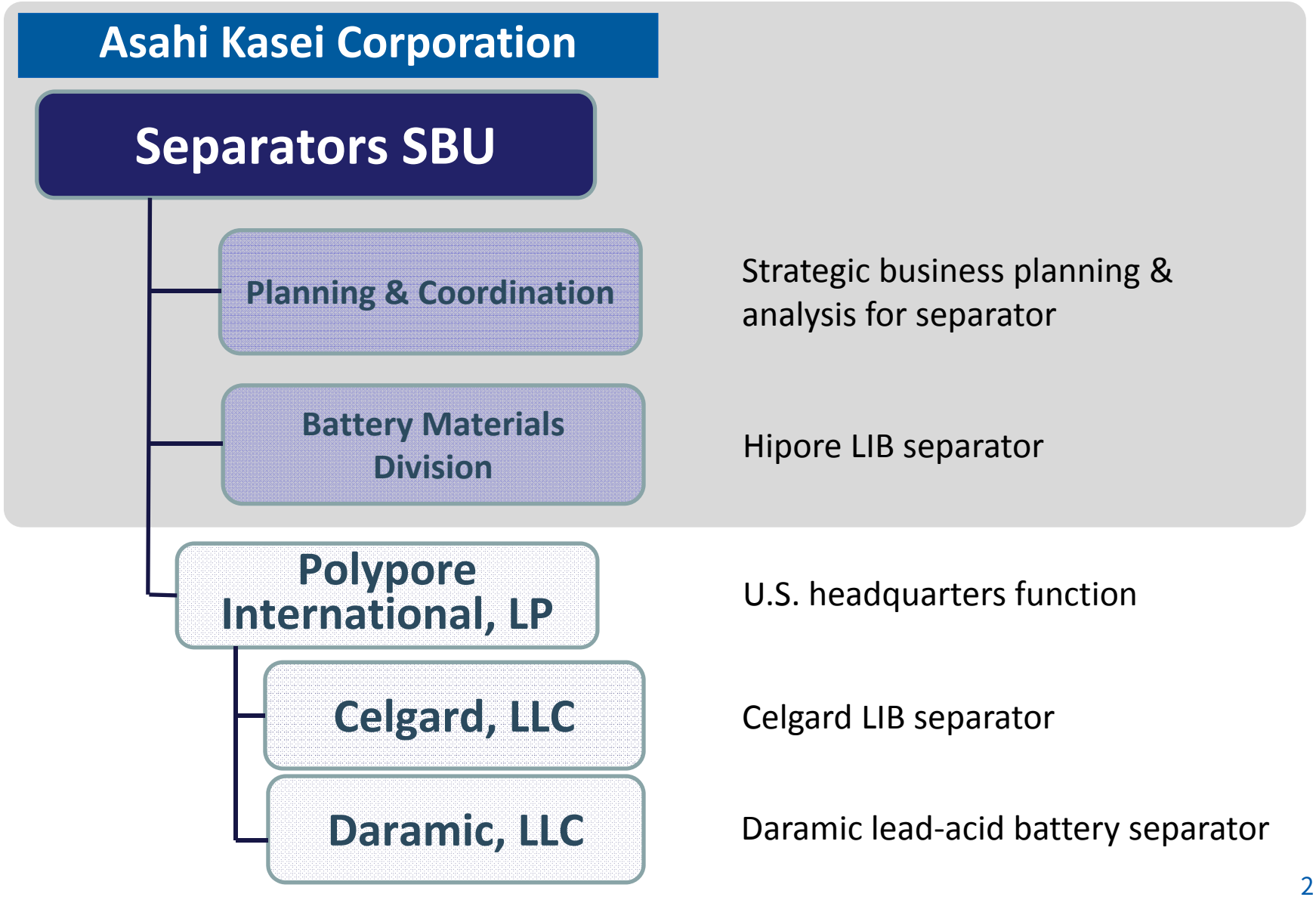
AsahiKASEI

Material Sector Business Briefing

Separators SBU

September 8, 2016
Asahi Kasei Corp.

Separators SBU



Overview of Polypore

Acquisition of Polypore announced in February 2015 and closed in August 2015

Pursuing growth strategy of battery separator business with high growth potential

- **R&D and manufacturing technology**
- **Marketing**
- **Human resources and corporate culture**

Polypore

Battery Separator Business*

Net sales **$450 million** Operating income **$87 million**

(segment income before corporate expenses)

Lithium-ion battery separator

CELGARD Net sales **$127 million**

Applications:

- Mobile electronics
- Power tools
- Eco-friendly vehicles
- Energy storage systems

Lead-acid battery separator

DARAMIC Net Sales **$323 million**

Applications:

- Automobiles, trucks, buses
- Forklifts
- Backup power

* Polypore's Energy Storage Segment results in 2014.

Battery Separator Business Overview

Integrate technology and marketing, accelerate delivery of value to customers

- Shift from organizational integration to new value proposals for customers
- Utilize Asahi Kasei Group technology for materials, analysis, and manufacturing
- Optimize global manufacturing, marketing, and development configuration to meet customer needs

HIPORE

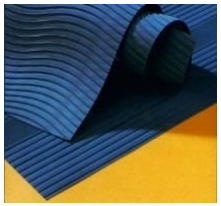
Wet-process Li-ion battery separator

- Presence and development strength in **CE** (consumer electronics)
- Continuing growth of IT-related markets

CELGARD

Dry-process Li-ion battery separator

- Strength in **EDV** (Electric Drive Vehicle) applications
- Rapid market expansion from stricter environmental regulation



DAIRAMIC

Lead-acid battery separator

- World-leading presence
- Stable market growth centering in emerging countries
- Market inflection with spread of ISS* vehicles

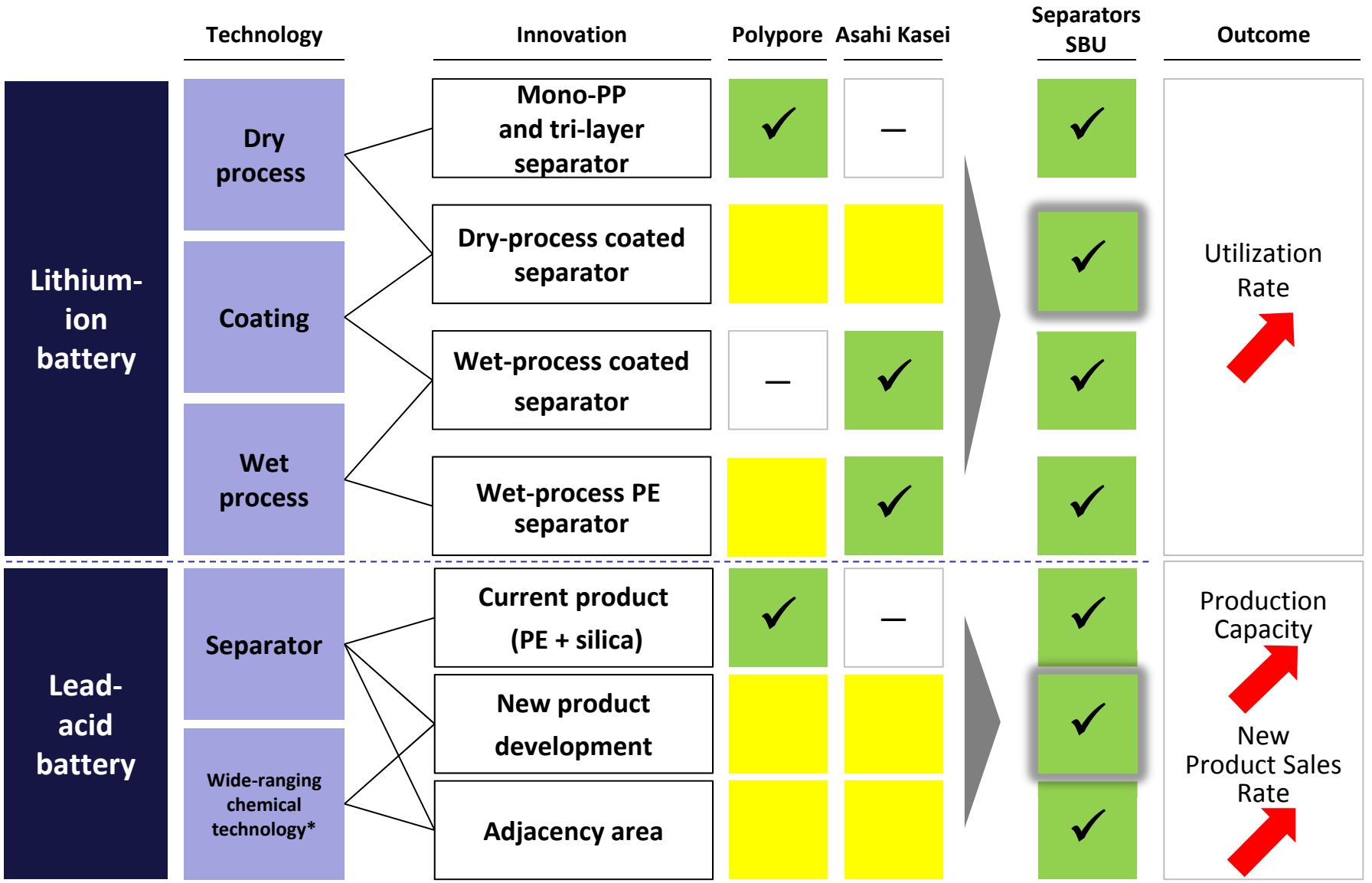
Solidify world-leading position through unique solution proposal ability having both wet and dry processes, with global manufacturing, marketing, and development configuration, meeting various customer needs

Strengthen customer support, capture demand in emerging markets, develop new products with group technology

Pursue synergy between lead-acid and Li-ion battery separators

*ISS = Idling stop and start

Technology innovation



* Analytical capability, material technology, electrochemistry.

Technology innovation and business transformation (1)

1. Celgard

■ EDV[*1] : Dry-process coated separator

- Product development

  Commercial sample (sample products manufactured on mass production line) developed

  → ready for mass production

- Early start-up of Celgard commercial coating line

  Applied Hipore coating technology and know-how

  → commercial line in operation

■ CE[*2] **:** Technology and process innovation at Celgard Korea, Ltd.

- New products developed with sequential stretch process (wet)

  → ready for mass production

- Improved quality, productivity, and yield

  Applied Hipore production technology and know-how

*1 Electric Drive Vehicle
*2 Consumer Electronics

Technology innovation and business transformation (2)

2. Daramic

- Analysis by Asahi Kasei's Analysis & Simulation Center
  - Analysis of quality flaws and mechanism of functional expression
    → opened path to new product development
- Process improvement by Asahi Kasei's Corporate Production Technology
  - Improved quality, productivity, and yield
    → customer complaints resolved, sales increased
- New product development through procurement of high-quality, high-performance materials
  - Studying adoption of Asahi Kasei's Sunfine ultrahigh molecular weight polyethylene
    → opened path to new product development
- Marketing and technical service in Japan by Asahi Kasei
  - Swiftly handling the Japanese market
    → ripple effect in Asian markets

Technology innovation and business transformation (3)

3. Business transformation

- Cost reduction by revising Polypore's corporate function
  - Administrative overhead
    → reduced by approximately half
  - Utilizing global infrastructure & professional functions
    → synergy within Asahi Kasei Group
- Leveraging Asahi Kasei's purchasing power for global procurement and sourcing, Raw materials, logistics, etc.
    → cost reduction
  - Jointly accessing Japanese leading-edge equipment & machine manufacturers
    → high quality, state-of-the-art equipment and tooling

Characteristics of our separator business: Both lead-acid and lithium-ion (1)

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Our lead-acid battery separator business and lithium-ion battery separator business are both:

- ✓ The world's **market pioneer**
- ✓ The world's **technology leader**
- ✓ The world's **top supplier**

Characteristics of our separator business: Both lead-acid and lithium-ion (2)

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The world's **market pioneer**

- **The world's first mass production of the present battery separator**
- **Establishment of the *de facto* standard**

→ technology and know-how accumulated over many years

Lead-acid battery separator (lead-acid battery invented by Gaston Planté in 1859)

- Daramic business founded in 1930
- Commercialized world's first polyethylene separator in 1972

Lithium-ion battery separator (lithium-ion battery invented by Dr. Akira Yoshino in 1985)

- Celgard and Hipore each developed from late 1960s to early 1970s for various applications
- Celgard (polypropylene) and Hipore (polyethylene) were commercialized as lithium-ion battery separator in early 1990s

Characteristics of our separator business: Both lead-acid and lithium-ion (3)

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The world's **technology leader**

- **Product technology**

  Product design capabilities and processing know-how that contribute to improved battery performance

- **Production technology**

  High volume and reliable supply capability

- **Evaluation technology**

  Separator development backed by battery evaluation technology

Characteristics of our separator business: Both lead-acid and lithium-ion (4)

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The world's **top supplier**

Global manufacturing and R&D in proximity to local markets

- Lead-acid battery separator
  - Manufacturing: Europe (Germany, France), the US (Kentucky, Indiana), Asia (India, Thailand, China)
  - R&D: Europe (France), the US (Kentucky), Asia (India)

- Lithium-ion battery separator
  - Manufacturing: Asia (Japan, Korea, China), the US (North Carolina)
  - R&D: Asia (Japan, Korea), the US (North Carolina)

Characteristics of our separator business: Both lead-acid and lithium-ion (5)

AsahiKASEI

Our lead-acid battery separator business and lithium-ion battery separator business are both:

- ✓ The world's **market pioneer**
- ✓ The world's **technology leader**
- ✓ The world's **top supplier**

Marketing: Quickly discerning market trends and technical requirements

R&D: Technology and know-how to meet requirements

Manufacturing: Providing stable supply at high quality and high volume

History of Hipore

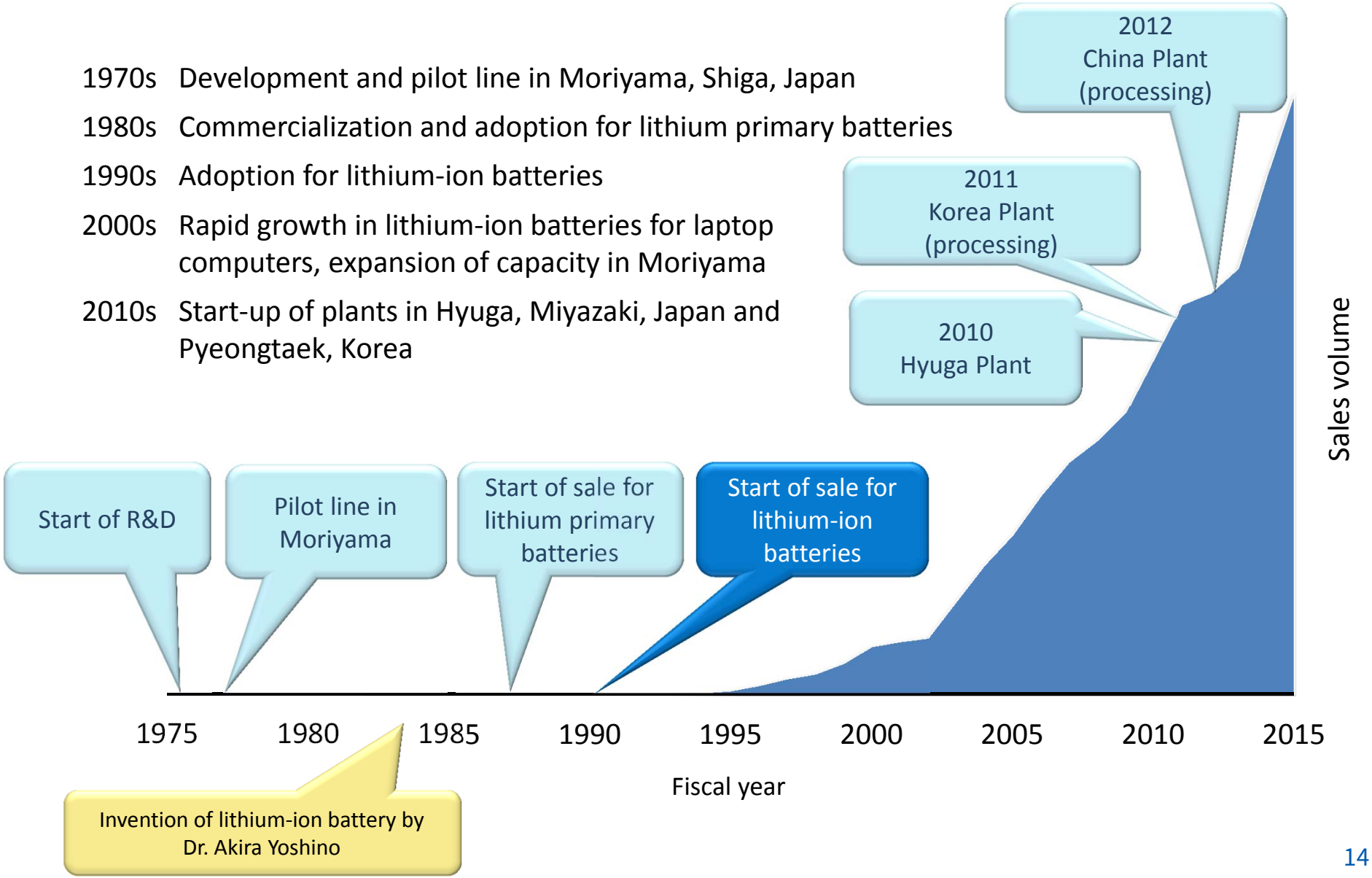
1970s Development and pilot line in Moriyama, Shiga, Japan

1980s Commercialization and adoption for lithium primary batteries

1990s Adoption for lithium-ion batteries

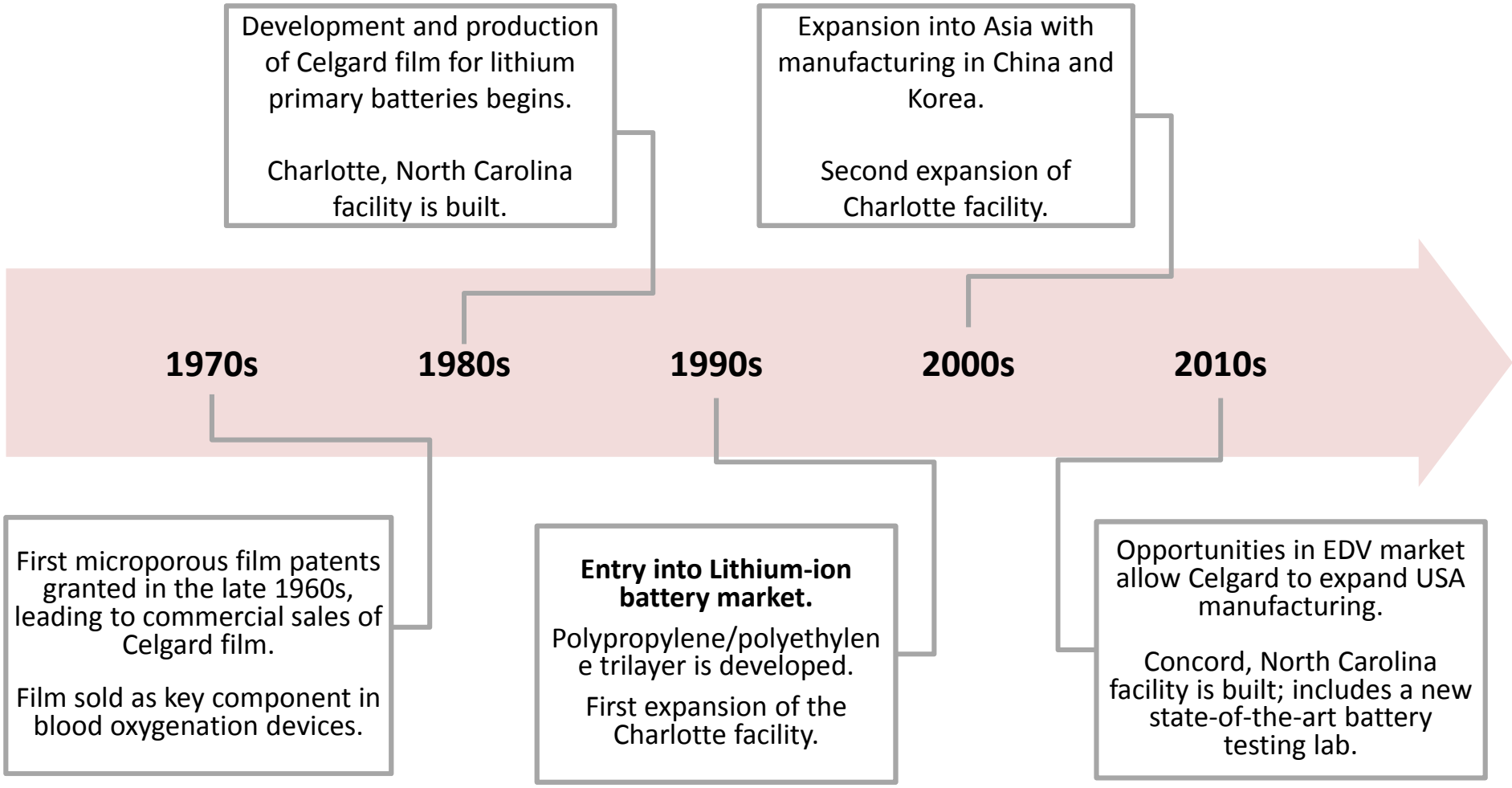
2000s Rapid growth in lithium-ion batteries for laptop computers, expansion of capacity in Moriyama

2010s Start-up of plants in Hyuga, Miyazaki, Japan and Pyeongtaek, Korea

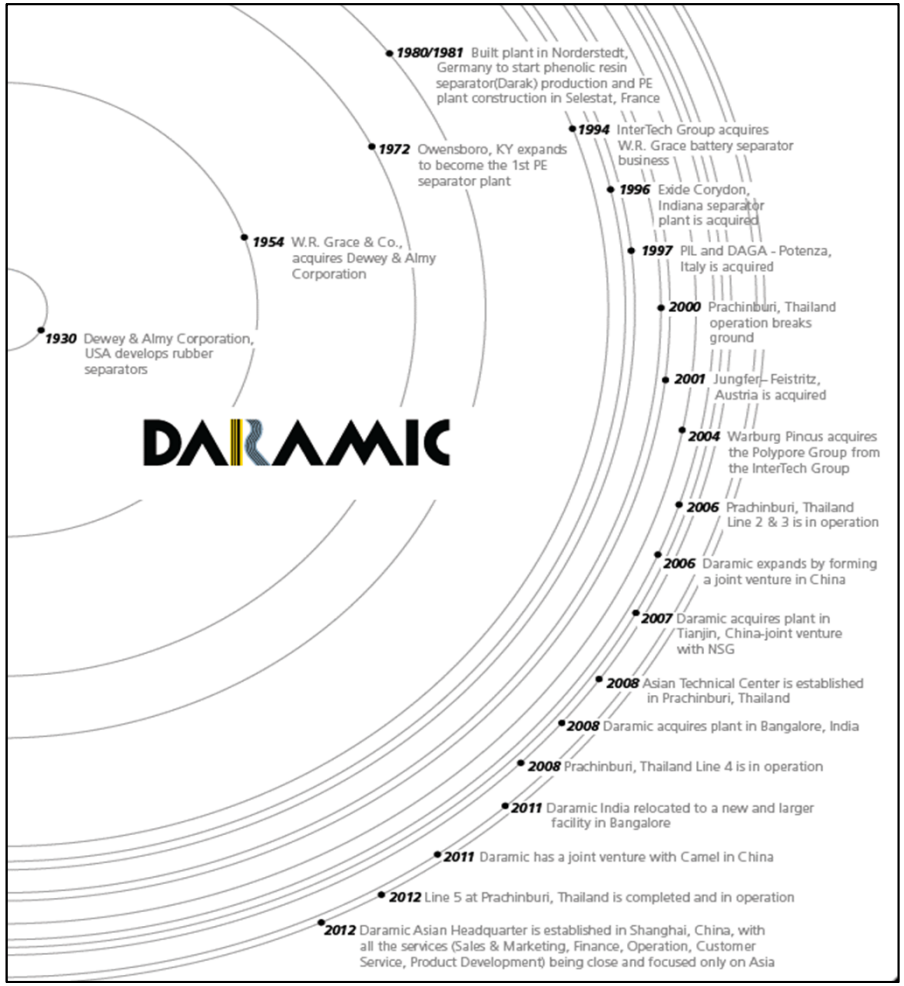


History of Celgard

With more than 40 years of market-leading research, development, and manufacturing, Celgard delivers **highly-engineered products with proven quality and performance.**



History of Daramic

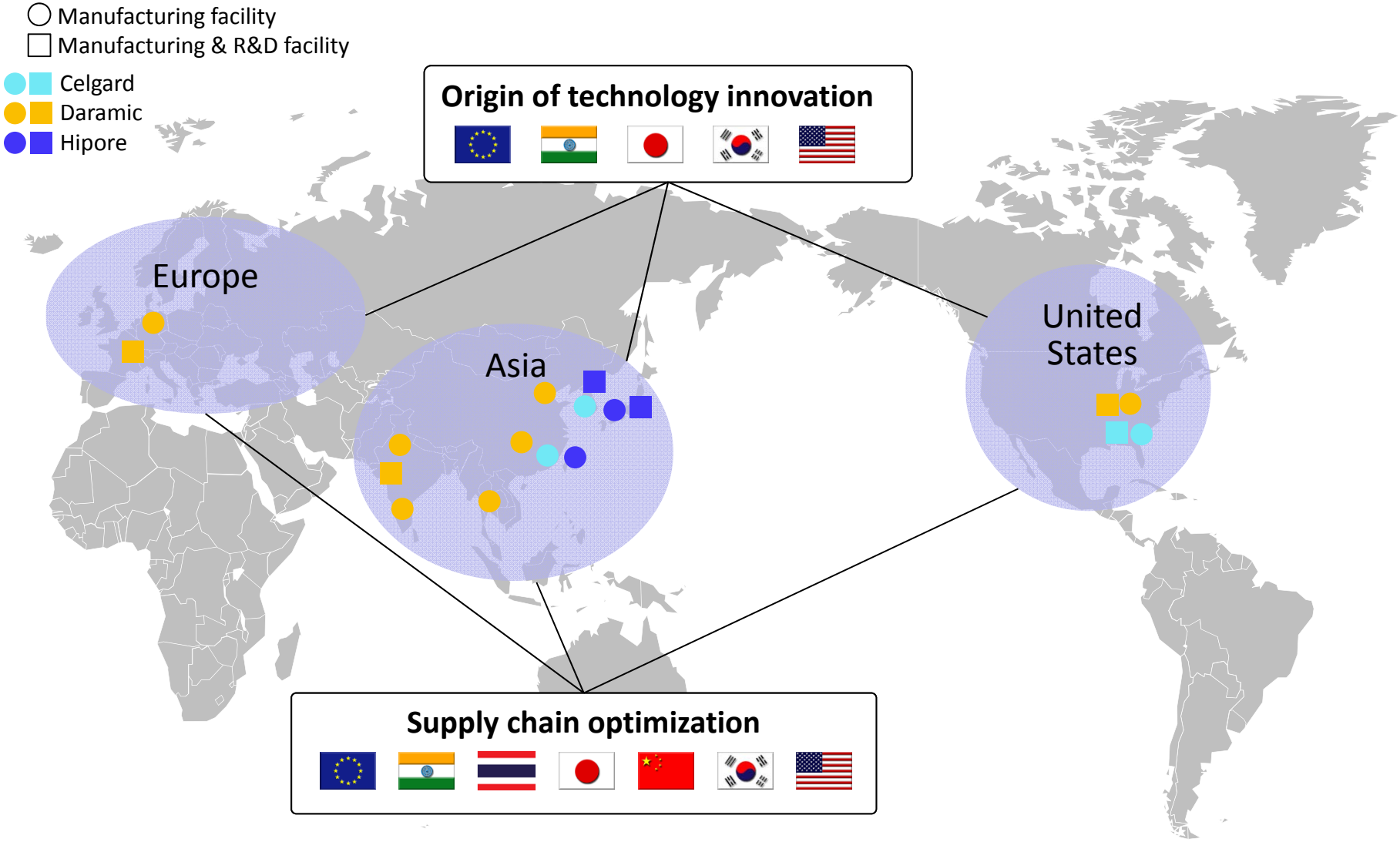


Continuous facilities upgrading and capacity increases

1930	Founded as Dewey & Almy Corporation, USA and developed rubber separators
1969 / 1972	Invented Polyethylene(PE) separator and Owensboro become the 1st PE plant in the world
1980 / 1981	Built phenolic resin separator(Darak) plant in Norderstedt, Germany and PE plant in Selestat, France to start operation footprint in Europe
2000	Built plant in Prachinburi, Thailand and started operation footprint in Asia
2004 / 2007	Became a Polypore company and became public in New York Exchange (NYSE:PPO)
2015	**Became an Asahi Kasei company**

For 86 years, Daramic has led the way in developing innovative technology for the lead-acid battery market

Global operations



Characteristics of our lithium-ion battery separator business

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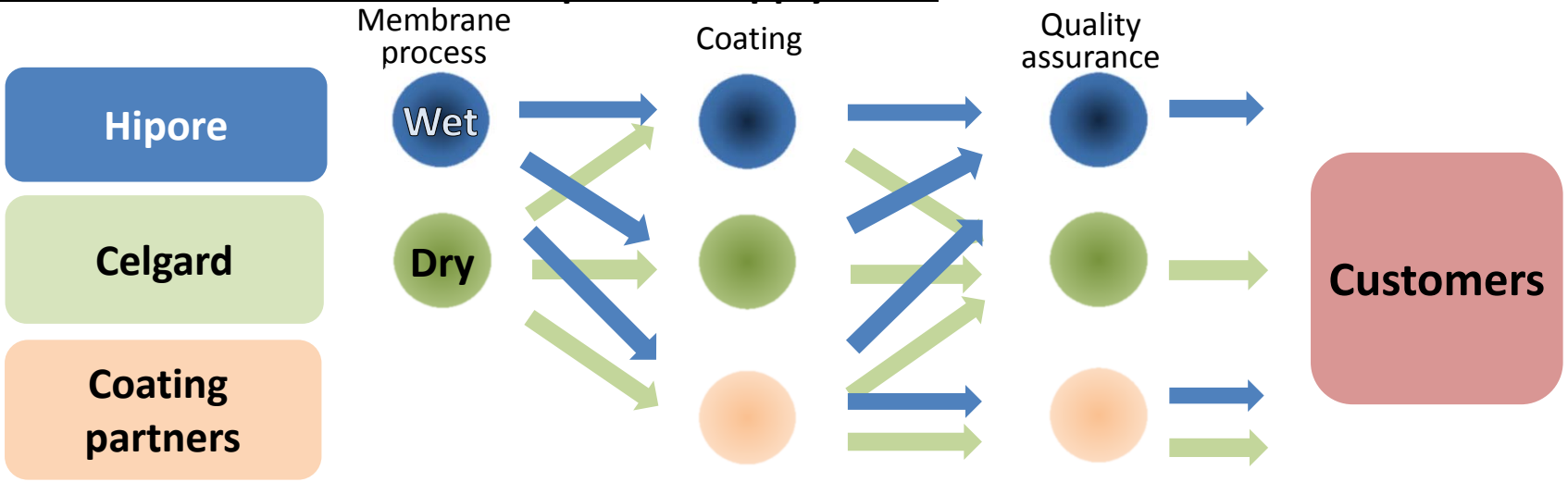
World's leading capacity and track record of supply for both wet-process and dry-process

- Able to provide optimum separator for various battery designs and performance requirements
- Supply capability backed by product technology and manufacturing technology
  → producing and evaluating samples on commercial line
  (especially important for EDV applications)

Established capability from R&D to high-volume supply for both membrane manufacturing and coating

- Both wet-process and dry-process manufacturing technology with coating technology and high-volume track record for coating both wet-process and dry-process membrane
  → supplying higher added value products through collaboration with coating partners

Schematic illustration of coated separator supply chain



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Lithium-ion battery separator manufacturing processes

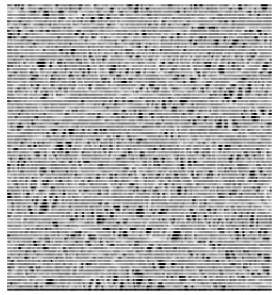
Wet process

Polymer and plasticizer

Features of wet-process separator

Various control factors, e.g., plasticizer, polymer and stretching conditions, enable ***diverse design and control of pore structure***. Thinner membrane formation is possible.

- Extrude the mixture of molten **polymer and plasticizer** and obtain the precursor film.
- Stretch and control the film structure. Bi-axial stretching in both machine and traverse directions is conventional.
- Extract the plasticizer and form the porous morphology.



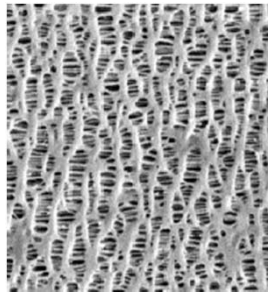
Dry process

Polymer only

Features of dry-process separator

No plasticizer extracting and treatment is necessary. ***Solvent free, simple process contributes to lower manufacturing cost***.

- Heat up and melt the crystalline polymer and obtain the extruded film.
- Stretch the film to tear the crystalline interfaces, and form the porous structure.



Lithium-ion battery separators

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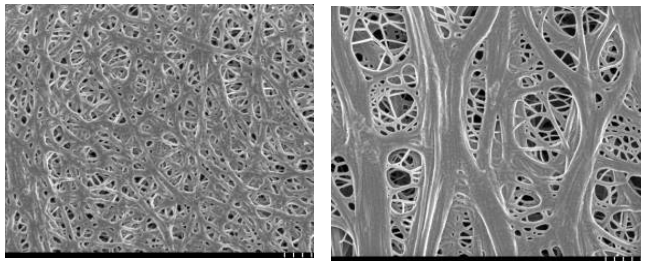
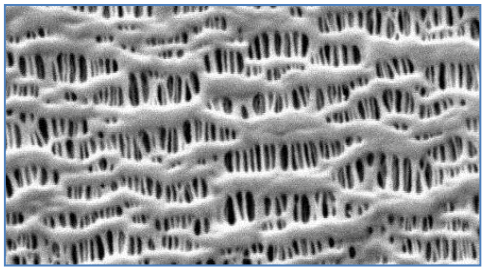
Base film

HIPORE (wet process)

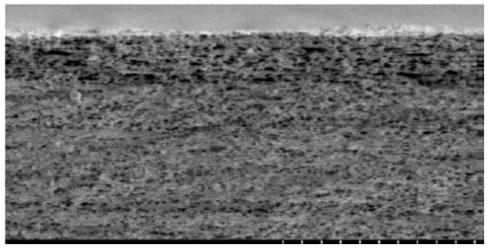


N-series S-series

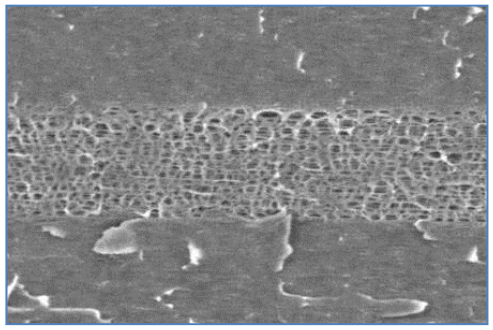
CELGARD (dry process)



Monolayer PP



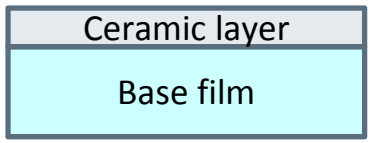
Layered membrane



Trilayer PP/PE/PP

Laminated and co-extruded

Coating

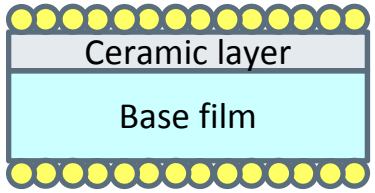


Ceramic

(Heat resistance)

Polymer

(Adhesiveness)



Combined

(Heat resistance + adhesiveness)

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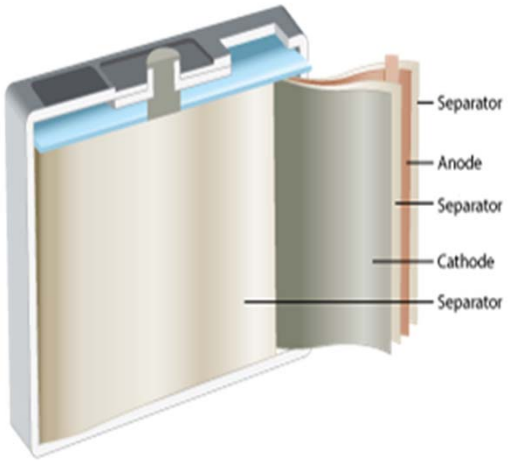
Lithium-ion battery separator for EDV applications

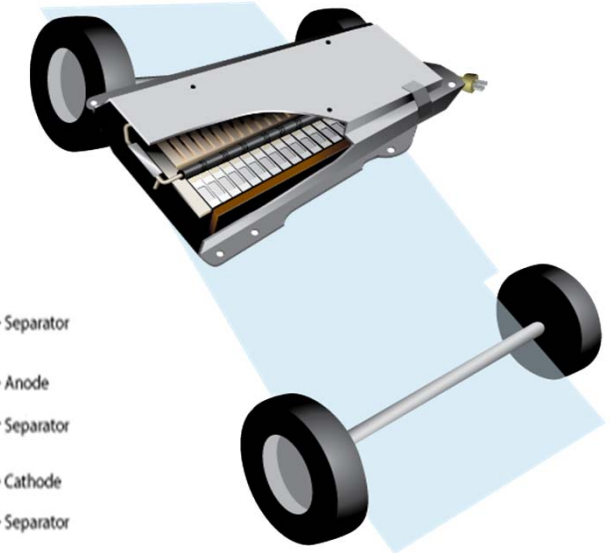
Cylindrical cells

Battery packs containing cylindrical cells are used by some vehicle manufacturers.
(ex: Tesla, some Chinese electric bus manufacturers)

Prismatic cells

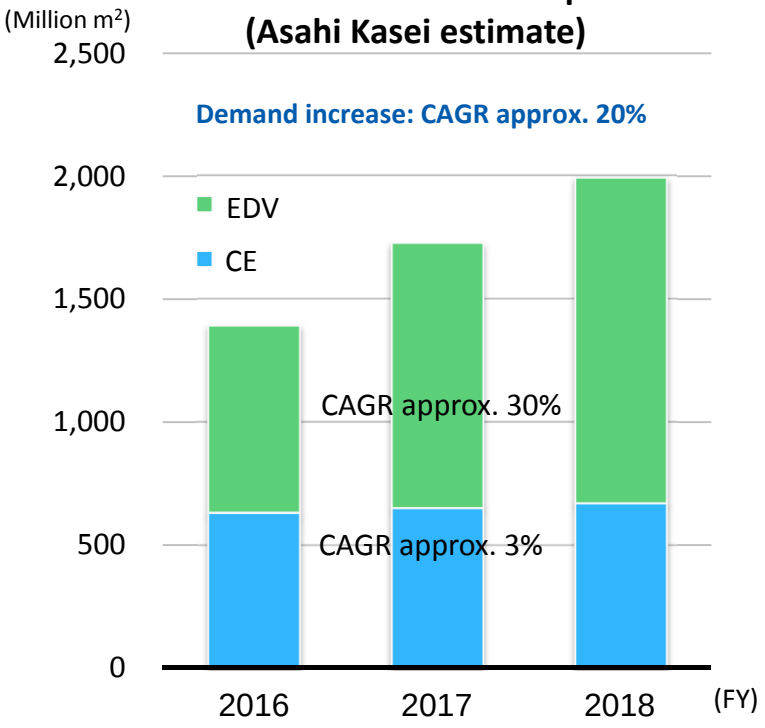
Electric vehicles typically contain a single battery pack containing several large-format prismatic cells which are configured into module packs.



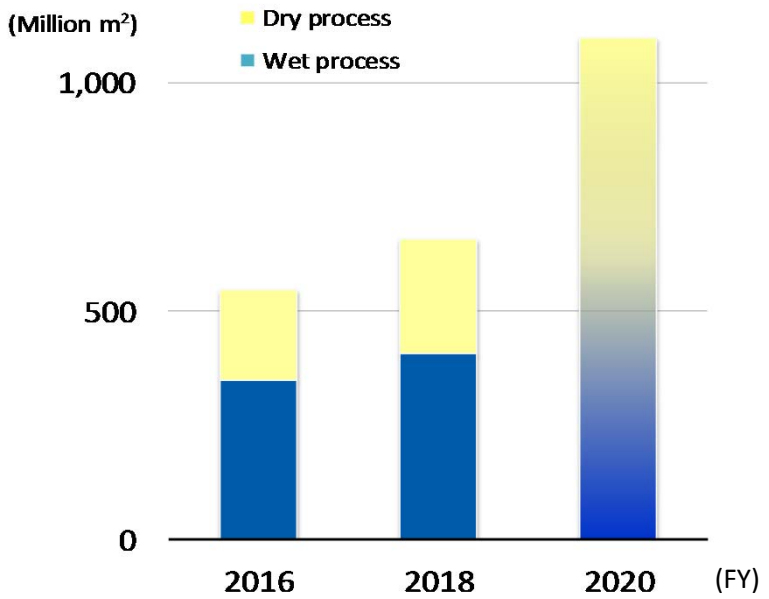


LIB separator demand growth and capacity expansion

Demand forecast for LIB separator (Asahi Kasei estimate)



Asahi Kasei production capacity for LIB separator (planned as of May 2016)



Capacity expansions from 2016 to 2020

Location	Process	Capacity increase	Investment	Start-up
Hyuga, Miyazaki, Japan	Wet	60 million m²/year	≈¥5 billion	Spring 2016
Moriyama, Shiga, Japan	Wet	60 million m²/year	≈¥6 billion	1H 2018
T.B.D.	Wet and Dry	500 million m²/year	¥15–20 billion	By 2020

Asahi Kasei's LIB separator strengths and strategy

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Dry-process separator

Cost competitiveness: Simple process (solvent-free), efficient investment for expansion

→ Expanding sales in fast-growing EDV market by leveraging capability for low cost and stable supply. Accelerating performance improvements by applying Asahi Kasei membrane design technology.

Wet-process separator

Discerning and responding to leading-edge customer requirements: Providing new products to leading-edge customers with accumulated technology

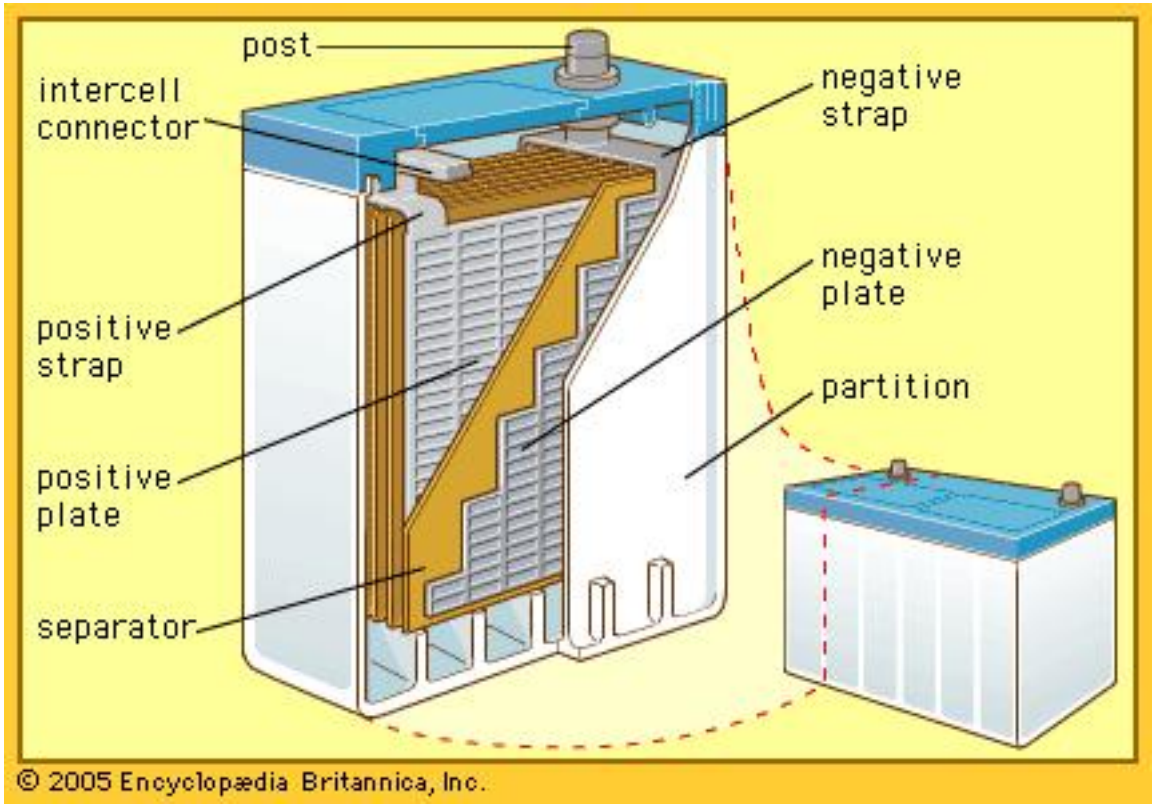
→ Landing big programs through investments to expand capacity and product enhancements.

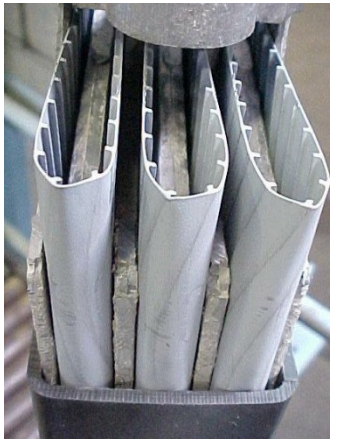
Synergy between dry-process and wet-process separators

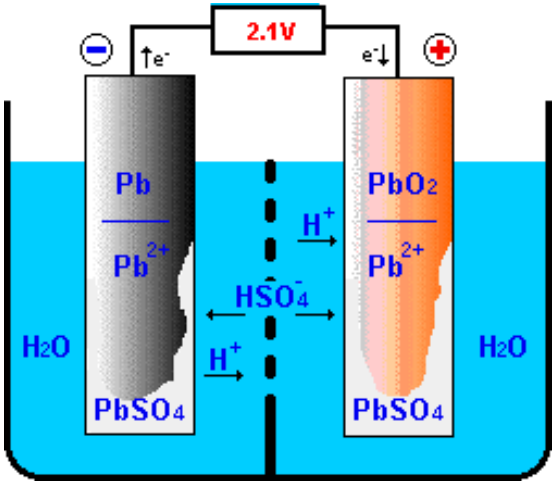
Integrated marketing and R&D: Gaining a comprehensive view of LIB separator requirements

→ Providing leading value to customers by having both dry-process and wet-process products.

Lead-acid battery structure







cell reaction:

$Pb(s) + PbO_2(s) + 2HSO_4^-(aq) + 2H^+(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

Daramic markets and applications

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Transportation

Automotive

- Cars
- Buses
- Trucks
- Motorcycles

Specialty

- Golf cart
- Marine
- Aircraft

Industrial

Traction

- Forklift
- Mining
- Railroad
- Submarine

Stationary

- UPS
- Telecom
- Renewable Energy
- Inverter

Market leader in lead-acid batteries for automotive and industrial applications