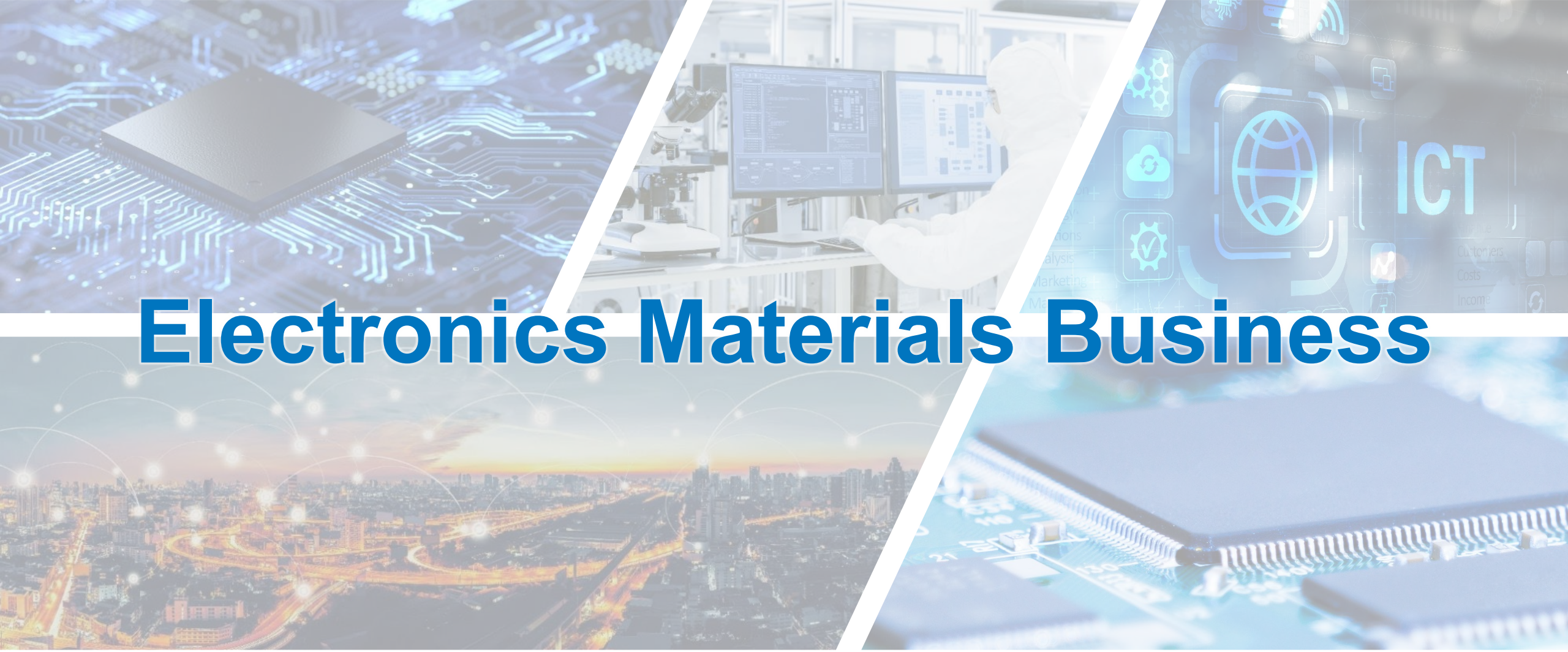


Electronics Materials Business

Electronics Materials Division, Specialty Chemicals Business Sector

MITSUBISHI GAS CHEMICAL CO., INC.

October 2, 2024

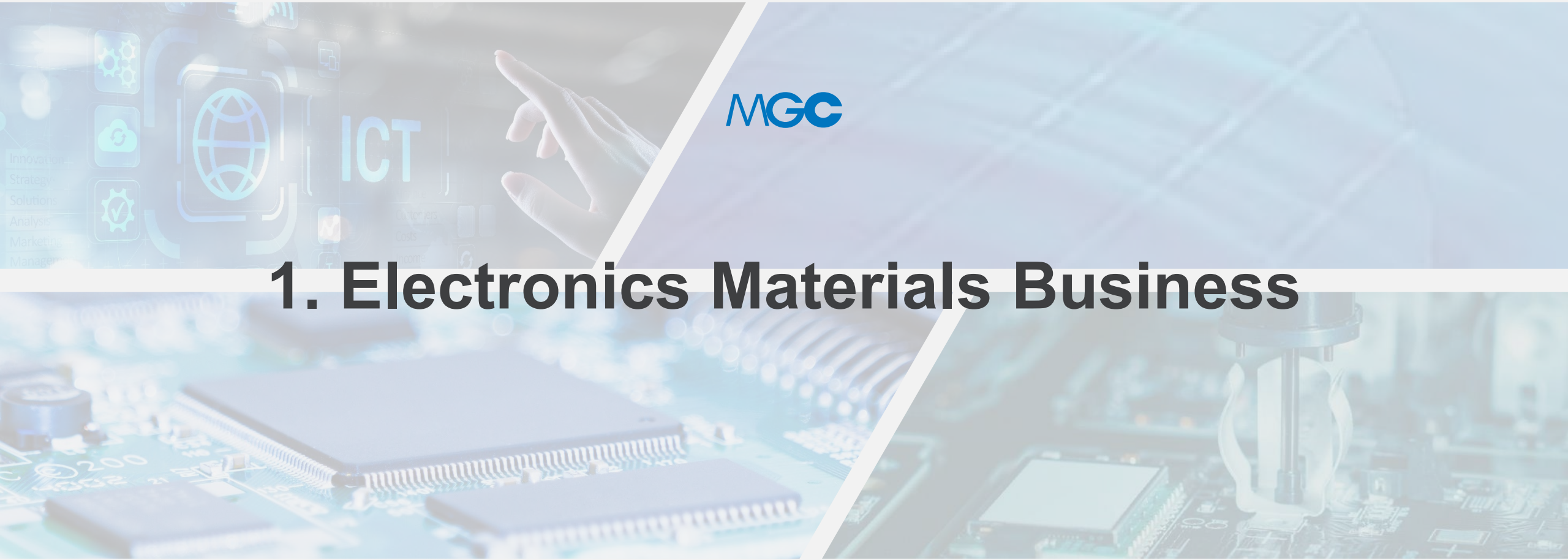
TSE Prime
4182

Today's agenda

1 | Electronics Materials Business

2 | BT Materials

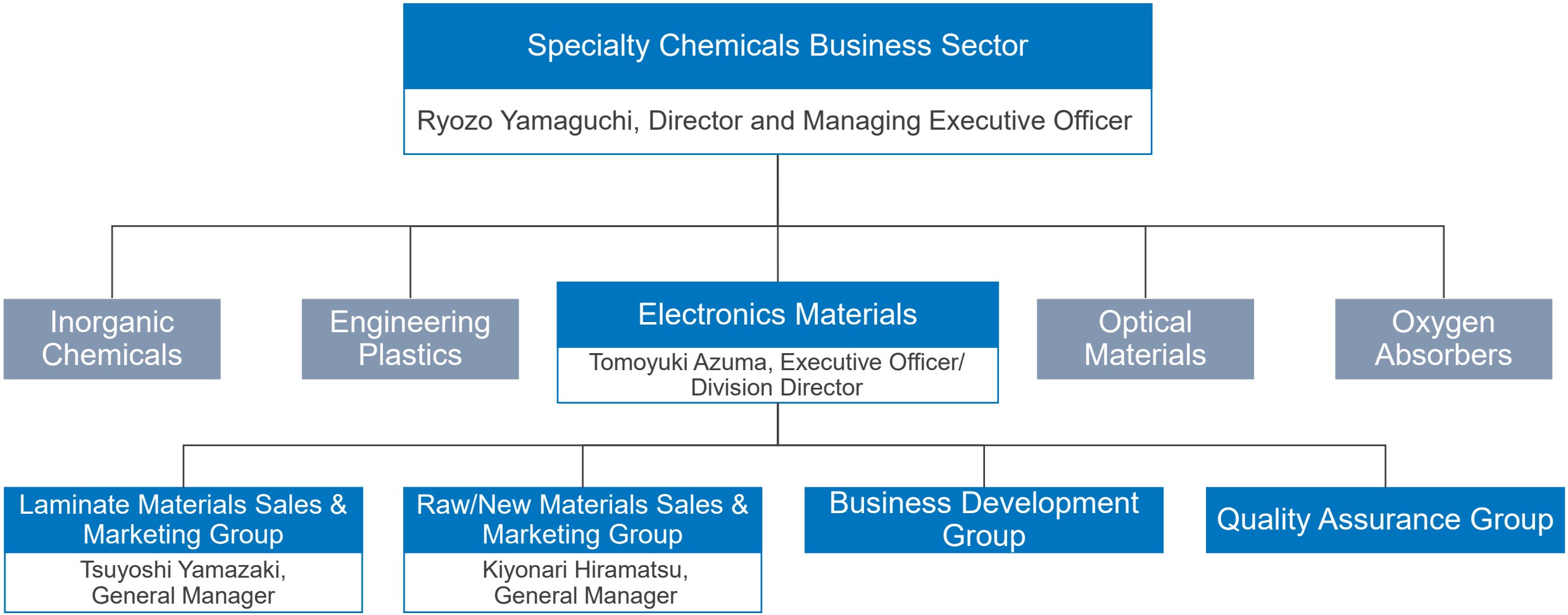
3 | OPE Derivatives



1. Electronics Materials Business

Electronics Materials Business organizational chart

– In April 2021, to strengthen the product portfolio, we shifted to a structure of two business sectors by consolidating resin products for laminate boards.



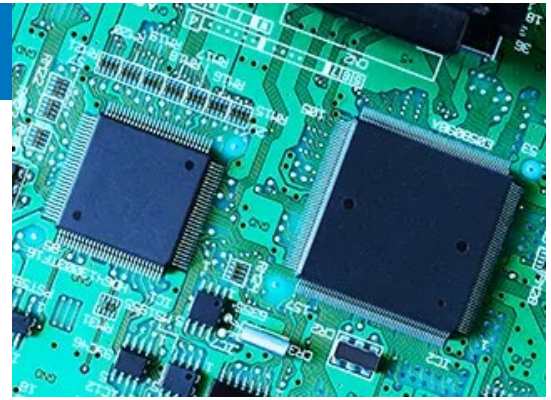
Key products made by Electronics Materials Business Division

Products described today

Copper-clad laminates for IC plastic packages

BT materials

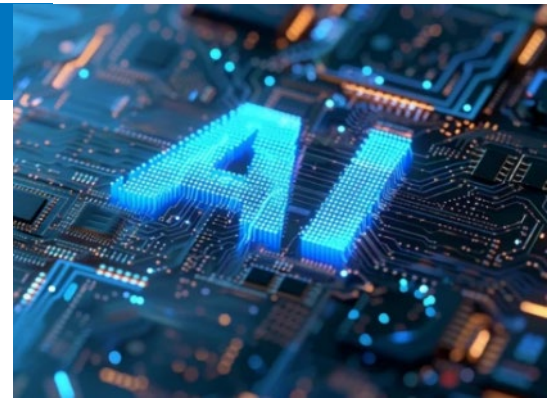
- Smartphones
- Home electronics
- Computers



OPE derivatives

OPE™

- Multilayer boards



Subsidiary material for the drilling of printed circuit boards

LE SHEET

- Substrates for IC plastic packages
- Automotive PCBs
- Ultra-multilayer PCBs

Copper-clad laminates for chip LEDs

White BT materials

- Chip LEDs

Laminate boards for multilayer printed circuit boards

High-performance epoxy materials

- Servers, data centers
- Base stations

Main Electronics Materials facilities

Yonezawa Dia Electronics

(Yonezawa City, Yamagata Prefecture)

- Manufacture of sheet products
- Manufacture of copper-clad laminates with inner-layer circuitry

MGC ELECTROTECHNO

(Nishishirakawa-gun, Fukushima Prefecture)

- Manufacture of BT copper-clad laminates and prepregs

MGC ELECTROTECNO

(Thailand)

- Manufacture of BT copper-clad laminates and prepregs

MGC-ITEQ Technology

(Taiwan)

- Joint venture
- Manufacture and sale of PCB laminate materials

MGC-ITEQ

Electronics Materials Division

Key roles

- Strategy
- Sales and marketing
- SCM

Tokyo Research Laboratory

Key roles

- Development of laminate materials

Yokkaichi Plant

(Yokkaichi City, Mie Prefecture)

- Manufacture of OPE™

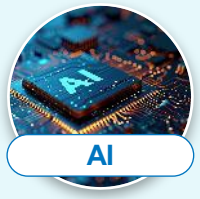
Business expansion in the Electronics Materials Sector

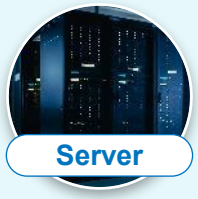
Current business areas | **New business areas**

Substrate market

High to middle end

- Ongoing approach with BT materials
- Expanding use in AI products, servers, mobile devices, and other state-of-the-art products





Middle to low end

- Introducing MGC-ITEQ products alongside BT materials
- Addressing the growing China market

Assemblers, electronic device manufacturers

IC plastic packages

Semiconductor manufacturers

Laminate materials

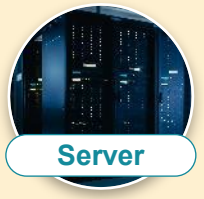
BT materials — Laminate materials manufacturers for IC Substrates — MGC-ITEQ laminate materials

MGC

Printed circuit board market

High-speed telecommunications / low-transmission loss PCBs

- Approaching high-speed telecommunications/ low-transmission loss printed circuit boards through sales of OPE derivatives



Assemblers, electronic device manufacturers

PCBs

PCB manufacturers

Laminate materials

Epoxy materials — Laminate materials manufacturers for PCB

MGC

BT resins — Resin manufacturers — OPE™

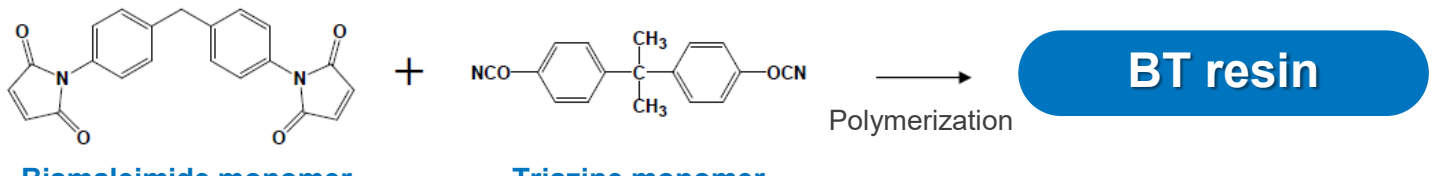
MGC

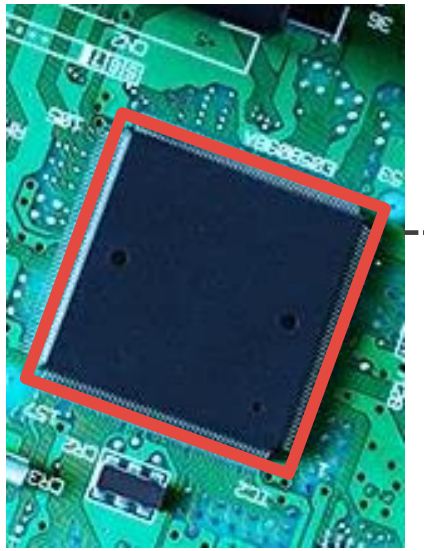
2. BT Materials

BT materials

- Substrate materials made of BT resins developed using our proprietary technologies
- Used for substrates on which semiconductor chips are mounted

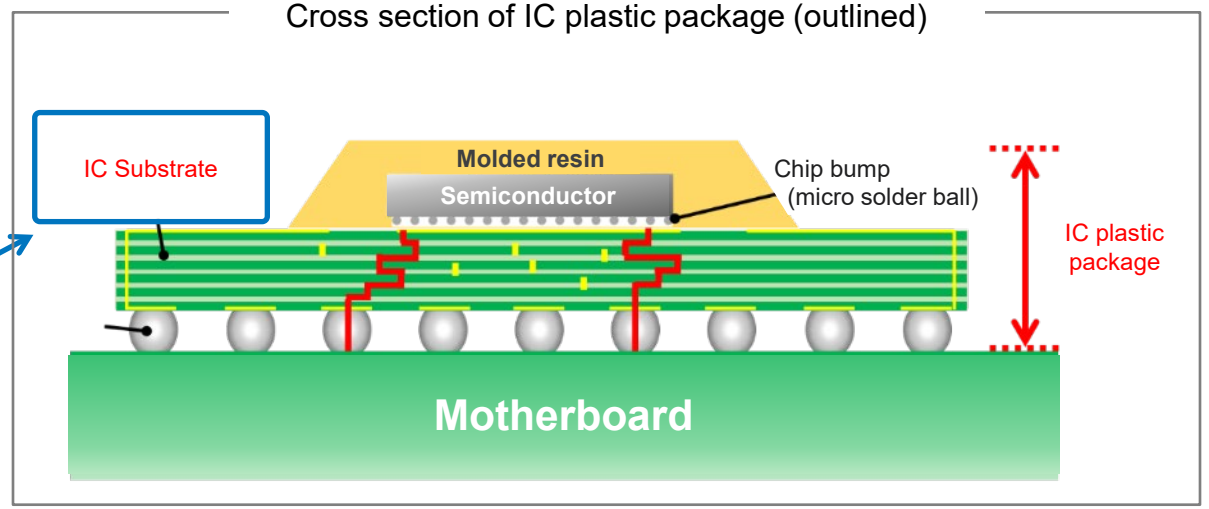
BT refers to polymer resins made mainly of **bismaleimide (B)** and **triazine (T) materials.**





Package (outlined) combining various semiconductor chips and substrates mounted on a motherboard (green board)

BT materials are used for substrates that constitute IC plastic packages



Note: In some cases, “BT” is used to refer to substrate materials in general, whether or not they are MGC materials.

BT business strengths

– We maintain the leading market share for substrate materials due to our reputation for high performance and quality, production structures, and other advantages.

Industry-leading performance and quality

Heat resistance, low warpage

Resistant to heat generated during semiconductor operation; thin and easy to process

High electrical insulation

Effective control of metal ion migration to prevent malfunctions and defects

Outstanding electrical properties

Lower permittivity and dissipation factor than other heat-hardened resins

Stable supply capabilities

- Since their commercial introduction, our BT products have earned the trust of customers without any serious quality issues.
- Efficient production structure at two facilities, one in Japan and one in Thailand

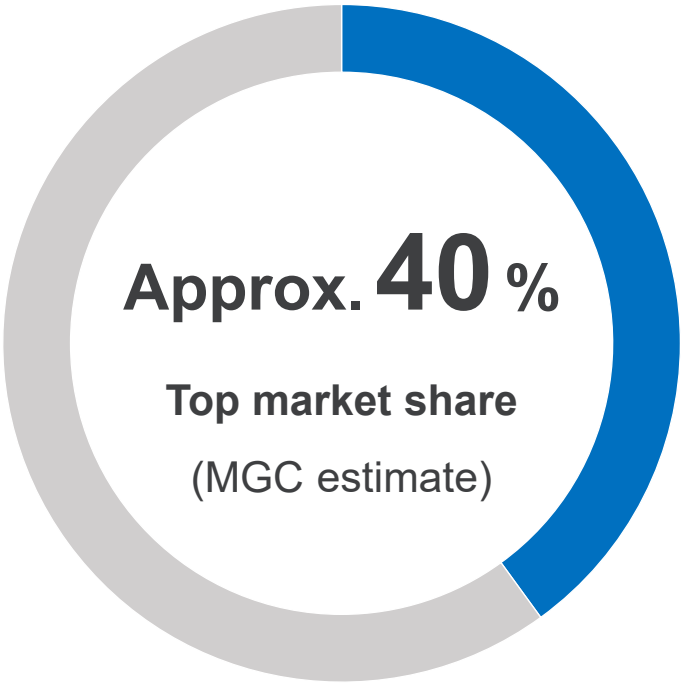
Proprietary production technologies and strong development capabilities

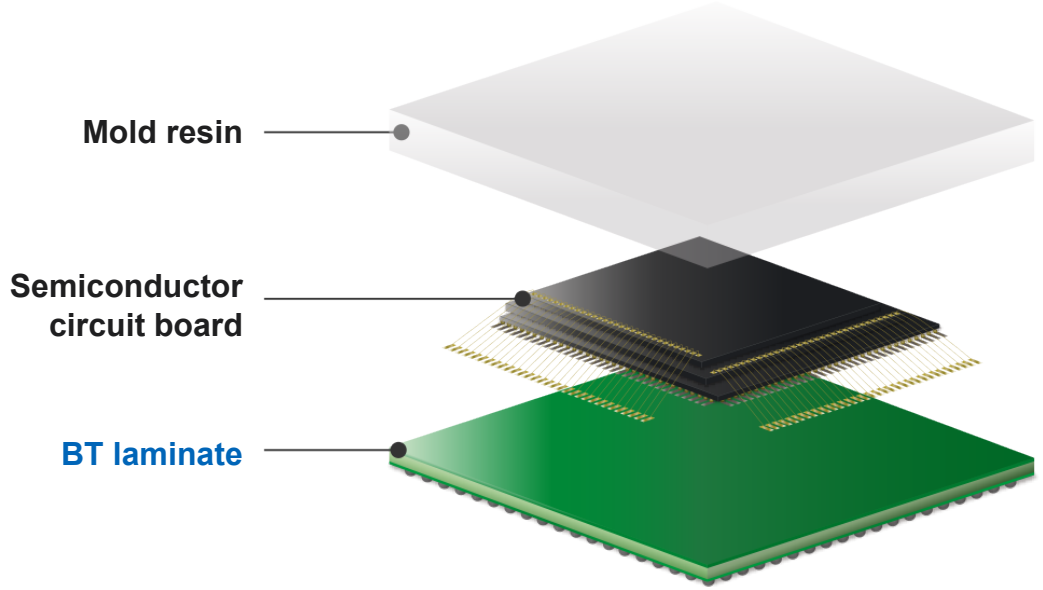
- Our unique BT resins are "one and only" products made using proprietary technologies.
- Drawing on years of R&D progress and accumulated data, we continue to create state-of-the-art products.

Establishing the BT brand and market advantages

- Our market share is backed by the advantages and reliability of BT resins, which have led to wide recognition of BT materials and our BT brand.
- We have built strong relationships with our customers backed by an extensive and wide-ranging track record and an operating structure that makes it easier to develop state-of-the-art products, starting in response to the first calls made by our customers when they develop new products. We have established virtuous cycles that maintain our high market share.

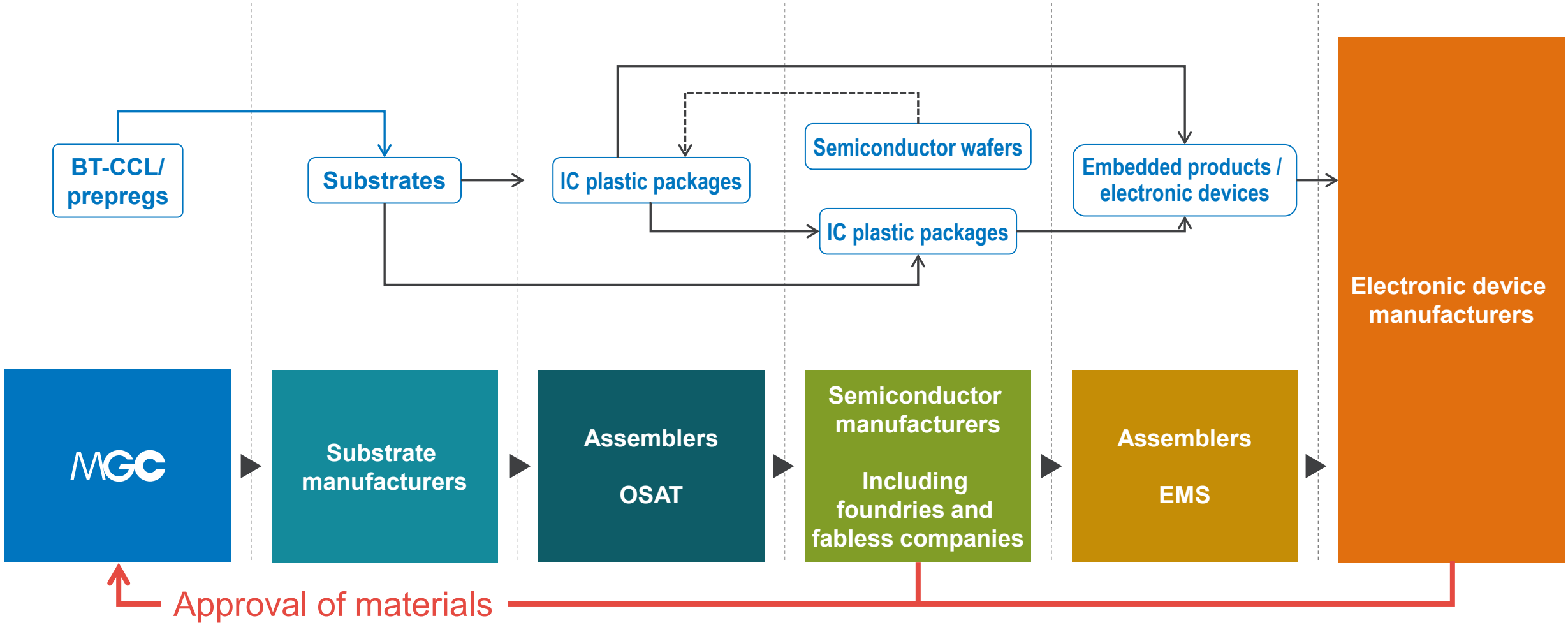
Share of substrate materials market held by our BT resins





BT materials supply chain

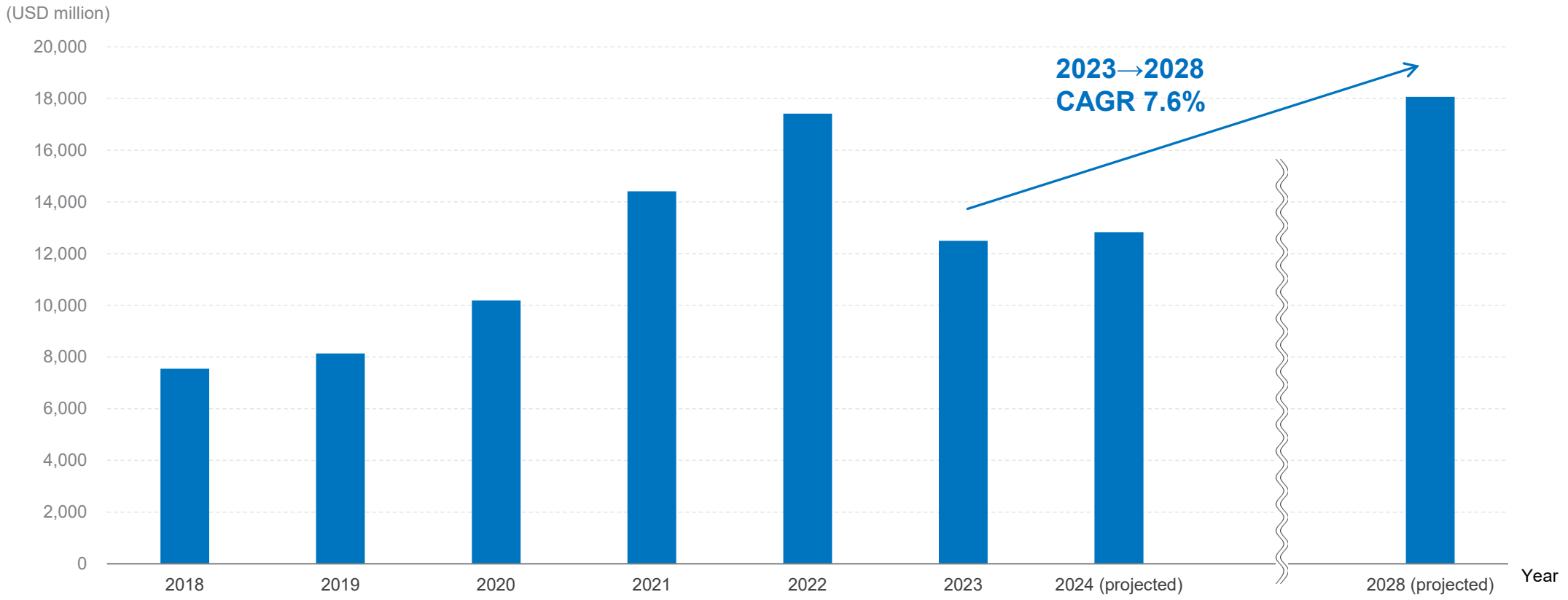
– Our relationships with manufacturers of electronic devices and semiconductors are just as important as our relationships with substrate manufacturers.



Substrate market outlook

– Both the semiconductor and substrate markets are projected to grow, driven by booming AI-related investments.

Substrate market: CAGR of 7.6% projected for 2023–2028

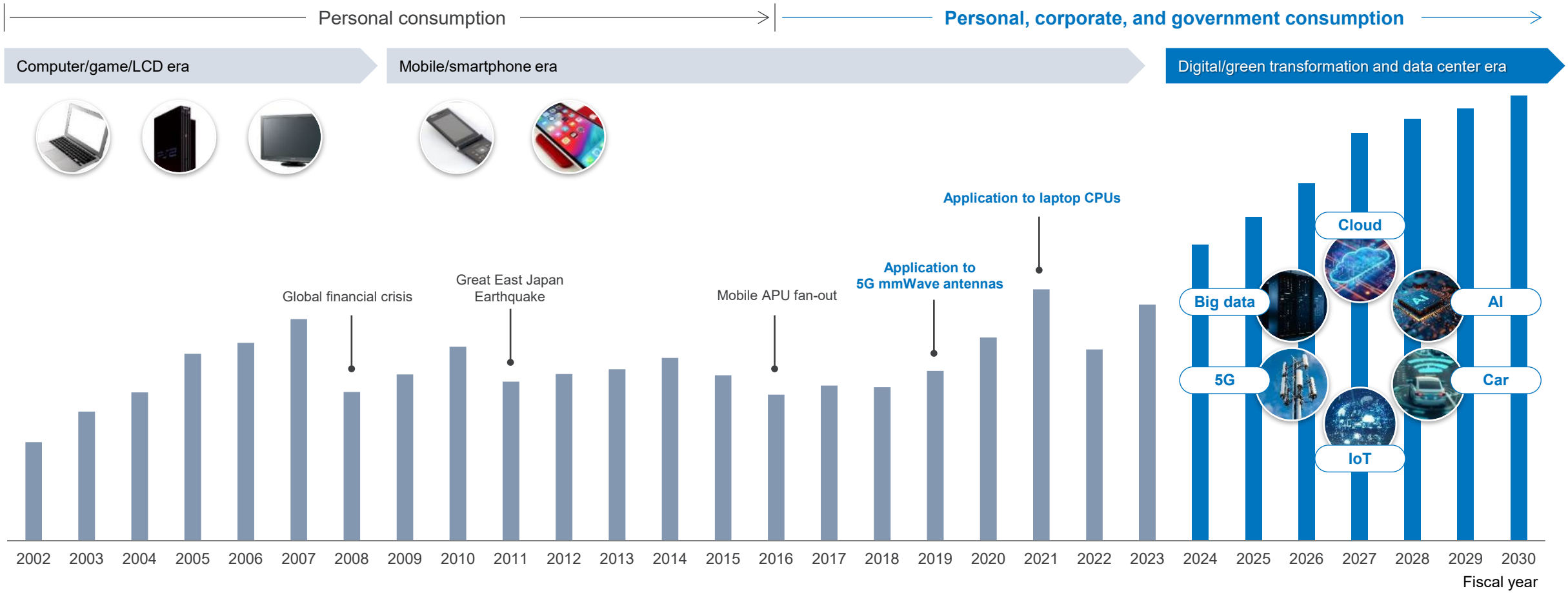


Source; Prismark

BT Materials enter the next stage of growth

- The semiconductor market is projected to grow alongside the transition from the computer/game/LCD era through the mobile/smartphone era to an era of investments in data centers and in green transformation.
- Consumption will shift from consumers to corporate and national scales based on infrastructure investments.

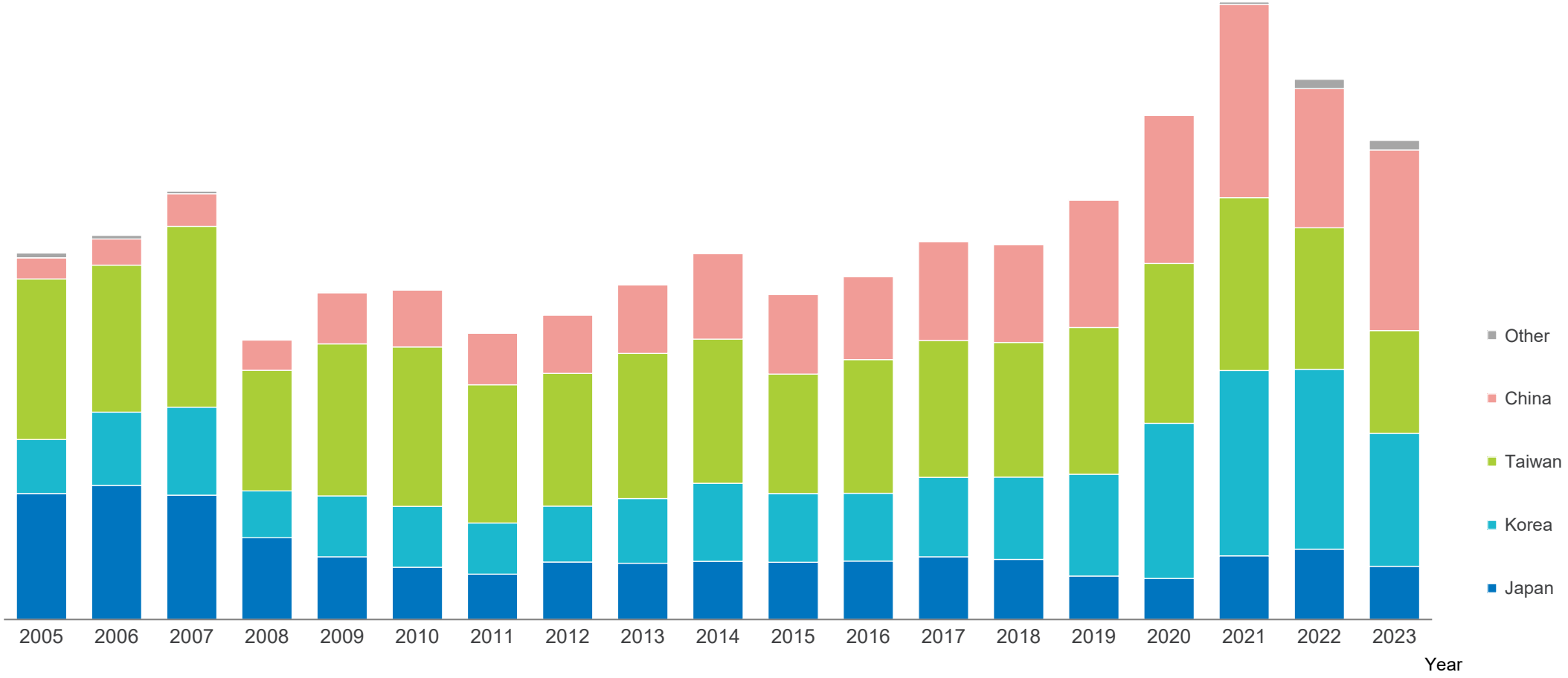
Sales of BT laminate materials



BT materials sales trends by region

- Growth in sales of high-end products is centered on the Korean market. China accounts for significant sales growth for middle- to low-end products.
- In response to demand for middle- to low-end products for the China market, we plan to introduce MGC-ITEQ products alongside our BT materials.

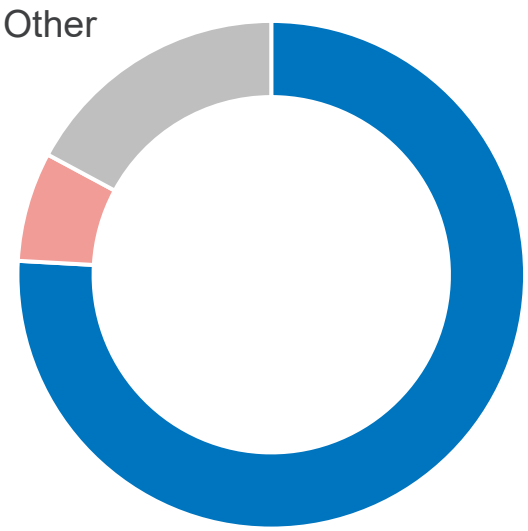
Totals by shipment destination



BT materials by package composition and by final use

- Growth in the FC-BGA business is centered on laptop CPUs.
- Considerable WB/FC-CSP (thin package) use continues.

Shares of package composition



FC-BGA

Key applications:

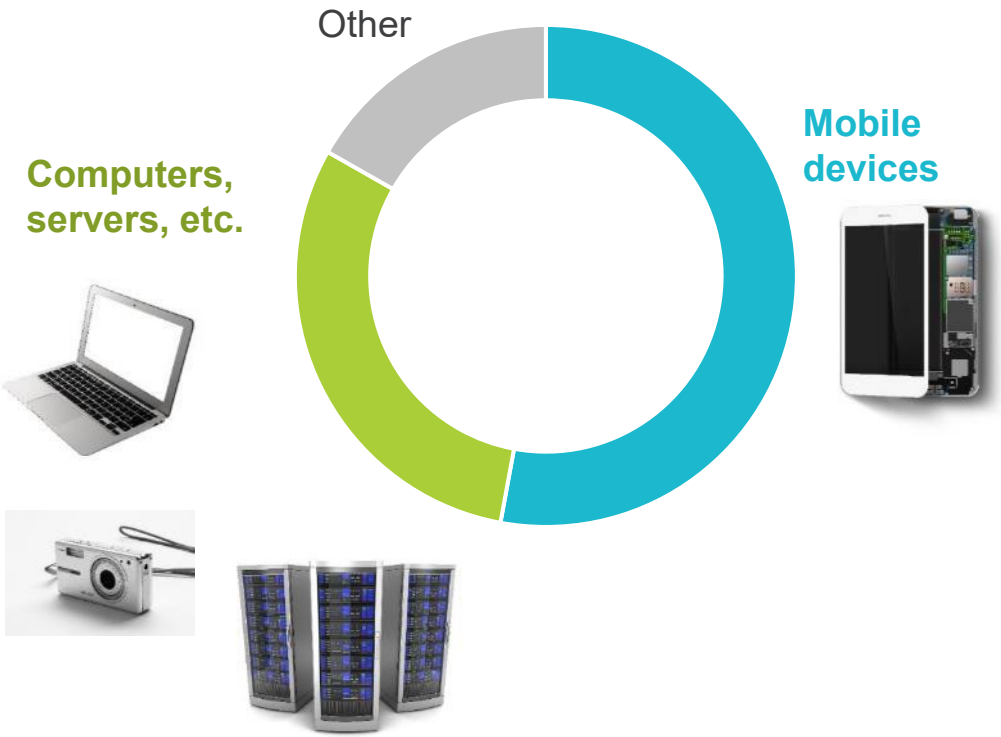
- CPUs for computers etc., GPUs

WB/FC-CSP

Key applications:

- Smartphone AP and RF modules, memory applications, etc.
- Computer and data center memory applications, etc.

Shares of final application

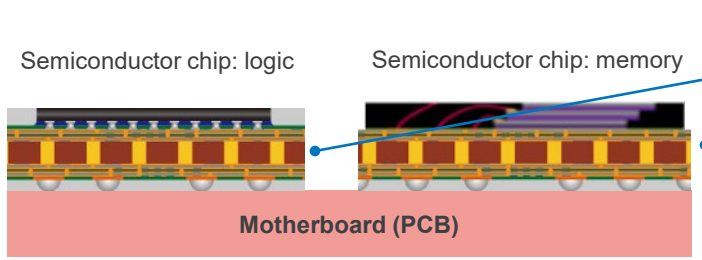


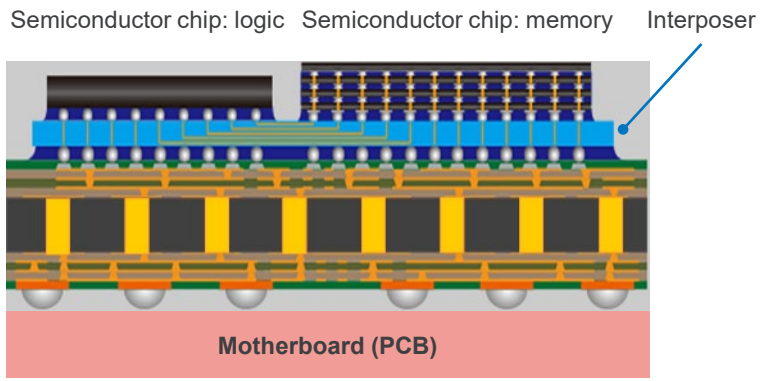
* WB = Wire-Bonding
FC = Flip-Chip
CSP = Chip-Scale-Package
BGA = Ball Grid Array

Future applications development, business strategies, and vision (1): Proposing materials for next-generation FC-BGA use

- Substrates are growing in thickness and surface area as demand for higher performance leads to larger chip dimensions.
- The trend in high-performance FC-BGA chips is toward 2.xD packages, with chiplet structures to mount and connect multiple chips on an interposer.

	Until now	From now on
Application	**Computers, games, telecommunications devices and base stations, servers**	**AI, ADAS, servers**
Technical trends	– Shortening data transfer distances and increasing transmission speeds via high-density implementation – Lower cost and higher performance via smaller dimensions and chip lamination	
Package trends	**FC-BGA**	**2.xD package**





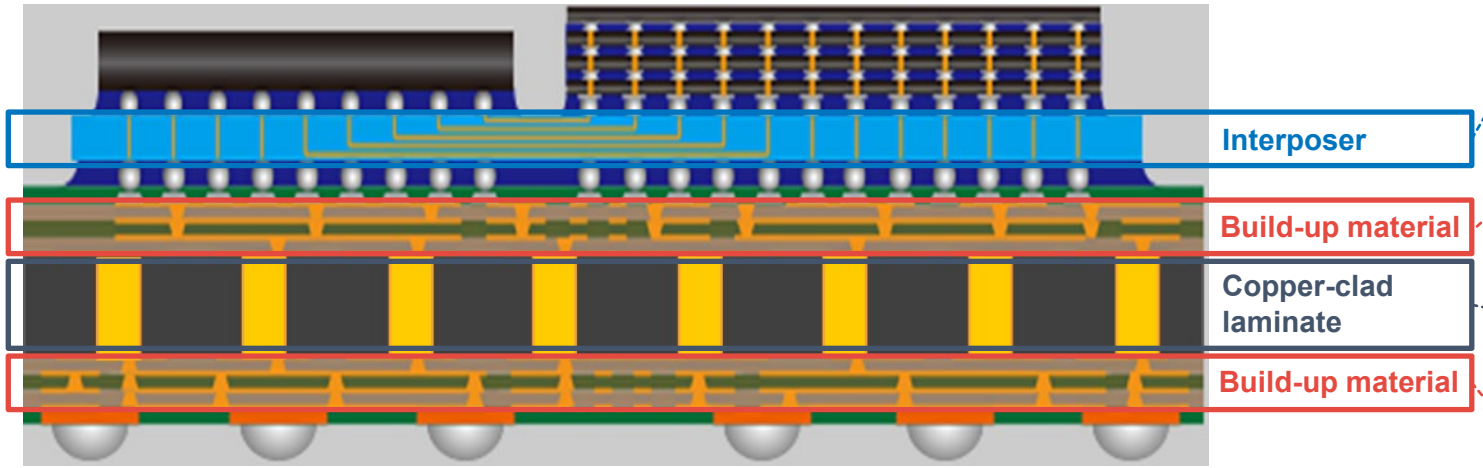
- Each semiconductor chip is mounted on its own package substate.
- Data is transmitted through the motherboard (PCB).

- Multiple semiconductor chips are mounted on an **interposer**.
- Data is transmitted through the **interposer**.

Future applications development, business strategies, and vision (1): Proposing materials for next-generation FC-BGA use

- For copper-clad laminates, we are promoting HL832RS (LCA)* as a next-generation low warping materials for FC-BGA use.
- We will highlight BTCOPPER™ CRS and BF as build-up materials.

* Winner, 20th Japan Electronics Packaging and Circuits Association (JPCA) Award in 2024



2.xD IC plastic package

BTCOPPER™ CRS

Build-up for copper-clad laminates
BTCOPPER™ CRS

Build-up for glass core
BTCOPPER™ BF (unclad)

Copper-clad laminates
HL832RS (LCA)

Build-up for copper-clad laminates
BTCOPPER™ CRS

Build-up for glass core
BTCOPPER™ BF (unclad)

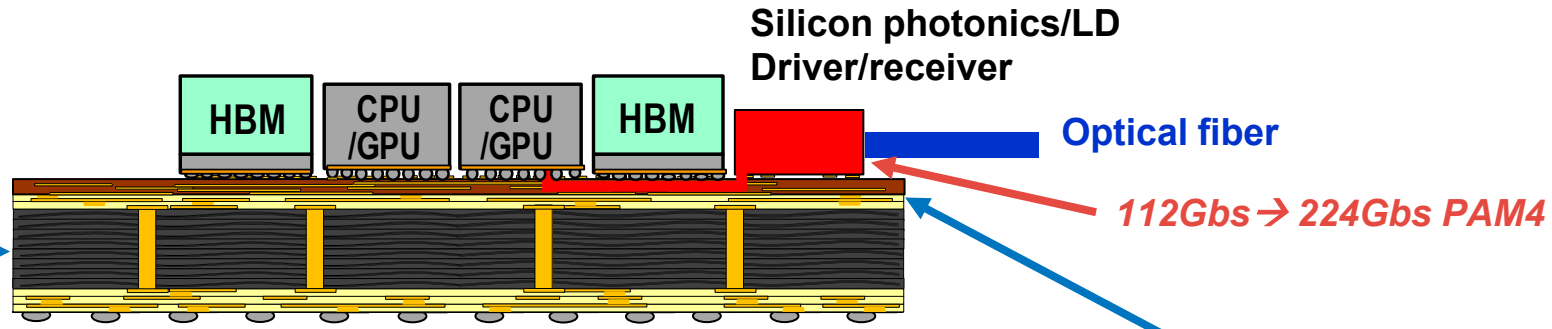
Future applications development, business strategies, and vision (2): Proposing materials for next-generation photonics-electronics convergence

Co-packaged optics (CPO) roadmap

Co-Packaged Optics

	2020	2025	2030
Ethernet	400GbE 56Gbs PAM4 x 8	1.6TbE 112Gbs PAM4 x 16	**3.2TbE** 224Gbs PAM4 x 16

CPO package structure vision



Materials for center core use

Require-ments	**Ultra-low dissipation factor, low thermal expansion**
Proposed products	**Lamination materials with ultra-low transmission loss (Dk ≤ 3.0, Df ≤ 0.0020)**

Materials for build-up use

Require-ments	**Ultra-low dissipation factor, ultra-thinness, fine-pitch circuitry, high insulation reliability**
Proposed products	**BTCOPPER™ CRS (Dk 2.5~2.3)** **BTCOPPER™ BF (Dk 3.0~2.4)** Both products are capable of building insulation layers as thin as 6 μm.

3. OPE Derivatives

About OPE™

OPE derivatives: About OPE™

- OPE™ is a thermosetting PPE oligomer developed with MGC's proprietary polymerization technologies. It delivers a sound balance between low dielectric properties and various special features such as high heat resistance, low water absorbency, flame resistance, and low viscosity.
- It is used for state-of-the-art laminate materials (PCB insulating layers), including the motherboards of high-end servers and wireless base stations.

Low dielectric properties (low dielectric constant, low dissipation factor) indicate a **substance's capacity to store** and **react to electricity**.

Higher electric signal transmission speed

(Higher communication speeds)

↓

Realizing 5G and other high-speed communications

Controlling electric signal attenuation and loss

(Reducing power consumption)

↓

Helps conserve electricity and improves product environmental performance.

(Reference) Transmission loss: Lower dissipation factor (Df) and dielectric constant (Dk) figures mean better control of loss.

Transmission Loss = **Conductor Loss (Cu foil)** + **Dielectric Loss (Insulator)**

$$\propto \sqrt{F} \cdot R$$

$$\propto 27.3 \cdot F/C \cdot \sqrt{\varepsilon} \cdot \tan\delta$$

F: Frequency
R: Conductor resistance
E: Dielectric constant of insulator (Dk)
tanδ: Dielectric loss tangent of insulator (Df)
C: Speed of light

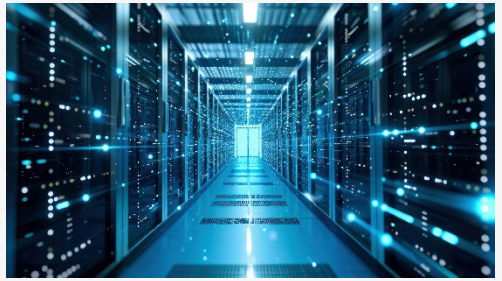
Factors driving growth in the OPE™ business

- Demand for high-performance multilayer boards is growing in infrastructure systems, keeping pace with growth in network communication volumes due to the proliferation of 5G and expanding adoption of advanced data communication network standards.
- The key factor driving growth in demand for OPE™ is the proliferation of AI servers. Since communication speeds of AI servers are equal to those of the most advanced standards in the market, the market for state-of-the-art laminate materials using OPE™ is growing.

History of OPE™

OPE™

Yokkaichi Plant



2001
R&D began

2006
Pilot plant completed

2013
- OPE™ plant completed
- OPE derivatives business launched (Yokkaichi Plant)

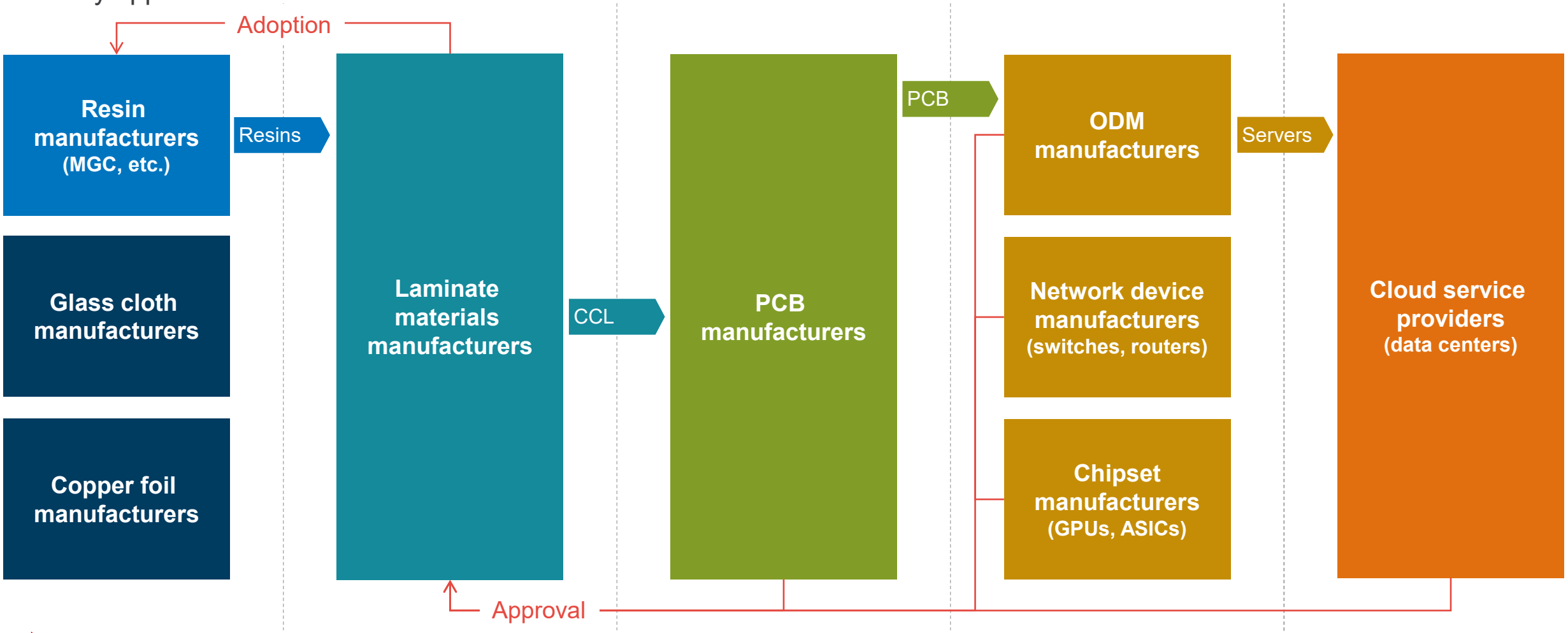
2016
External sales began

2021
OPE™ plant production process improvements completed

Growth of the generative AI market since 2023 has promoted growth of the market for OPE™ use.

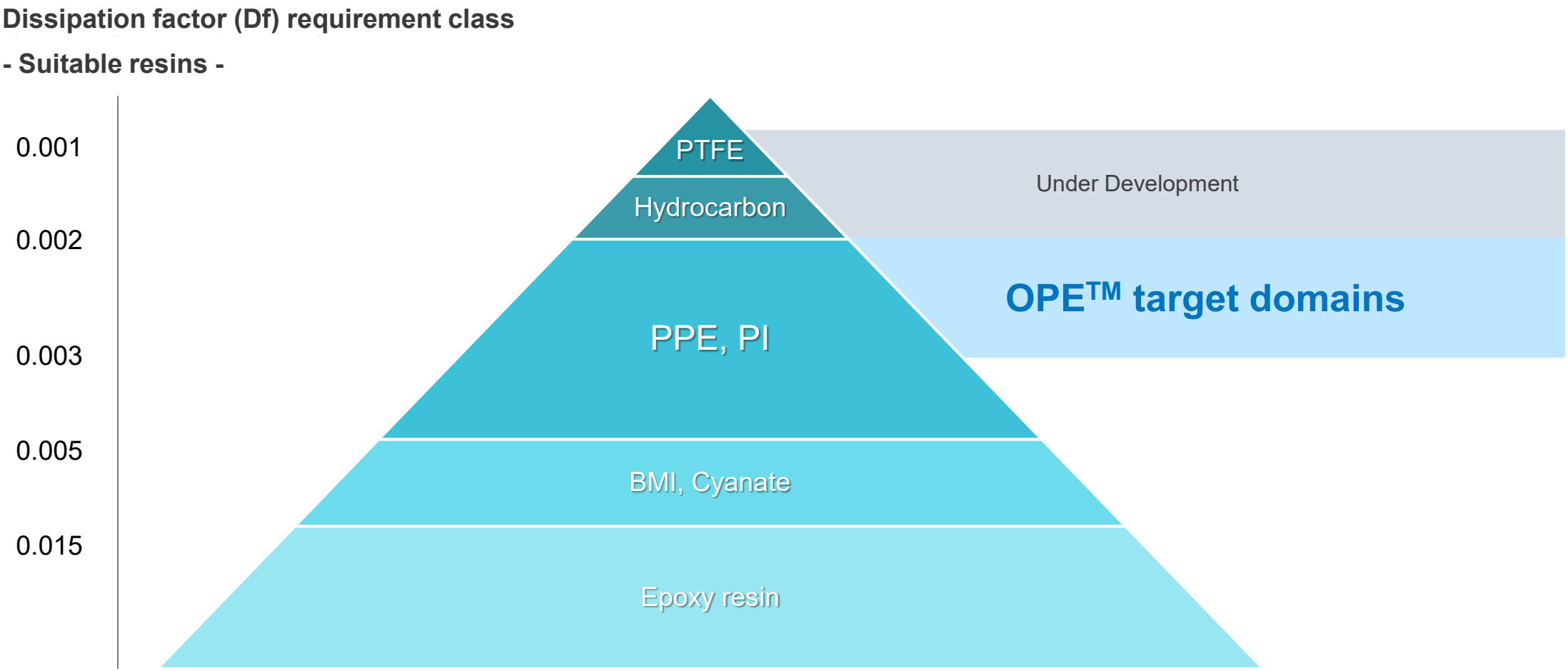
OPE™ supply chain

- OPE™ is one of the products that have expanded our business area in electronics materials from laminate materials to upstream raw resins.
- Since various raw materials are used in insulating layers of laminate materials, we provide technical support for laminate materials manufacturers, while promoting development of resin formulations and pursuing a proactive approach to achieve early approval in end-user markets.



OPE™ target domains

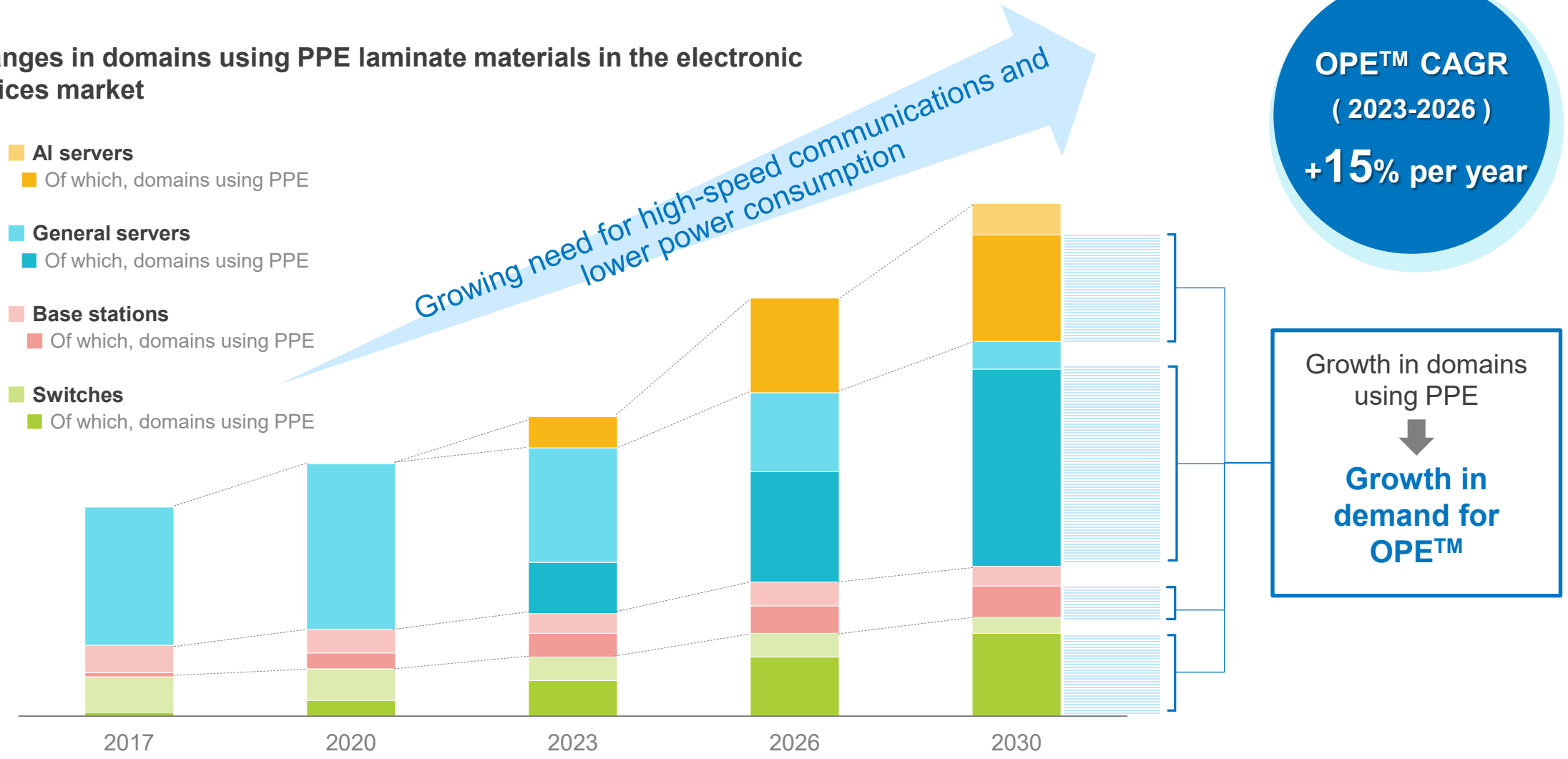
– OPE™ is used for laminate materials that require low dielectric properties. The growing laminate materials market is driving demand for OPE™.



Factors driving OPE™ market growth

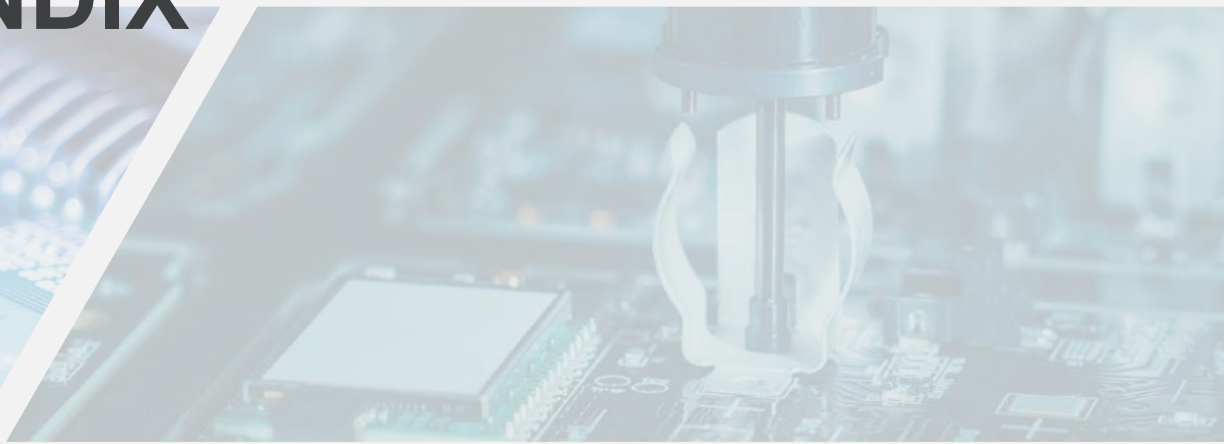
– Growth in demand for PPE laminate materials in the electronic devices market, particularly in domains and items using OPE™, supports business growth.

Changes in domains using PPE laminate materials in the electronic devices market




ICT
Innovation
Strategy
Solutions
Analysis
Marketing
Management

APPENDIX



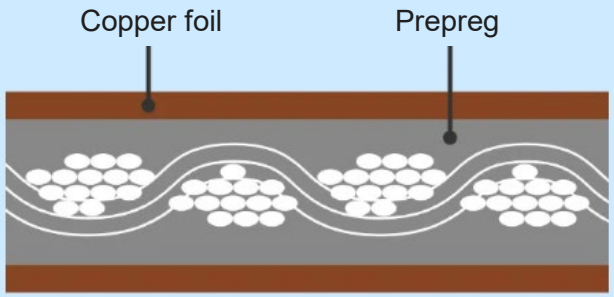
History of the BT materials business

– We have built trusting relationships with customers, backed by strong proprietary technologies, since developing BT resins in 1976.

1950s	**First PCB delivered in Japan** First use of our lamination materials to make transistor radios
1976	**BT resin developed** Tokyo Plant begins production of glass epoxy copper-clad laminates
1991	**Electrotechno Co., Ltd. established**
1998	**BT lamination materials shipment volumes increase** (certified for BGA use)
2003	**Growing demand for halogen-free BT and BT suitable for use with lead-free solder** (environmental considerations)
2008	**HL832NS low-CTE material for flip chip package use developed**
2012	**MGC ELECTROTECHNO (Thailand) established**
2022	**MGC ELECTROTECHNO (Thailand) prepreg production capacity increased**
2024	**HL832RS/GHPL-830RS next-generation low warp BT resin laminate board materials win 20th Japan Electronics Packaging and Circuits Association (JPCA) Award**

BT materials: Product structure and manufacturing process overview

Copper-clad laminate



Prepreg