Electronic Chemicals Business (EL Chemicals)

Inorganic Chemicals Division, Specialty Chemicals Business Sector

MITSUBISHI GAS CHEMICAL CO., INC.

October 2, 2024

TSE Prime
4182

Today's agenda

1 | Overview of Inorganic Chemicals Business

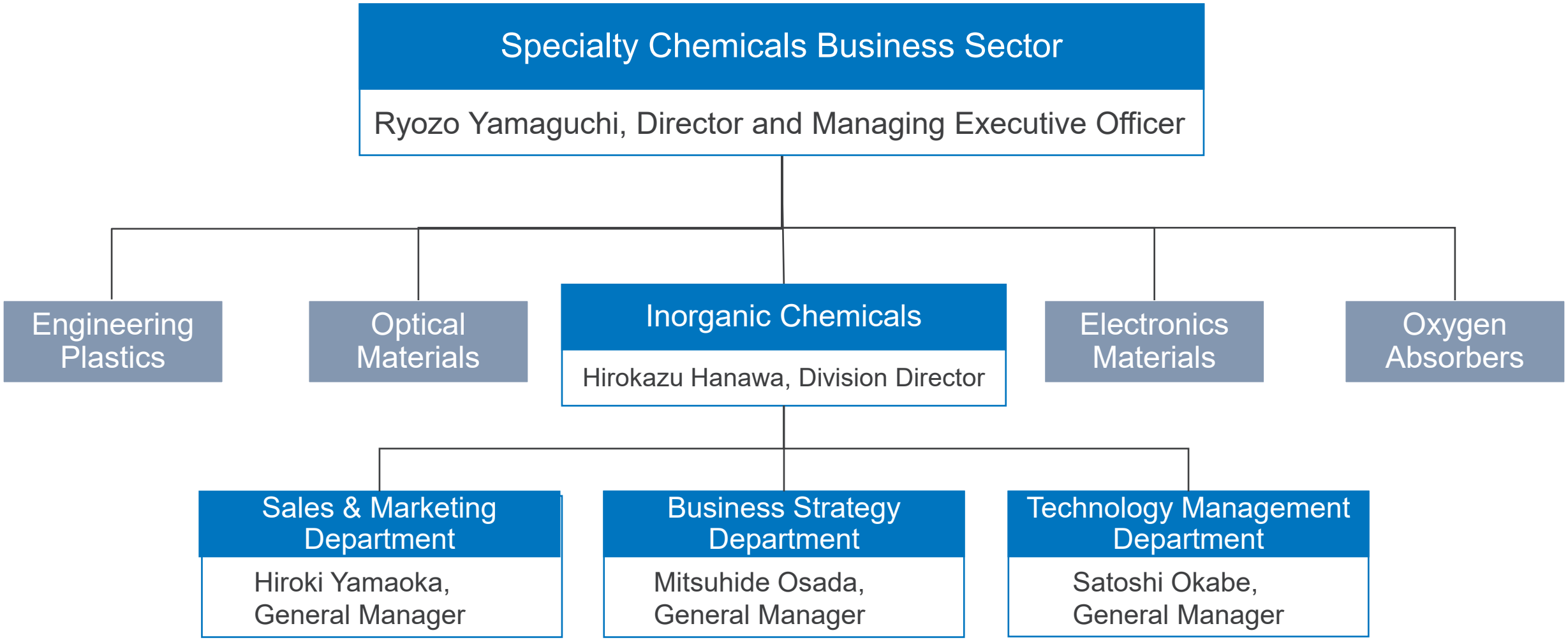
2 | Primary applications for EL chemicals in semiconductor manufacturing processes

3 | Strengths of our EL Chemicals Business

4 | EL chemicals market growth and environmental changes

1. Overview of Inorganic Chemicals Business

Inorganic Chemicals Business organizational chart



Inorganic Chemicals product lineup

Hydrogen peroxide

- **Persulfates**
  - Synthetic resin polymerization catalysts, etching agents, adhesive removal agents
- **Dia Power™**
  - Peracetic acid for food additive and sterilization uses

Electronic Chemicals (EL Chemicals)

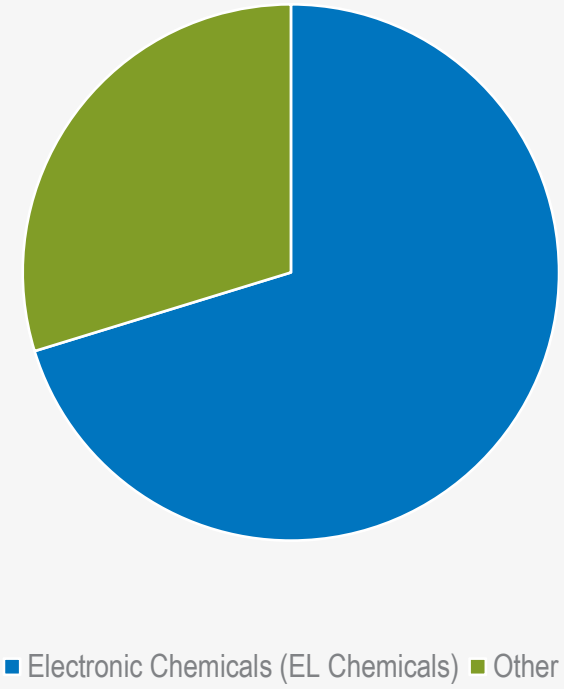
- **Super-pure hydrogen peroxide** — Top share of global market (50%)
  - Electronics industry cleaning agents, etching agents
- **Super-pure aqueous ammonia**

Hybrid Chemicals (HBC) — Customer grade

- **ELM clean™**
- **Clean etch™**
  - Metal-surface chemical etching agents, residue removers, selective etching agents, resist stripping agents

- **Hydrosulfites**
  - Dyeing auxiliaries, synthetic fiber reducing/cleaning agents, pulp/fiber bleaching solutions, reducing agents
- **Organic titanites**
  - Resin modifiers, reaction catalysts

Sales by product (FY2023)



History of Electronic Chemicals products

- Edogawa Industrial Limited (MGC's predecessor), a subsidiary of Mitsubishi Paper Mills, was the first to produce hydrogen peroxide in Japan, primarily for bleaching paper pulp and similar uses.
- Looking ahead to growing demand for electronic devices, we expanded our business to include electronic industry applications, improving quality and promoting production efficiency and scale.
- We built R&D and production structures that are closely connected to customers in response to the progress of semiconductor technologies and globalization of production.
- We aim to develop and produce new chemicals used in state-of-the-art processes, in line with semiconductor miniaturization and progress in packaging technologies.

Global development

1933 Began production of hydrogen peroxide

1962 Business expanded into electronic industry applications

1986 Super-pure hydrogen peroxide developed

1989 Korea

1990s Basis of hybrid chemicals technologies developed

1995 US

1998 Singapore

2001 Taiwan

2001 Electronic Chemicals R&D Center opened to strengthen hybrid chemical business

2020 China

Since 2010s
R&D and production structures closely connected to customers built in response to innovation in semiconductor technologies and higher production volumes

Hydrogen peroxide for paper pulp use

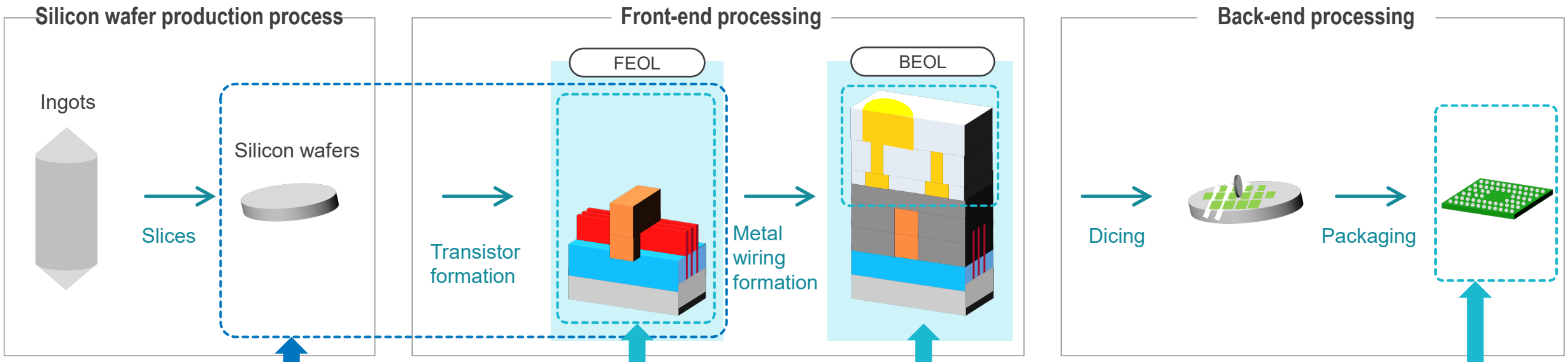
From hydrogen peroxide for semiconductor use to super-pure hydrogen peroxide

Hybrid Chemicals (HBC)

Expansion of applications and product portfolio

2. Primary applications for EL chemicals in semiconductor manufacturing processes

Primary applications for EL chemicals in semiconductor manufacturing processes



Super-pure hydrogen peroxide

Super-pure aqueous ammonia

ELM clean™

Various etching agents

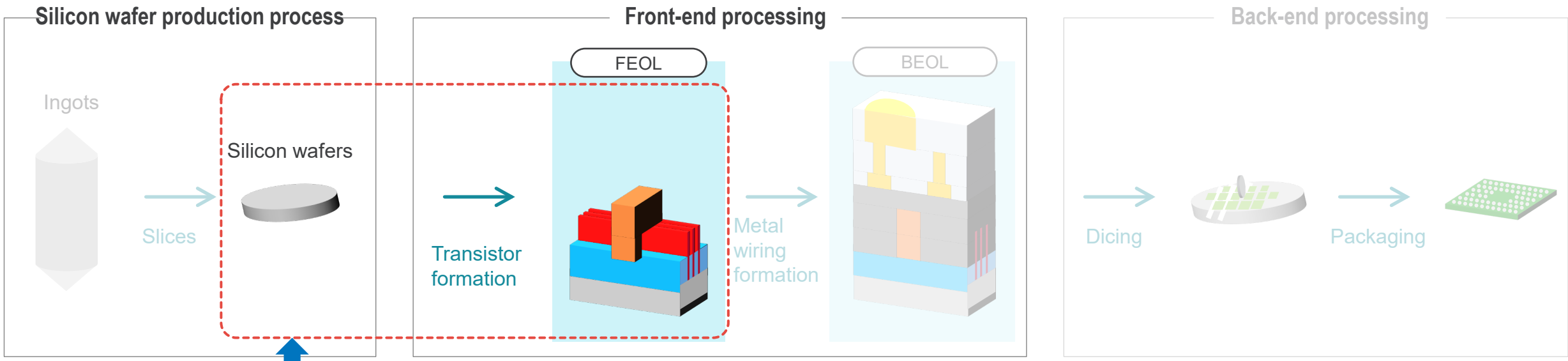
ELM clean™

Residue removers

Clean etch™

Resist stripping agents

Primary applications for EL chemicals in semiconductor manufacturing processes ①

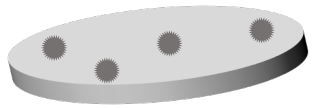


Application 1: Removing metal impurities

Super-pure hydrogen peroxide

Super-pure aqueous ammonia

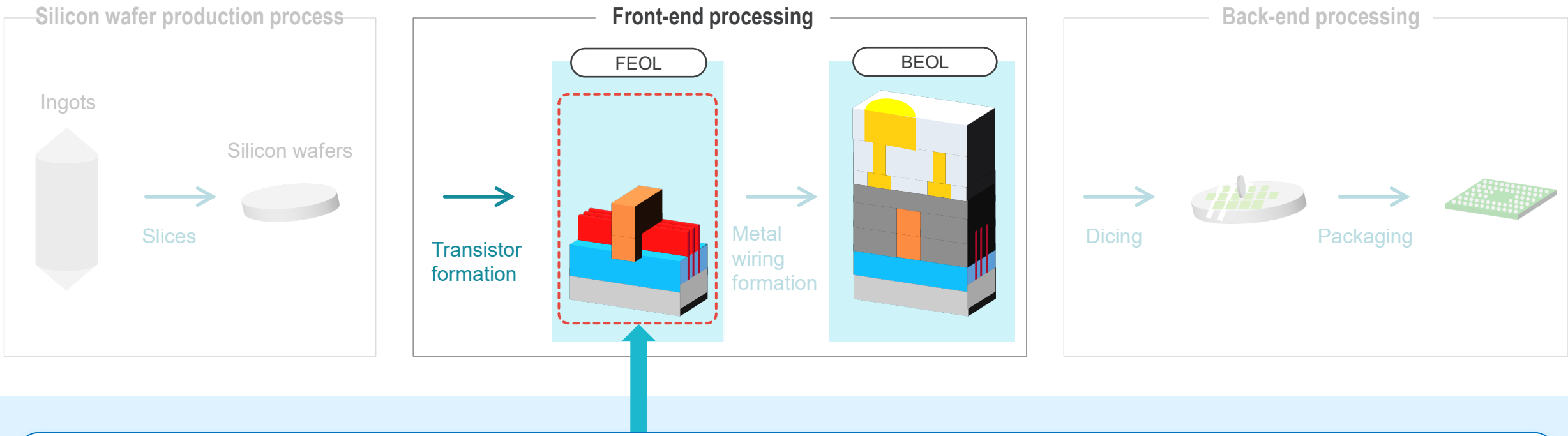
Metal impurities



Cleaning with mixtures of super-pure hydrogen peroxide, super-pure aqueous ammonia, etc.

Dissolving metal impurities without dissolving silicon wafers

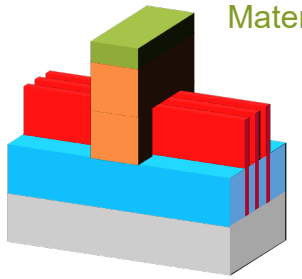
Primary applications for EL chemicals in semiconductor manufacturing processes ②



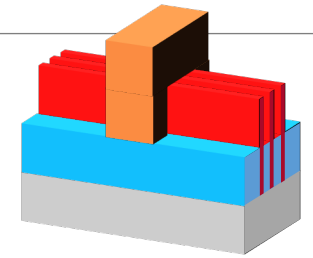
Application 2: Dissolution of specific substances

ELM clean™

Various etching agents

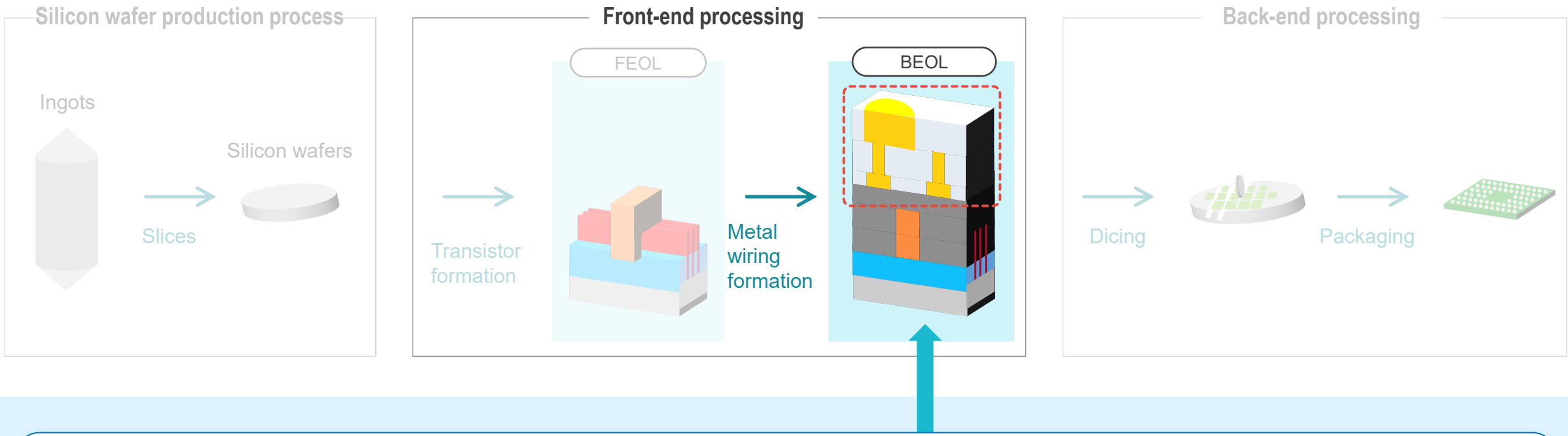


Cleaning with hybrid chemicals



Dissolving materials no longer needed without dissolving structure

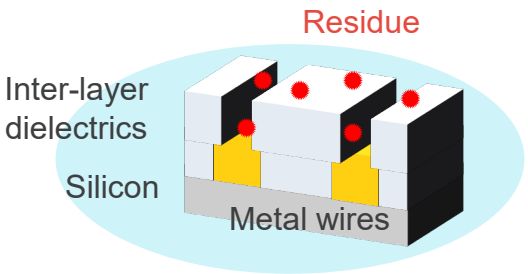
Primary applications for EL chemicals in semiconductor manufacturing processes ③



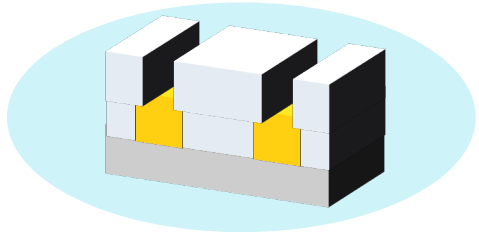
Application 3: Residue removal

ELM clean™

Residue removers

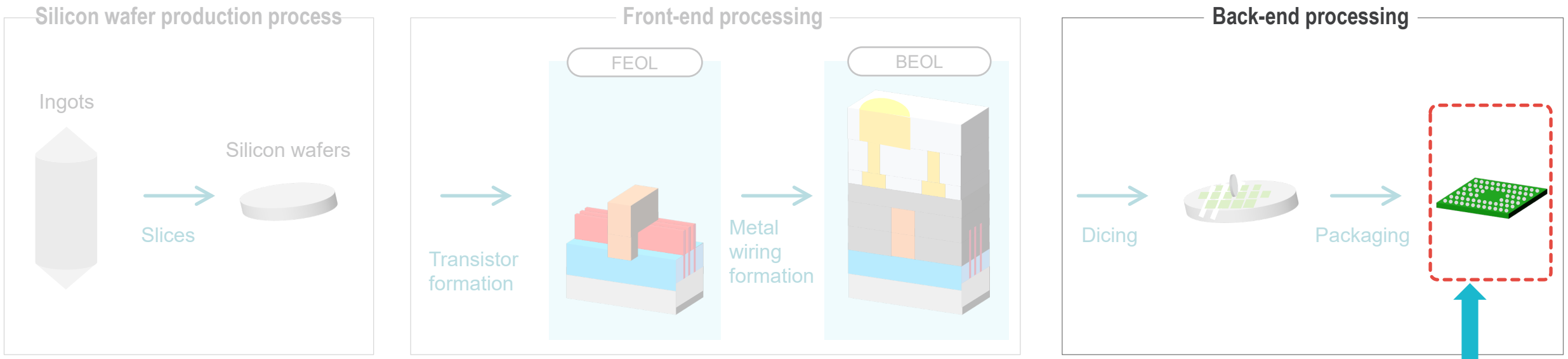


Cleaning with hybrid chemicals



Dissolving residue without dissolving structure

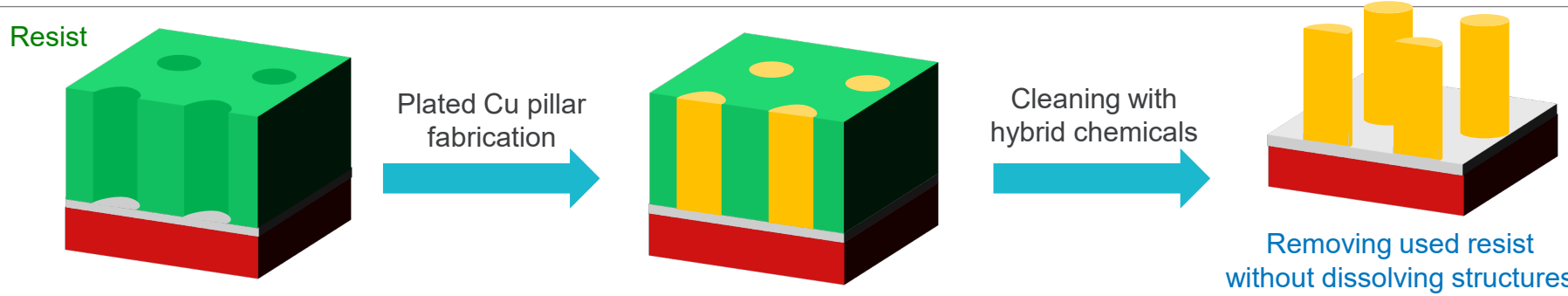
Primary applications for EL chemicals in semiconductor manufacturing processes ④



Application 4: Resist release

Clean etch™

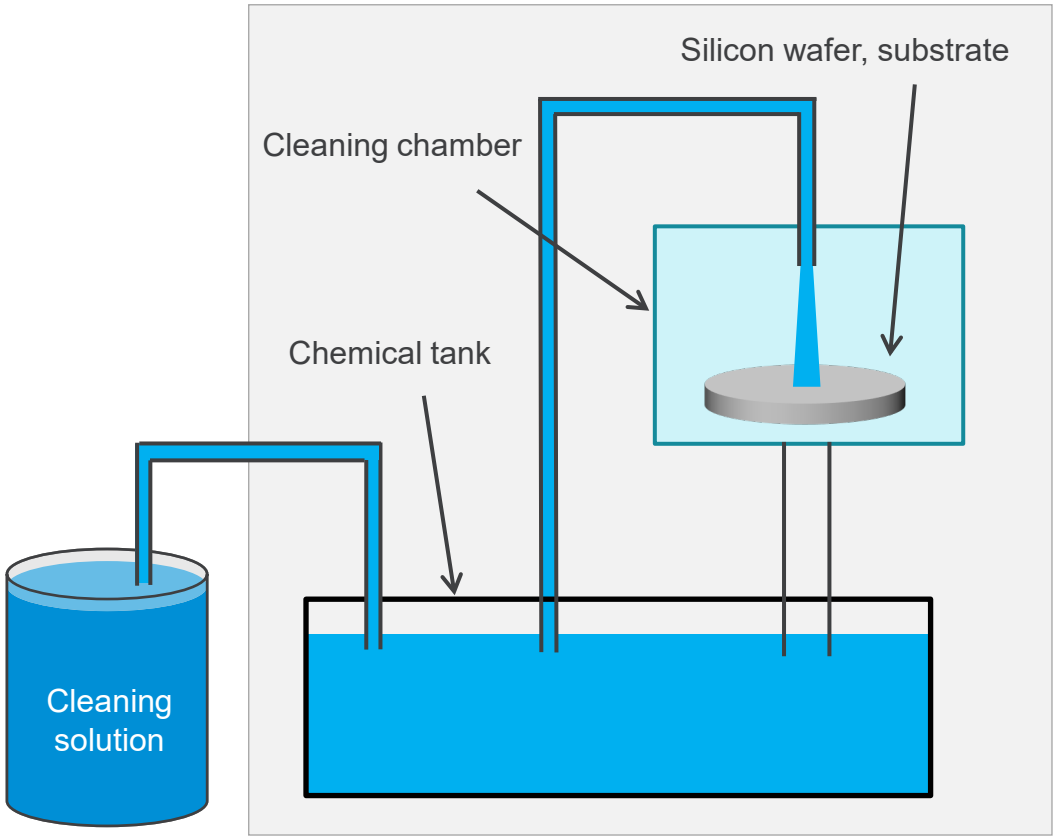
Resist stripping agents



Examples of EL chemical applications

- EL chemicals are supplied to the cleaning equipment's chemical tank.
- After temperature adjustments in the chemical tank, the chemicals are used to clean silicon wafers.
- After cleaning, they are recycled or disposed of as waste.

Structural diagram of semiconductor cleaning equipment



Inside a semiconductor plant (for purpose of illustration)

3. Strengths of our EL Chemicals Business

Strengths of our EL Chemicals Business

1

Customer proximity strategy

- Global production facilities

2

A research and development structure capable of meeting state-of-the-art needs

- Global research structure
- Comprehensive R&D capabilities upstream to downstream in the semiconductor production process

3

Customer relationships based on trust

- Earning trust through quality and stable supply

① Customer proximity strategies –Global production facilities–

– Facilities located near consumers to allow rapid response to customer needs and effective control of logistics costs

Korea

Super-pure hydrogen peroxide plant

410,000 MT/Y

Hybrid chemicals plant

China

Super-pure hydrogen peroxide plant

90,000 MT/Y

Hybrid chemicals plant

Japan

Super-pure hydrogen peroxide plant

77,000 MT/Y

Super-pure aqueous ammonia plant

21,000 MT/Y

Hybrid chemicals plant

Singapore

Super-pure hydrogen peroxide plant

30,000 MT/Y

Super-pure aqueous ammonia plant

10,000 MT/Y
+ Expansion underway 5,000 MT/Y

Hybrid chemicals plant

Taiwan

Super-pure hydrogen peroxide plant

90,000 MT/Y

Hybrid chemicals plant

USA

Super-pure hydrogen peroxide plant

140,000 MT/Y
+ Expansion underway 140,000 MT/Y

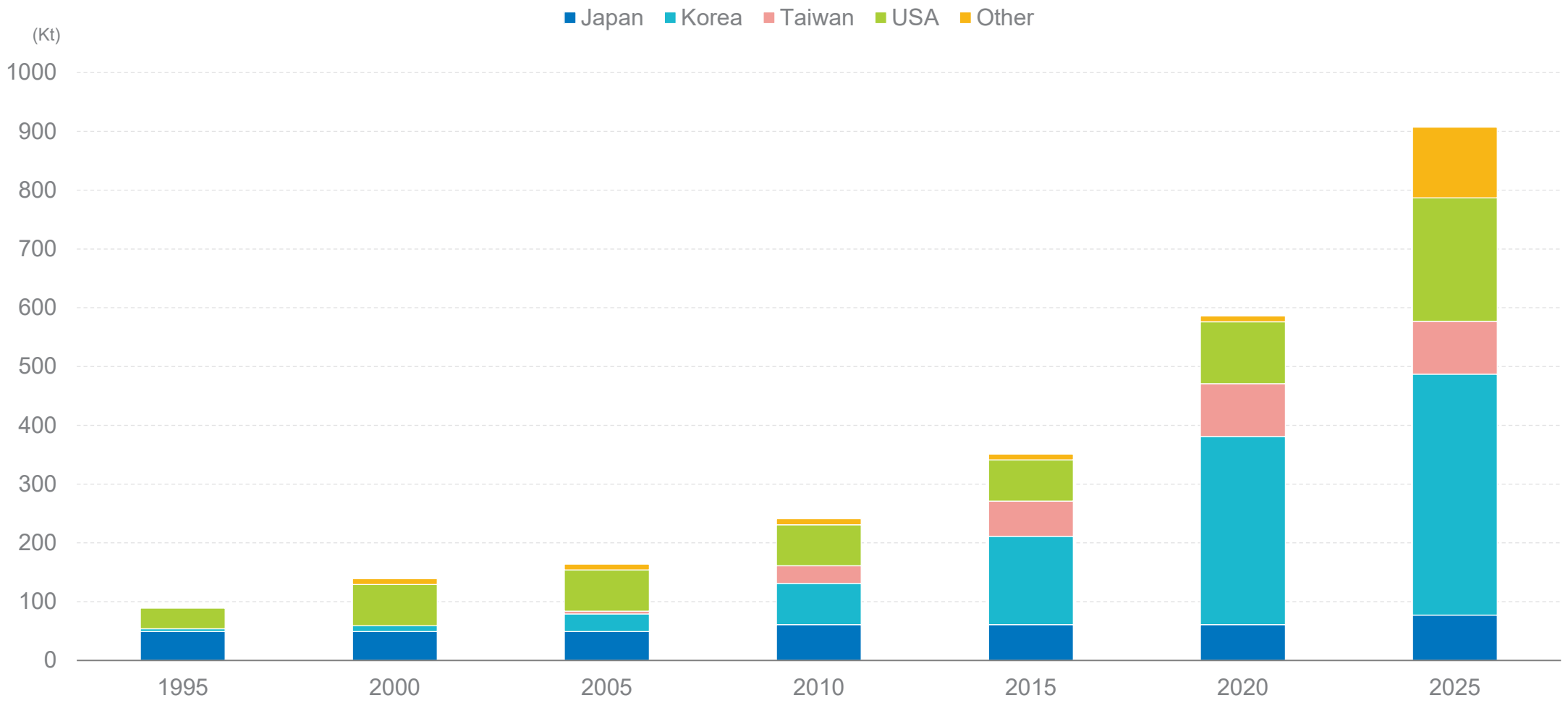
Super-pure aqueous ammonia plant

8,400 MT/Y
+ Expansion underway 19,000 MT/Y

Hybrid chemicals plant

Progress with efforts to expand capacity (Super-pure hydrogen peroxide)

– Steady investments to expand production in line with customer expansion projects



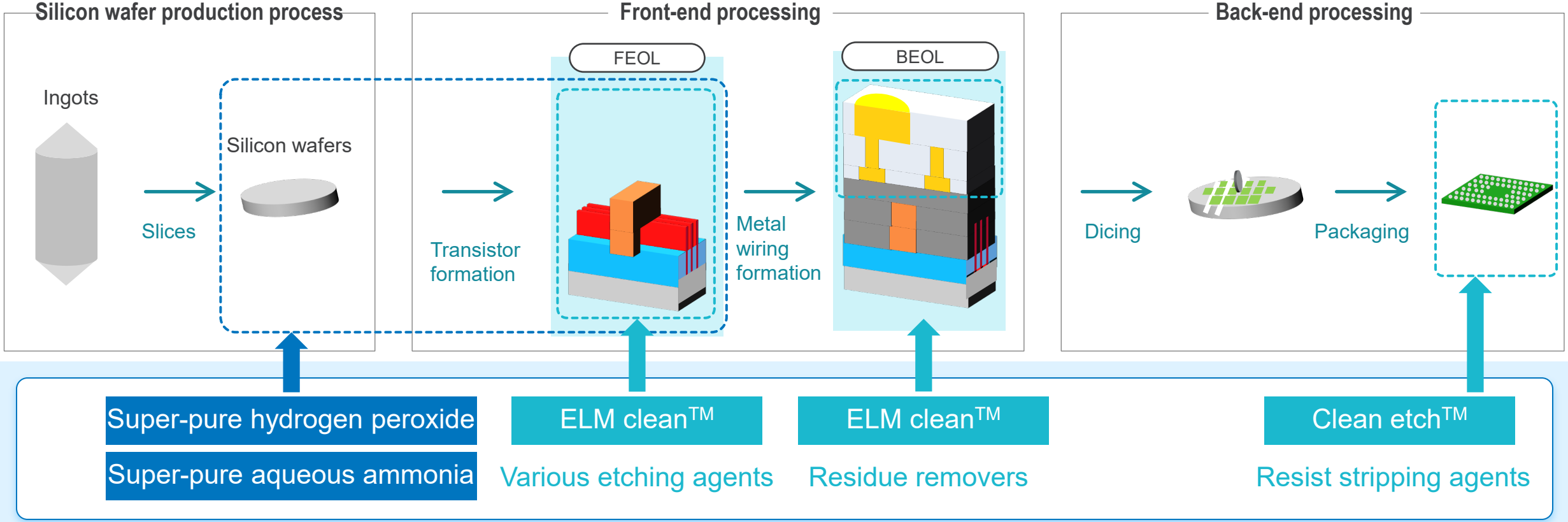
② A research and development structure capable of meeting state-of-the-art needs –Global research structure–

- Taiwan, Korea, the US, China, and Japan are centers of semiconductor development.
- Located at semiconductor research and development hubs, we keep up with latest global trends.
- Our close relationships with customers allow timely feedback, promoting rapid new product development.

② A research and development structure capable of meeting state-of-the-art needs

–Comprehensive R&D capabilities upstream to downstream in the semiconductor production process–

- We pursue comprehensive research and development on various chemicals and substrate materials to meet semiconductor production needs ranging from front-end processing to back-end processing.
- We generate synergies in research and development on process integration in advanced packaging and other areas.



As a unique chemicals company whose capabilities address the full range of front-end processing and back-end processing, we have developed highly unique research and development structures capable of meeting advanced needs.

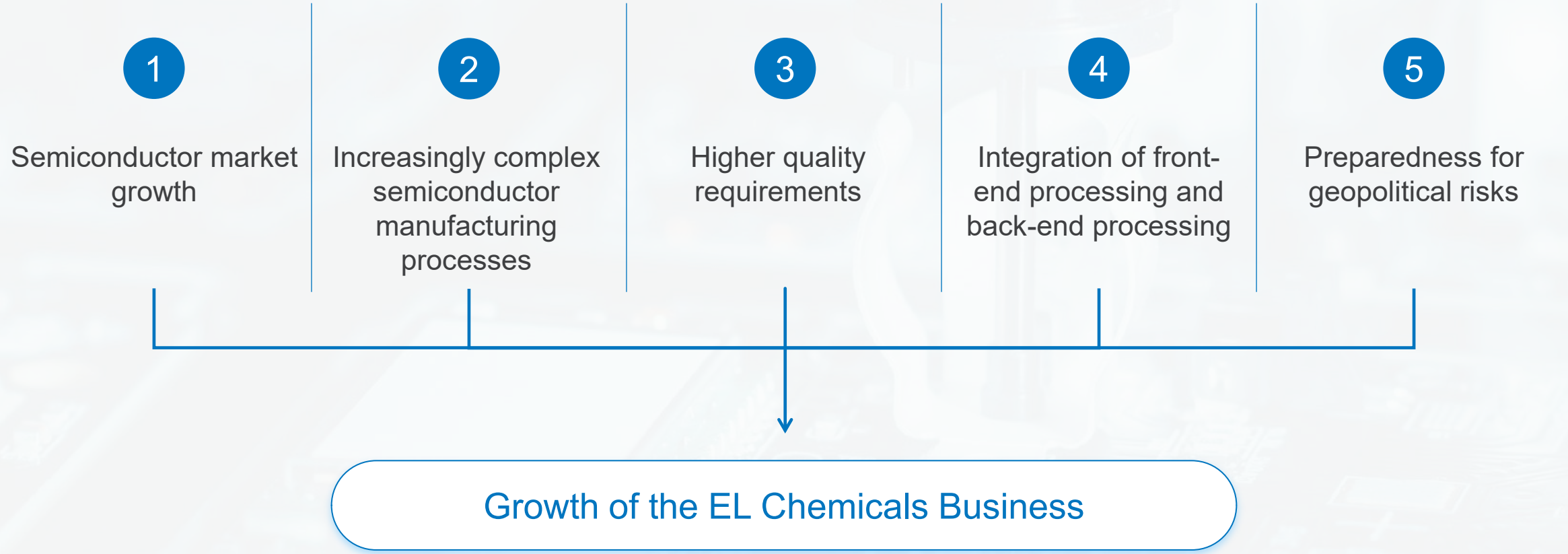
③ Customer relationships based on trust –Earning trust through quality and stable supply–

Awards won include:

- Ten awards from Intel Corporation, including the Supplier Continuous Quality Improvement Award
- Sony Contribution Award
- Awards from TSMC to MGC Pure Chemicals Taiwan
- Samsung Contributions Award (30 years of cooperation) to Samyoung Pure Chemicals

4. EL chemicals market growth and environmental changes

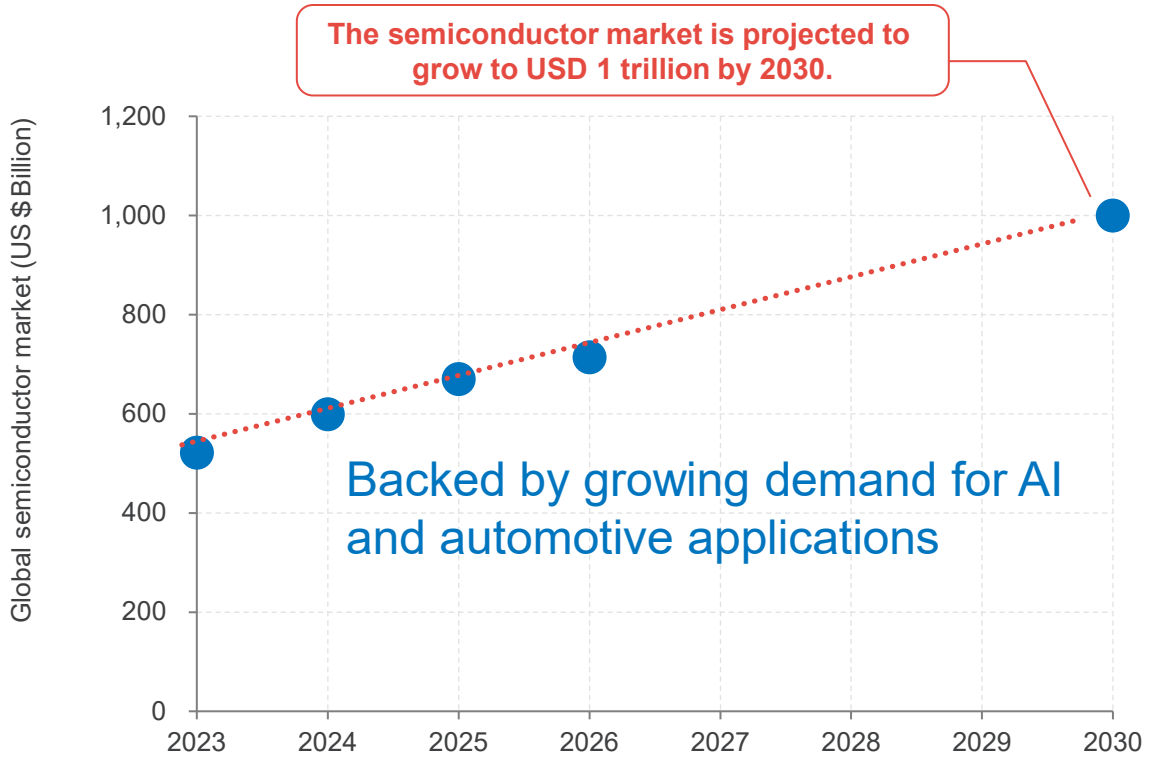
EL chemicals market growth and environmental changes



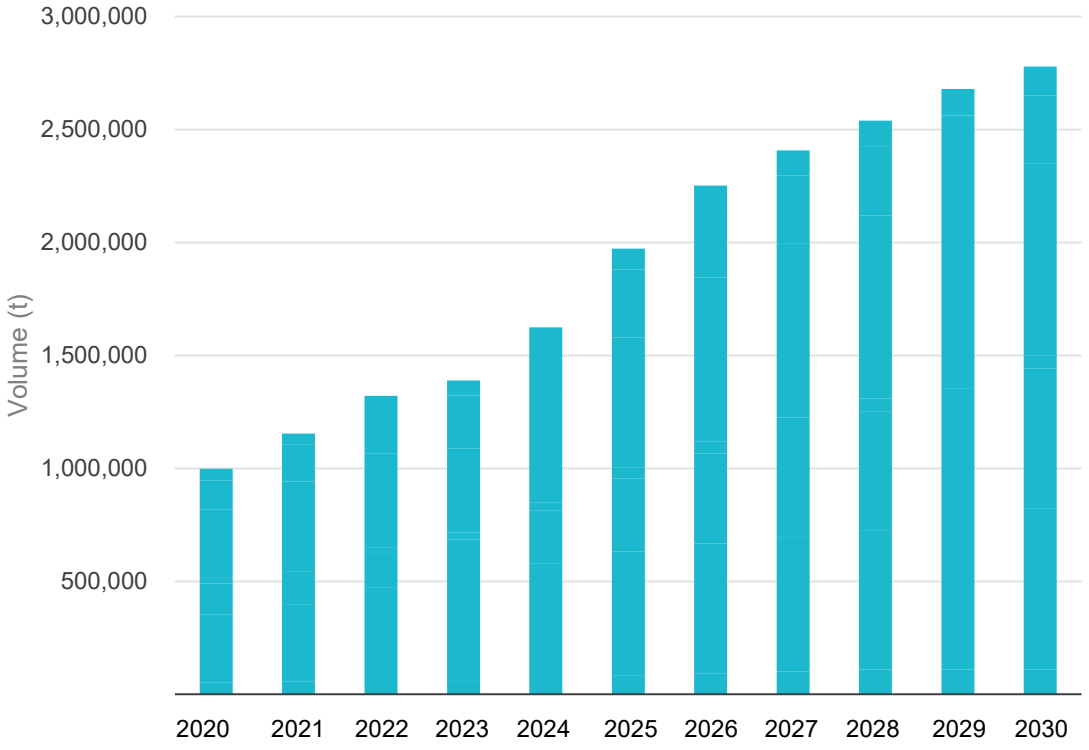
① Growth of the semiconductor and Super-pure hydrogen peroxide markets

– Backed by growing demand for AI and automotive applications, the semiconductor market is projected to grow to USD 1 trillion by 2030. This growth is expected to be accompanied by continuing growth in the Super-pure hydrogen peroxide market.

Semiconductor market forecasts



Size of the Super-pure hydrogen peroxide market (MGC estimates)

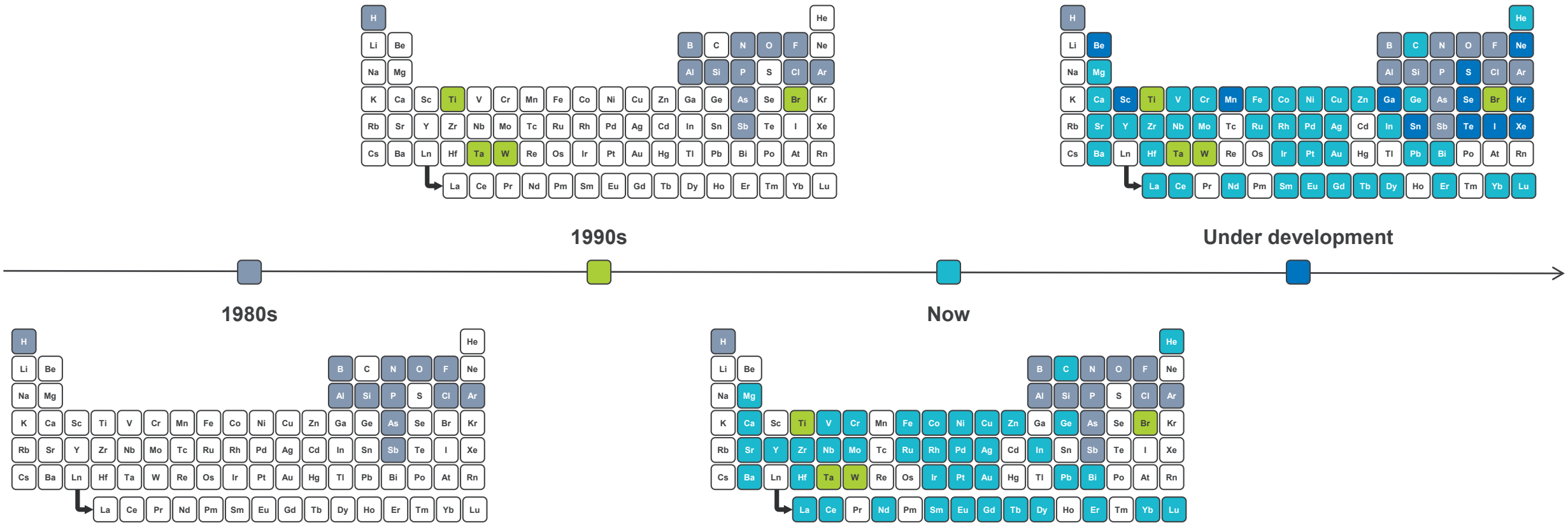


Source: SEMI Japan December 12, 2023 press release (edited by Inorganic Chemicals)

② Increasingly complex semiconductor manufacturing processes

- The pursuit of ever-greater semiconductor performance has led to an increasingly broad range of elements used.
- The requirements for HBC used in etching and residue removal are growing increasingly complex, generating expanding our business opportunities.
- Complex requirements serve as barriers to entry.

Changes in elements used in semiconductor manufacturing (MGC research)



③ Higher quality requirements for semiconductor chemicals

– Purity standards for semiconductor cleaning agents are expected to become stricter.

Example: Hydrogen peroxide requirements from the International Roadmap for Devices and Systems, 2022 Edition

Required purity is expected to double from 2023 to 2027 for most of the 62 substances.

Table YE3 Technology Requirements for Surface Environmental Contamination Control (excerpt)

Year of production	2021	2022	2023	2024	2025	2026	2027
30% H2O2 Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Sn, Ti, V, W, Zn + Pt* (ppt, each) from supplier	10	10	10	5	5	5	5
30% H2O2 Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Sn, Ti, V, W, Zn + Pt* (ppt, each) from POP	10	10	5	5	5	5	5
30% H2O2 Silicon(ppt)	500	500	500	500	400	300	250
30% H2O2: Anions(ppb) phosphates, sulfates, chloride	7	7	7	7	6	5	5
30% H2O2: Anions(ppb)nitrate	14	14	14	14	12	10	10
30% H2O2: resin byproducts(ppb) e.g. total amines	2	2	2	2	1	1	1
30% H2O2: % Assay Variance [51]POP [Functional Chemistry]	1.7	1.6	1.5	1.7	1.6	1.5	1.5
30% H2O2: Particle counts Supplier (20nm/ml) [Functional Chemistry]	500	450	400	350	300	250	200
30% H2O2: Particle counts (20nm, #/ml) POP [Functional Chemistry]	50	45	40	35	30	25	20
30% H2O2 Elemental Carbon	TBD	TBD	TBD	TBD	TBD	TBD	TBD
30% H2O2 organics, e.g. silicone (by nmr) and others (ppm)	TBD	TBD	TBD	TBD	TBD	TBD	TBD

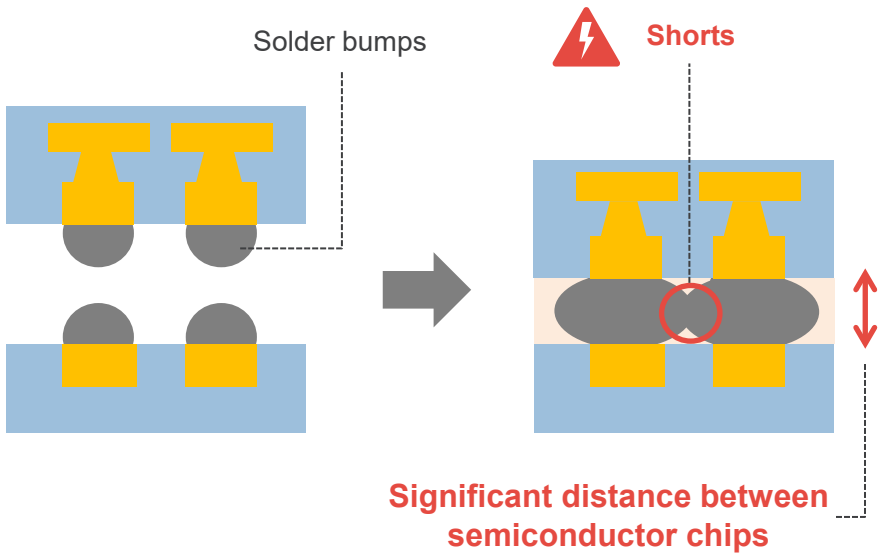
ppb: Parts per billion
ppt: Parts per trillion

④ Integration of front-end processing and back-end processing

- Semiconductor manufacturers are currently in the process of integrating front-end processing and back-end processing with the goal of achieving higher speed, higher performance, and more power efficient semiconductors.
- We are generating synergies based on research and development across a wide range of semiconductor manufacturing processes.
- We are leveraging our unique strengths as a company engaged in both front-end processing and back-end processing.

Back-end processing: To date

Connections using solder bumps

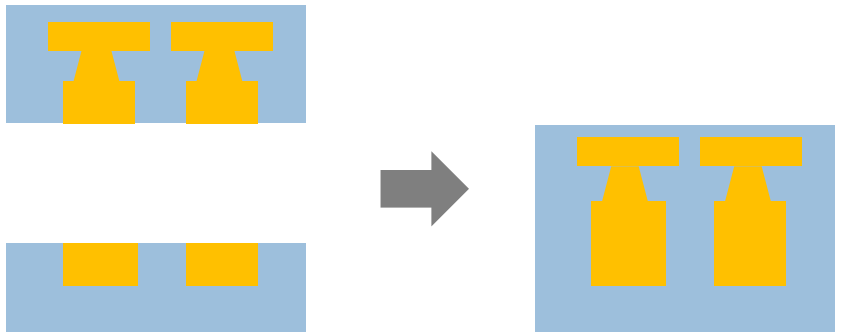


Use of front-end processing technologies

- High cleanliness
- High flatness
- Controlling surface form
- Advanced alignment

Back-end processing: Future

Direct connections without solder bumps



⑤ Preparedness for geopolitical risks

Increasingly intense US-China rivalry (e.g., CHIPS Act)

> The US Department of Commerce will provide additional support of 250 billion yen for semiconductor development under the CHIPS Act.
>
> *Nikkei*, July 10, 2024

> US-China rivalry intensifies as China bans semiconductors from US-based Micron Technology.
>
> Forbes, May 23, 2023

Semiconductor manufacturers are ramping up production in North America and elsewhere.

We are also preparing plans for production increases to meet large-scale demand growth.

To date, the US has demonstrated strengths in front-end processing while China has demonstrated strengths in back-end processing. With geopolitical risks in mind, the US has begun focusing on back-end processing and China on front-end processing.

> Amkor Technology opens new back-end processing plant in the US, beginning with TSMC chips for Apple
>
> *Nikkei Crosstech*, December 26, 2023

> US media reports that Huawei and SICarrier have patented self-aligned quadruple patterning (SAQP) technology capable of producing 5 nm chips without extreme ultraviolet (EUV) equipment.
>
> TECH+, March 27, 2024

Opportunities for business growth for MGC, a Group with production and R&D facilities located in major regions

Future vision for the EL Chemicals Business

Super-pure hydrogen peroxide, Super-pure aqueous ammonia

- Quality improvements that anticipate customer requirements
- Continued business growth in step with the growing semiconductor market

Hybrid chemicals products

- Driving semiconductor evolution through the development of high-performance chemicals
- Cultivating advanced packaging and other new business fields