentation material, the following are synonymous with each other unless otherwise noted.

- Carbon Nanotube (CNT) dispersions for cathode materials of lithium ion batteries
- CNT dispersions for LiB positive-electrode materials
- CNT dispersions for LiB

# Unique Core Technologies and Expansion of Business Areas



# History of Evolution with dispersions as the Core Technology

Applying Dispersion Technologies Which Have Been Accumulated for Many Years in Materials for LiB

Lengthy track record in automotive LiB

~1990



for automotive coatings

- ✓ Development of fine dispersion technology for conductive carbon black.
- Adopted for use in Data storage tapes

1990~



Date storage tapes

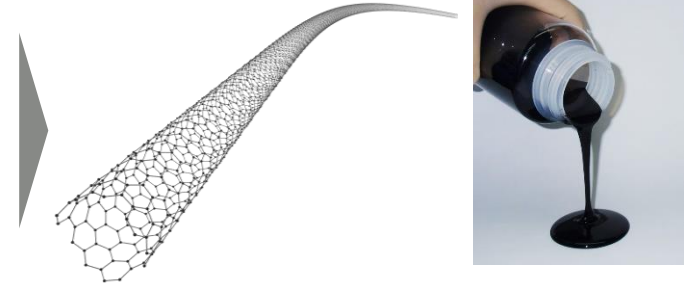
2015~



CB Dispersions for LiB cathode

- ✓ Adopted for LiB of HEV
- ✓ Birth of **LIOACCUM™** as battery use

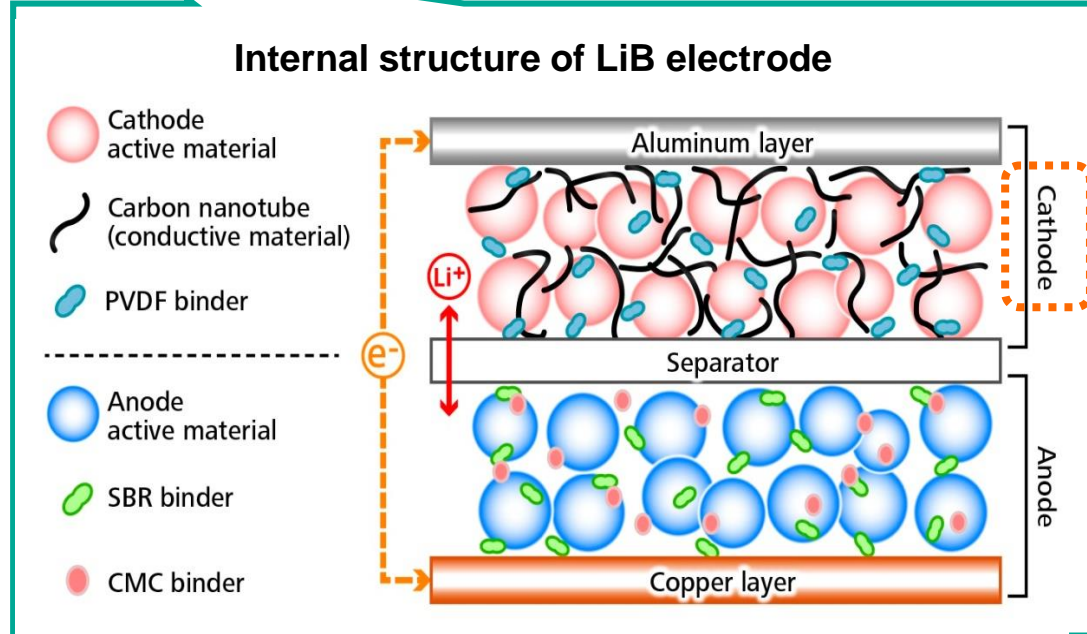
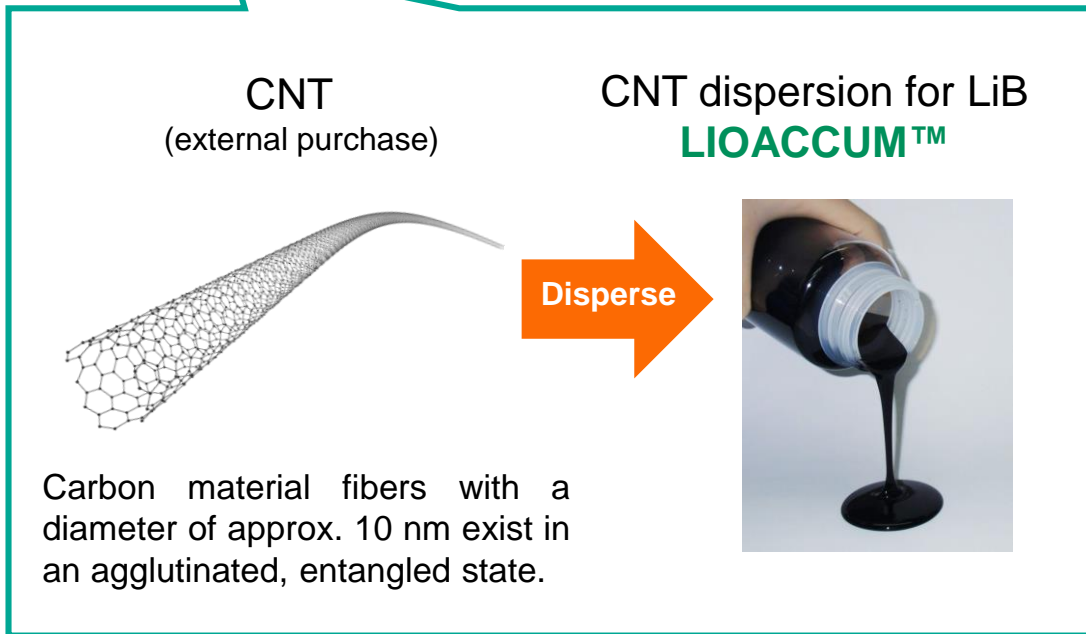
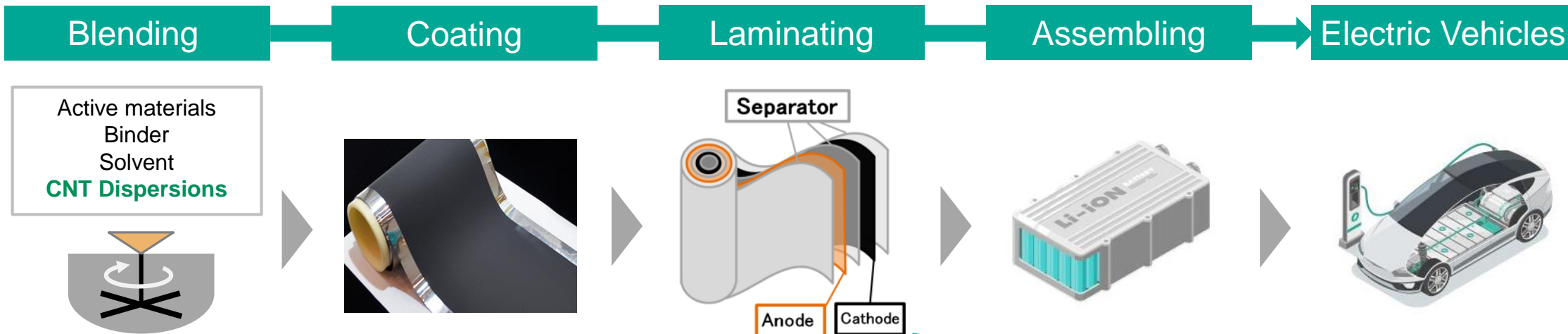
2019~



CNT Dispersions for LiB cathode

- ✓ **LIOACCUM™**: Adopted for LiB of EVs
- ✓ It was created by dispersing CNT, a next-generation conductive material, by using our proprietary technology.

# LiB Production Process and CNT Dispersions LIOACCUM™



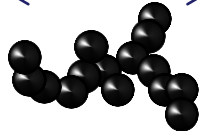
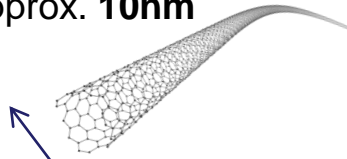
# Effect of Using CNTs in LiB as a Conductive Agent

- CNTs are more conductive and elongated than conventional conductive agent (CB: carbon black).

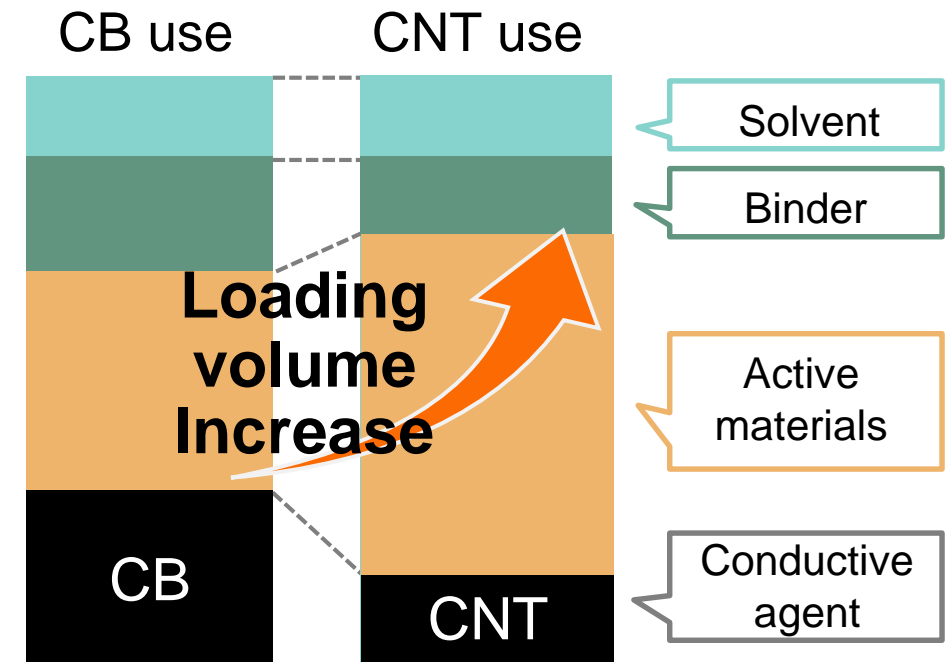
## Advantages of using CNTs

- **High capacity:**  
The capacity of LiB is increased by increasing the active materials inside the battery.
- **High output:** Increasing the output of LiB with high conductivity
- **Long life:**  
The service life of LiB is increased through the uniform use of the active material.

## ■ Conductive agent's features

	CB	CNT
Shape, size	<p>Approx. 500nm</p>  <p>A structured form with connected particles</p>	<p>Approx. 10nm</p>  <p>Fine and long fibers</p>
Conductivity	Low	High
Additive amount	More	Less
Dispersion difficulty	Easy	Difficult

## ■ Cathode material's components



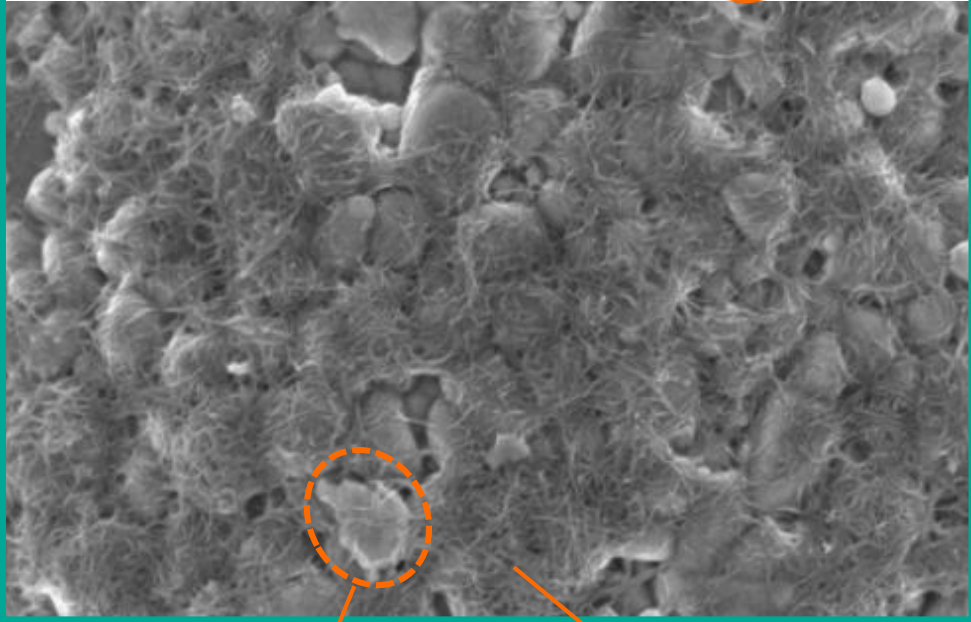
# Our Technical Strengths of CNT dispersions LIOACCUM™

- Damage-free unraveling of long, thin materials and absorbing to the surface of active materials
- Our products form a conductive network with a smaller amount of additives.

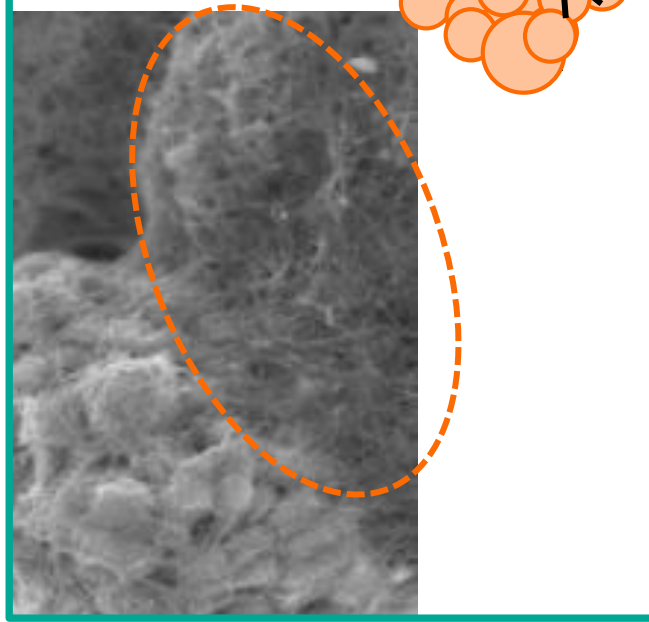
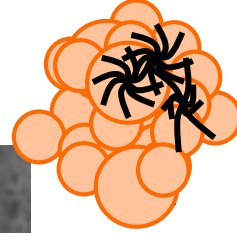
Contributes to improved battery performance  
(Increased capacity, output, and life)



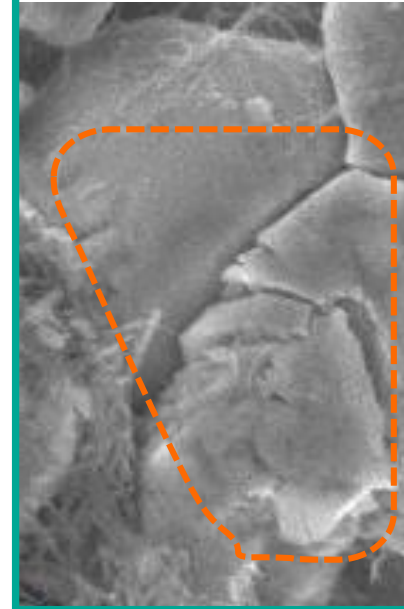
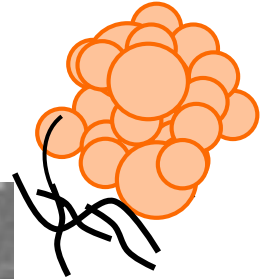
CNTs are uniformly adsorbed onto the surface of the active materials.



CNTs **clump** together and are **unevenly** adsorbed onto the surface of the active materials.



CNTs are **partially removed** from the surface of the active materials.



active material



CNT (White elongated line in the photo)



# EV Market Overview and Trends

## Background behind the expansion of EVs: Automakers face the urgent task of responding to environmental regulations.

- CAFE regulation in Europe (CO2 emission regulation  $\hat{=}$  Fuel consumption regulation)  
If the use of EVs continues to increase at the current rate, the total amount of the fine will exceed tens of billions of euro in 2030.
- ZEV regulations in the US (passed by California and 13 other states): The purchase of carbon credits is rejected when there is a failure to comply with fuel consumption regulations.  
⇒ It becomes virtually impossible to sell vehicles in the target area.

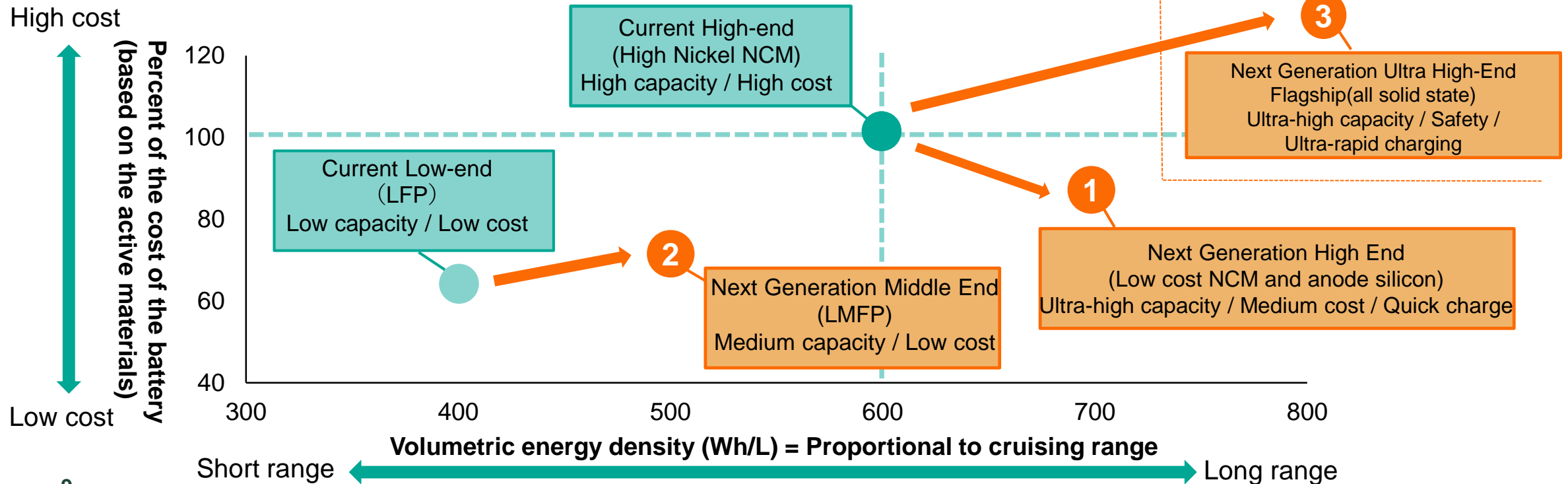
## Challenges regarding the popularization of EVs

Price      cruising range      Charging time

EVs diversify to suit different uses and lifestyles, and the needs for LiBs are also changing

## LiB development trend reflecting the diversification of EVs

CNT dispersions are important for next generation LiBs in all categories (1), (2) and (3).



# Types of Automotive Batteries and Developed Products Using LIOACCUMTM™

- LIOACCUM™ is used as a cathode conductive agent in the currently produced high-end LiBs using NCA/a ternary active material (NCM).
- ① Next-generation high-end LiBs: A CNT dispersion was also developed for silicon anodes aimed at achieving high capacity batteries. Customer evaluations are in progress.
- ② Next-generation middle-range LMFPs: A CNT dispersion that caters to new demand for products in the medium-capacity and low-cost LMFP market.
- ③ Super-high-end all-solid-state batteries: We are working together with customers to develop CB and CNT dispersions.

Electrolyte	EV Trends	Needs for automotive batteries	Cathode materials		Anode materials	
			Active materials	Conductive agent	Active materials	Conductive agent
Liquid	Current Low-end	Low capacity / Low cost	LFP	CB	Graphite	-
	② Next Generation Middle End	Medium capacity / Low cost	LMFP	CNT		
	Current High-end	High capacity / High cost	NCA/Ternary (High Nickel NCM)			
	① Next Generation High End	Ultra-high capacity / Medium cost / Quick charge	Ternary (Low cost NCM)		Graphite · SiO <sub>x</sub> /SiC	CNT
Solid	③ Next Generation Ultra High-End	Ultra-high capacity / Safety / Ultra-rapid charging	Ternary	CB/CNT	Graphite	-

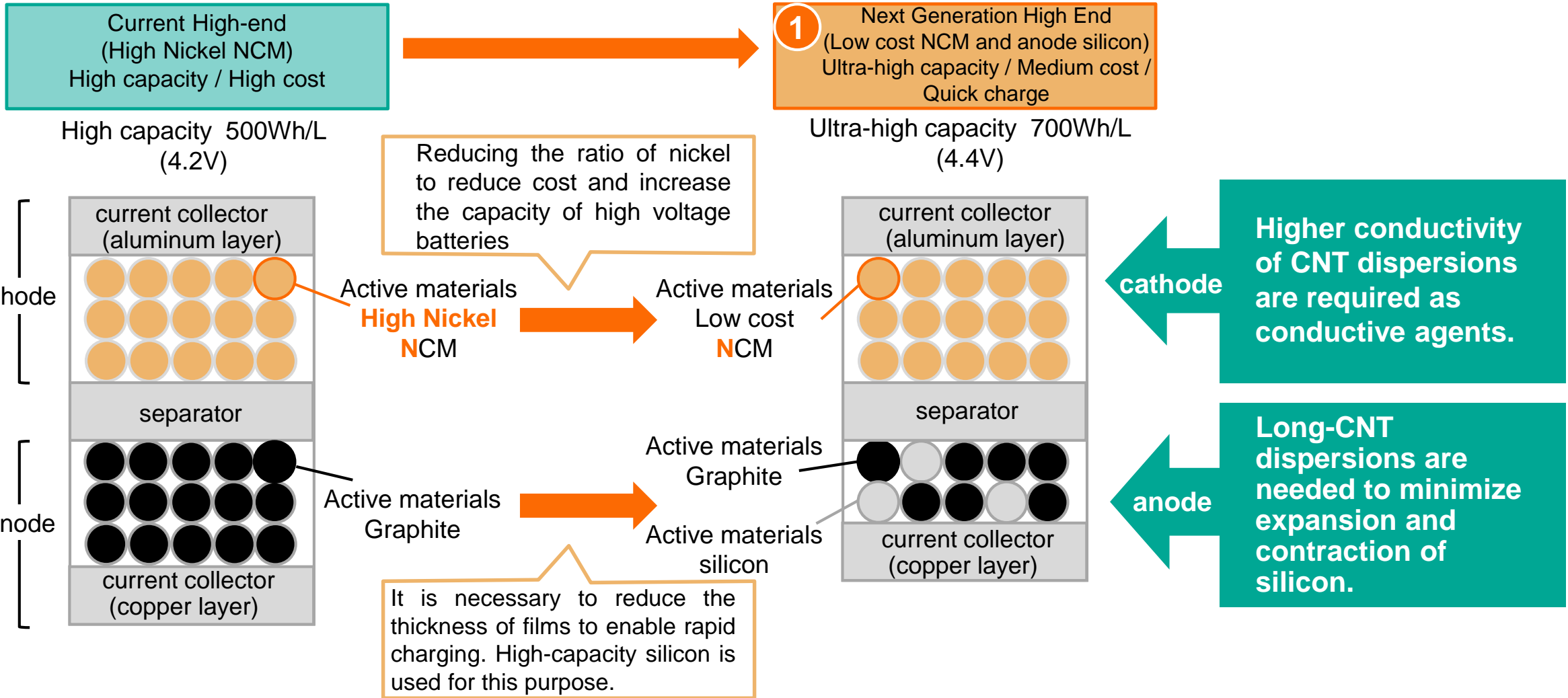
\*1 : LFP 【Lithium iron phosphate】 A cathode active material with low energy density and low cost. \*2 : LMFP 【Lithium manganese iron phosphate】

\*3 : NCA 【Li (Ni Co Al) O<sub>2</sub>】 /Ternary (NCM) 【Li (Ni Co Mn) O<sub>2</sub>】 A cathode active material with high energy density.

\*4 : SiO<sub>x</sub>/SiC (Silicon-based active material) Anode active material with capacity more than four times greater than that of graphite. Its problem is that it expands and contracts significantly during charge and discharge.

# ① Development of CNT Dispersions for Next Generation High End Lib

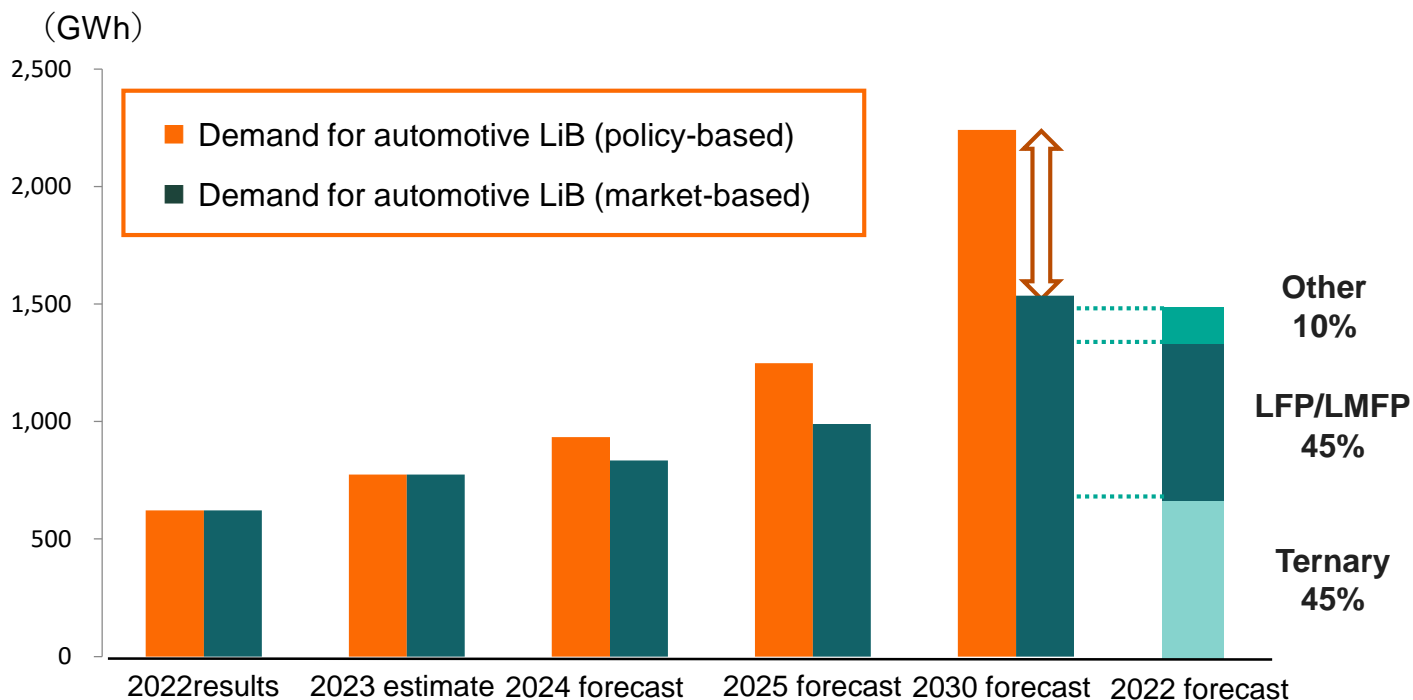
- CNT dispersions are needed for cathode materials and anode materials to reduce battery cost, increasing capacity and enabling rapid charging.



# Market Forecast for Automotive LiB and Conducting Agents

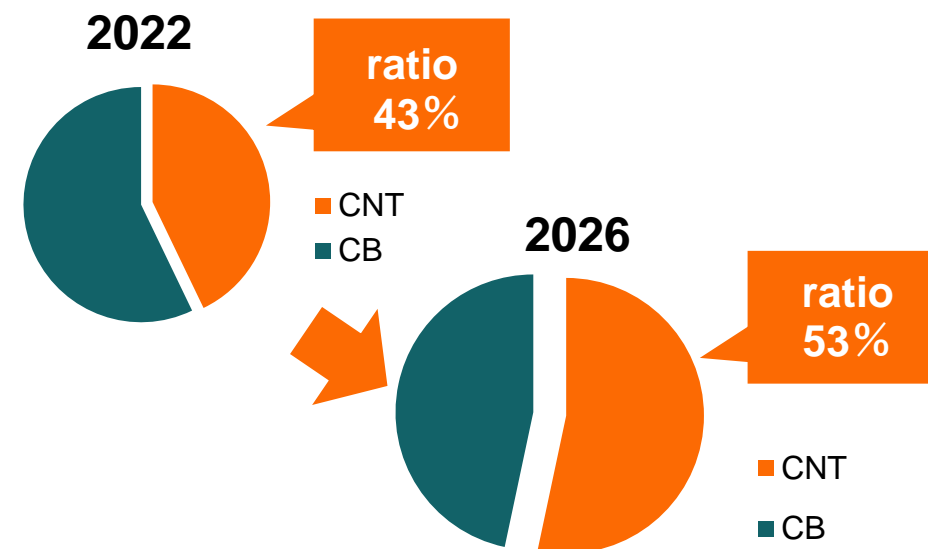
■ Sales of HEVs are increasing from the second half of 2023 as growth in the EVs market continues to slow. However, the shift to EVs as a medium- to long-term trend will remain unchanged. A gap has emerged between the initial policy-based forecast and the market-based forecast, and growth of EVs, including infrastructure, is essential to achieve carbon neutrality.

## ■ Forecast for demand for automotive LiB and ratios by type\*



## ■ Market size forecast of conductive agents by type (Percentage by sales amount base)

**CNT outperform CB in sales amount base due to increased use as conductive agents.**



Sources: Demand for automotive LiB) Yano Research Institute Ltd. "Global Automotive Lithium-ion Battery Market: Key Research Findings 2023", released on December 28, 2023 / Ratio of battery types as of 2030) Estimated by the company

Estimated by the company : The market size of conductive agents is based on powder, including CNT and CNF.

# Overview and Outlook of CNT dispersions for LiBs

## Overview of 1H of FY2024 :

Sales decreased year on year to 2.1 billion yen due to the persistently sluggish EV market. In particular, demand was weak in Europe and the US. Preparations for production in China have been completed, and there has been progress in the development of products for next-generation batteries.

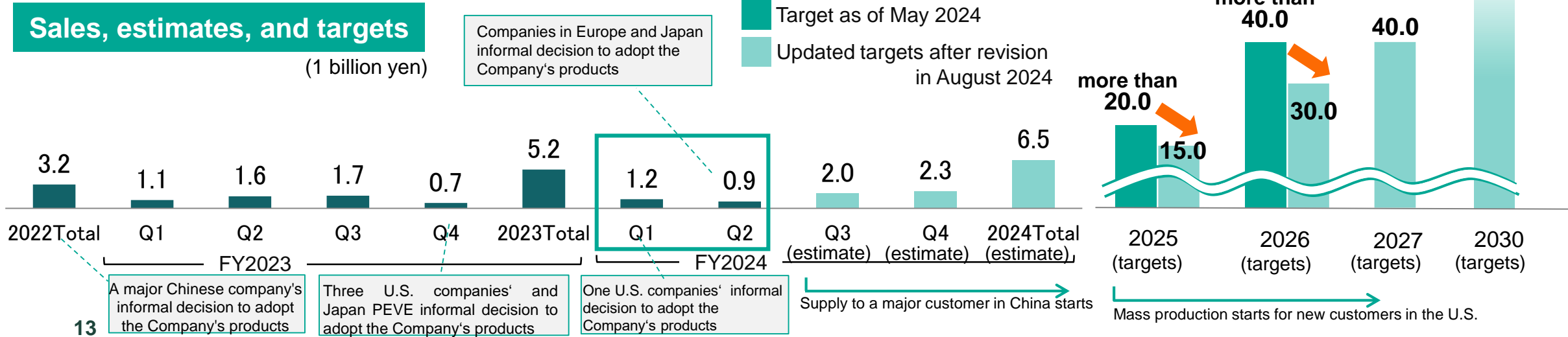
## Major news in Q2 of FY2024 :

- Sites in Georgia, US and in Hungary: In business for SKon, demand has remained weak. Newly adopted informally by a EU customer.
- Site in Kentucky, US: A new plant is under construction, with production expected to begin in 2025. The scale of production will be two to four times larger than Georgia.
- Site in Zhuhai, China: Production for a major customer commenced in July. We expect an increase of at least 20% over our forecast in Feb.2024.
- Site in Japan: Following PEVE, another customer newly adopted our product informally.

## Future prospects :

The recovery of demand in Europe and the US will continue to be slow, and the production for a major customer in China is expected to be the driving force for the business. For 2025 and beyond, there has been no change to the informal decisions made by customers, including other customers that are expected to select our products, but targets for 2025 and 2026 have been changed, reflecting the latest forecasts. The achievement of 40.0 billion forecast has been postponed to 2027, one year later than initially expected. Activities to obtain new offers are ongoing.

(Newly developed products, such as products for anodes and LMFPs, are not included in the targets below.)



# Top CNT dispersion manufacturer supplying from five production sites in four regions of the world

## North America

### Georgia

LioChem, Inc. is the key CNT dispersion production base in North America. Production began in 2021 following the expansion of an existing base. The production volume will be increased by the facilities, which are located close to customers including SKon.

### Kentucky

LioChem e-Materials LLC was established in January 2023 to augment production capacity in anticipation of the future growth of demand. The plan is to start mass production in 2025, and the production capacity in North America is expected to increase significantly.

Total number of companies that have begun using our products: 5



LioChem Inc.



LioChem e-Materials LLC

## Europe

### Hungary

TOYO INK HUNGARY KFT., our core base in Europe, began production in 2022. To date, investments up to the third phase have been completed. We plan to act flexibly to prepare for the future expansion of the market.

2



TOYO INK HUNGARY KFT.

## China

### Zhuhai

Zhuhai Toyocolor, which is the Toyo Ink Group's dispersion manufacturing base in China, decided to expand its facilities in 2023 in response to the adoption of its products by a major battery manufacturer in China. Full-scale production commenced in July 2024.

1



Zhuhai Toyocolor Co., Ltd.

## Japan

### Fuji

The Group's core technology development base. We are planning to expand the facility for the production of products for manufacturers in Japan, including the production of a CNT dispersion that was chosen to be used in HEVs in Japan for the first time.

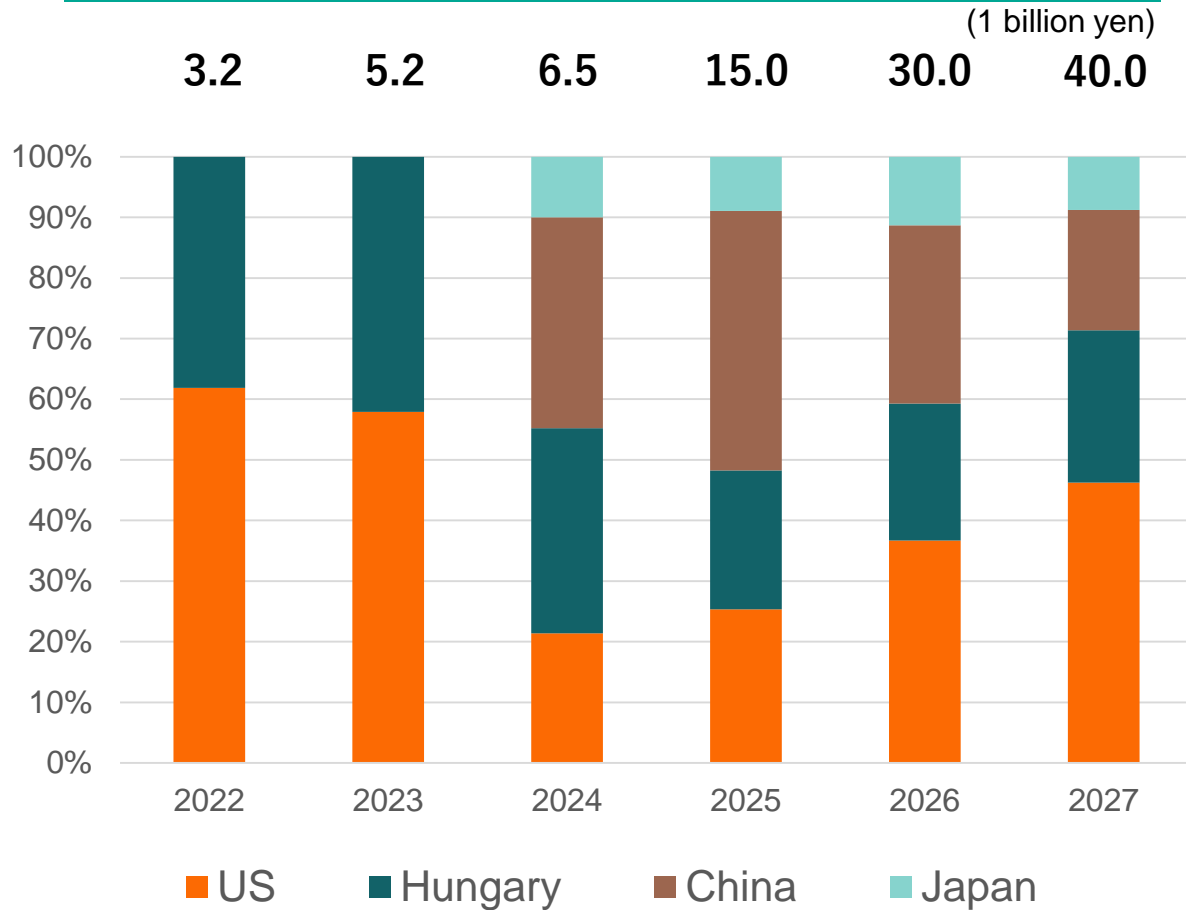
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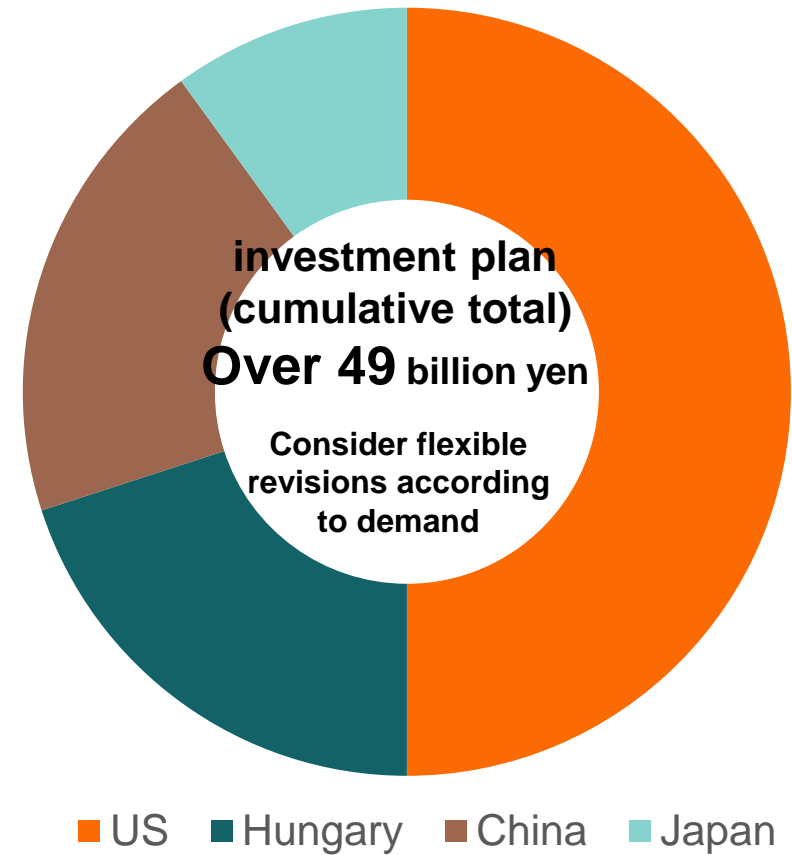
Fuji factory, Toyocolor Co., Ltd.

# Estimated sales and investment ratio by area

Estimated sales ratio by area



Estimated investment ratio by area



## Our Competitive Advantages

### 1 ) A professional in dispersion

We have proprietary technologies for dispersion that have been accumulated over more than 100 years and CNT's surface modification.

### 2 ) Many years of trust and a long track record

With 10 years of experience in lithium-ion battery materials for automotive applications, we have established a network with customers around the world. Based on the latest information, we have also started development for the next generation.

### 3 ) Top CNT dispersion manufacturer supplying from five production sites in four regions of the world

We have built a system for stable local procurement, production, and supply in the U.S., Europe, China, and Japan as major markets.



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■ **Website**     <https://www.artiencegroup.com>

## ■ Major News Releases

- **Toyocolor conductive CNT dispersions adopted for Toyota hybrid vehicles** (Feb.06 2024)

<https://www.artiencegroup.com/en/news/2024/24020601.html>

- **Chinese EV Battery Maker To Adopt Toyocolor's Battery Materials** (Feb.13 2023)

<https://www.artiencegroup.com/en/news/2023/23021302.html>

- **Toyo Ink Establishes Second U.S. Production Site for Li-ion Battery Materials**  
**Boosts conductive CNT dispersion capacity to 4x current level to meet rapidly growing demand in U.S. EV battery market** (Feb.13 2023)

<https://www.artiencegroup.com/en/news/2023/23021301.html>

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