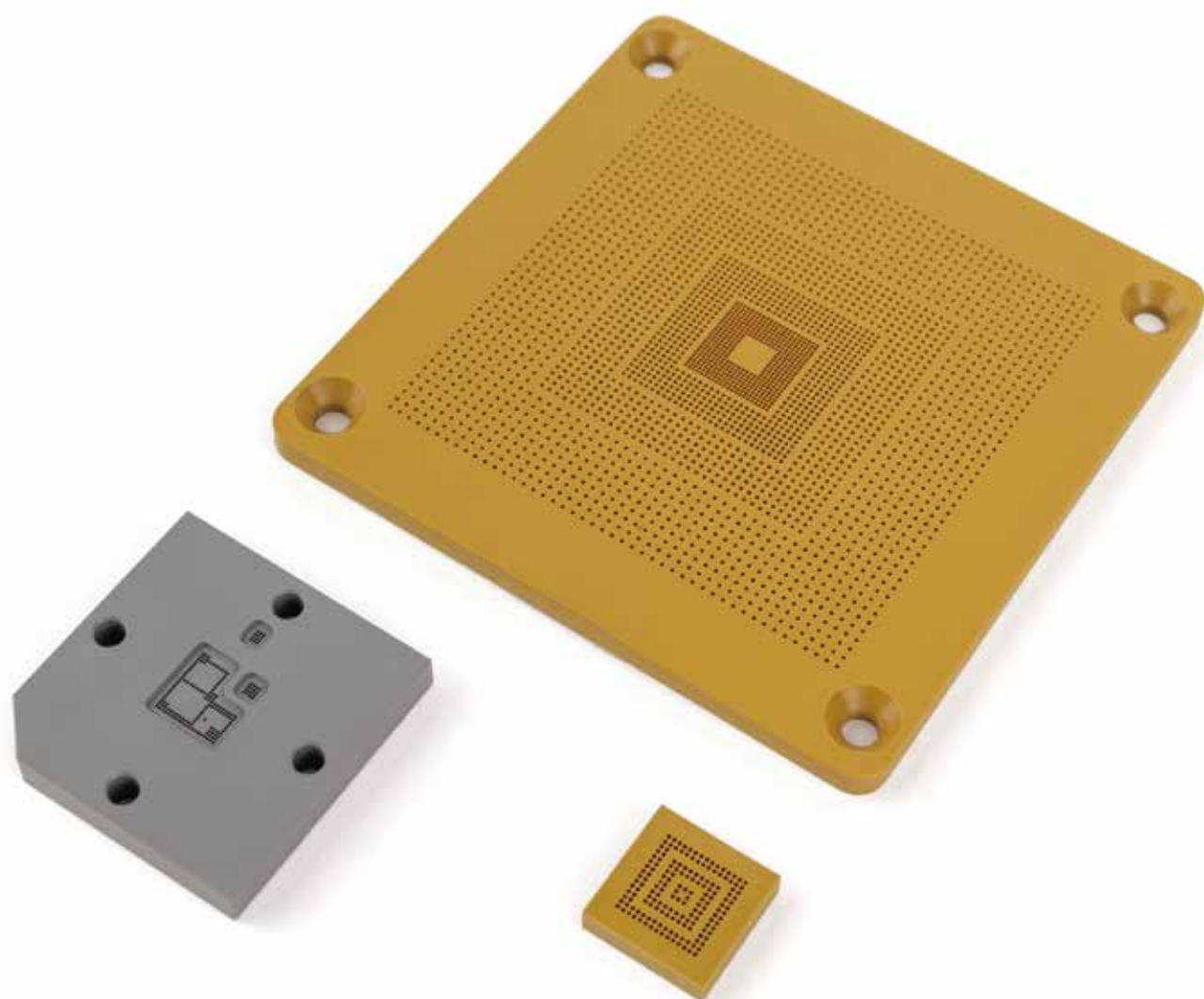


Beyond the Socket: Materials That Make the Test



Stability. Machinability. Strength. Cleanliness.

For fabricators and OEMs, traditional polymeric sockets fall short.

At Mitsubishi Chemical Group, we **eliminate these barriers at the source** by working alongside customers to **match materials to performance requirements** and **solving complex designs** with tight tolerance machining.

One partner, vertically integrated from polymer to finished part.

Why Advanced Materials Matter

As semiconductor packaging advances to finer geometries, socket materials face critical performance demands. Advanced polymers provide mechanical and thermal stability for ultra-tight geometries and millions of insertion cycles.

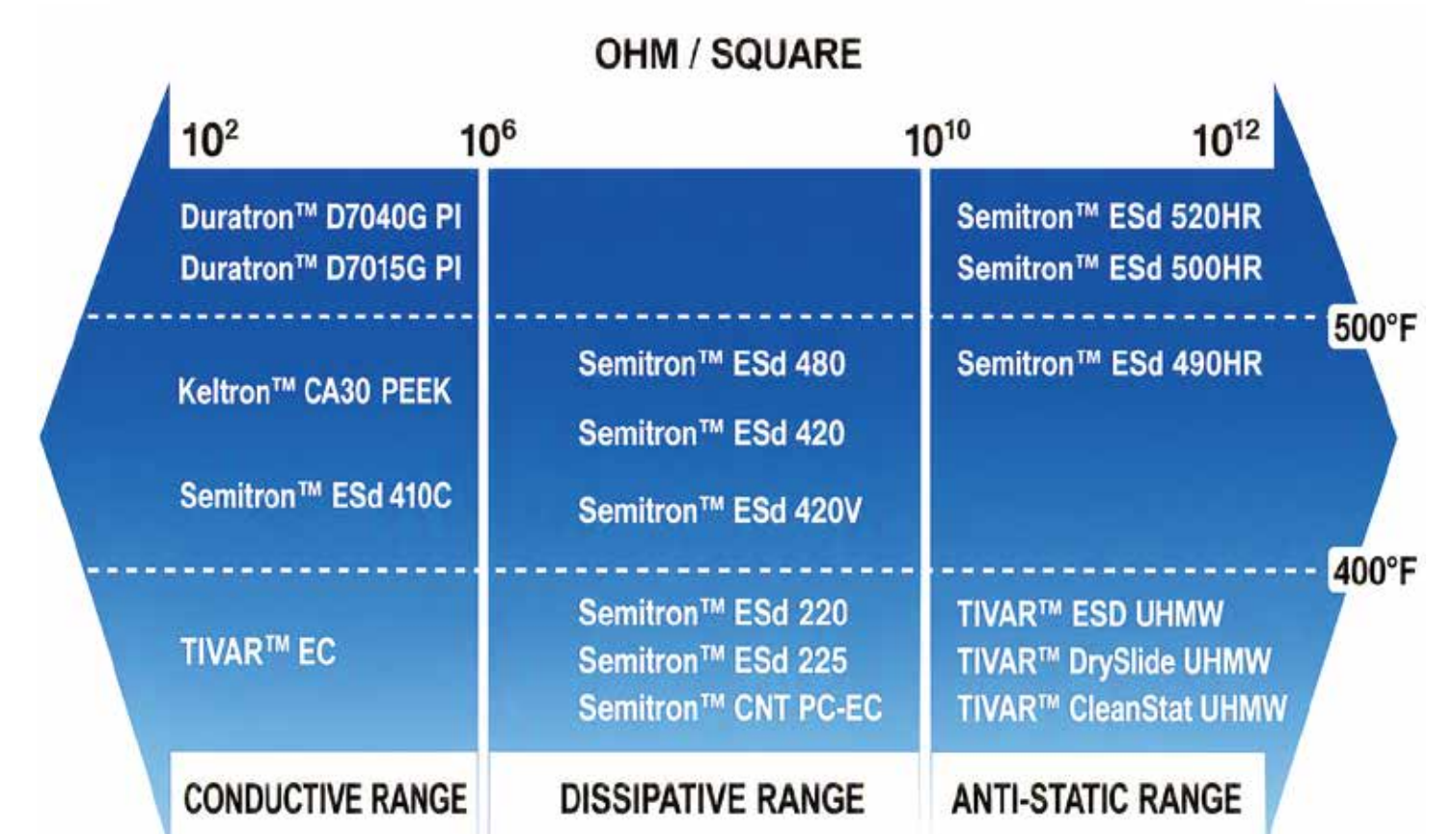
MCG addresses the four key challenges:

Dimensional Stability: Sub-0.5mm pitch sockets demand ultralow CLTE and minimal moisture uptake. Semitron MDS-100 (modified PEEK) flexural modulus >1,400,000 psi; moisture absorption only 0.10% at 24 hrs.

Thermal Performance: Burn-in and test environments reach 150-210°C. Semitron MDS-100 maintains dimensional integrity to 210°C (410 deg F).

Machinability: Excellent machinability for fine features. Low tensile strength allows for increased accuracy in hole placement and burr-free machining.

ESD Control: Semitron ESd grades (420 PEI, 480 PEEK, 520HR PAI) are inherently dissipative (10^6 - 10^9 ohms/sq.) - no surface treatments, no humidity dependence.



Products & Performance

SEMITRON MDS-100 (Modified PEEK) | The Precision Test Socket Standard

Flexural Modulus >1,400,000 psi | Thermal limit 210°C | Moisture 0.10% (24hr) | Density 1.43 g/cc | Test socket bodies, burn-in socket inserts, nests, fixtures | Available in thin plates (1-6mm) and standard thick plates

SEMITRON ESd 420 (PEI) | Workhorse ESD Socket Material

Surface resistivity 10^6 - 10^9 ohms/sq. | HDT 216°C | Inherently dissipative | Non-sloughing

SEMITRON ESd 480 PEEK | High-Purity ESD for Advanced Nodes

PEEK chemical resistance + controlled ESD | Excellent dimensional stability under humidity and temperature variation | Ideal for critical test fixtures and wet process tools

KYRON GC-100 | Ultra-Stiff Non-Fiber-Filled Complement

Flexural modulus non-fiber-filled polymer | Extremely low CLTE | Complements MDS-100 in thicker cross-sections (6-12mm)

The key components in next generation socket design

Socket Type	Basic	Challenging	Demanding
Hole size	>0.4mm	0.2-0.35mm	<0.18mm
Pitch size	>0.6mm	0.25-0.5mm	<0.25mm

Test socket material selection grid
Polymeric stability vs. machinability of fine features



We continue to develop next generation materials – schedule time to discuss your next project.



As wafers and panels grow larger and heavier, conventional materials can't keep up. DIALEAD™ pitch-based carbon fiber delivers solves conventional problems.

Why Pitch-Based CF for Wafer Handling? Aluminum deflects. Ceramics are heavy. DIALEAD™ eliminates the trade-off — ultra-high stiffness at low weight. Tensile modulus up to 760 GPa — 3× stiffer than standard PAN-CF — with 40% less mass than aluminum. The result: handling arms that barely deflect, even at full extension. Built-in vibration damping means faster settle times, tighter placement accuracy, and faster takt — without tuning. Ready for 450mm and beyond: as wafers get larger, DIALEAD™ scales with the demand for speed and precision.

How We Partner:

Co-development from spec to part. • Application engineering in Japan, US & Europe.
• Qualified with leading OEMs worldwide.

Representative cases for each material	Thickness mm	Deflection			Natural frequency Hz	Density g/cm ³
		self-weight mm	Load mm	Total mm		
CFRP Elastic modulus 320 GPa	2.0	0.1	0.8	1.0	60	1.8
Ceramics Elastic modulus 320~390 GPa	2.0	0.2	0.7	1.0	50	3.9
Aluminum Elastic modulus 70 GPa	2.0	0.7	3.0	3.7	26	2.7

*The load deflection values are calculated based on a $\phi 300$ wafer placed on the hand.
*The higher the natural frequency, the better the vibration damping performance.

Why DIALEAD™ ?

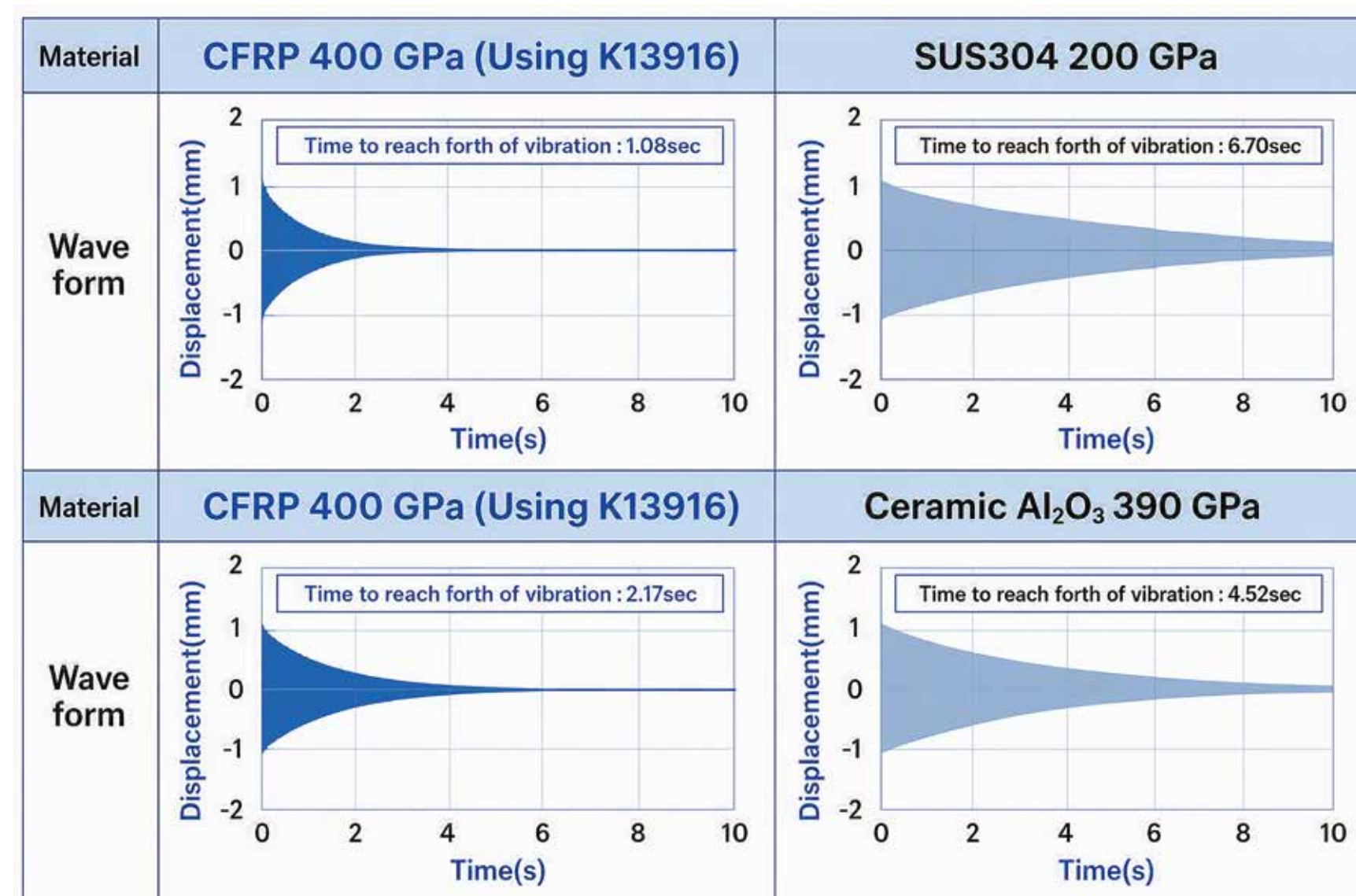
Exceptional Stiffness-to-Weight Ratio: Up to 40% lighter than aluminum at the same stiffness. Less mass = faster acceleration, lower motor load, longer equipment life.

Built-in ESD Control (No Coating Required): Stable dissipative performance built into the fiber — no ESD coating needed. Simpler design, fewer process steps, zero coating delamination risk.

Chemical Resistance: Withstands harsh chemicals and aggressive etch chemistries. Reliable across wet bench, CMP, and deposition environments.

Near-Zero Thermal Expansion (Low CTE): Near-zero CTE ($-0.9 \times 10^{-6}/K$ axial). Maintains placement accuracy through full thermal cycle — no drift, no re-calibration.

Why MCG vs. Alternatives: Fiber → prepreg → molded part — one supplier, one quality standard. MCG's vertical integration removes supply chain risk.



Unmatched Performance Data

DIALEAD™: Ultra-High Modulus Carbon Fiber Tensile modulus ≥ 760 GPa

Resin systems up to 300°C Epoxy, Cyanate Ester, Phenolic

Design & Analysis: MCG designs to your spec — fiber, layup, and component.

Vertically integrated supply chain: CF → Prepreg → Molded parts.

Material		Specific Gravity	Tensile Modulus		Thermal expansion coefficient		Thermal conductivity	
			X direction	Y direction	X direction	Y direction	X direction	Y direction
		g/cm ³	GPa	GPa	10 ⁻⁶ /K	10 ⁻⁶ /K	W/m·K	W/m·K
CFRP (Vf60)	PAN std modulus grade	1.6	100	30	1.7	5.8	2.4	1.3
	Pitch high modulus grade	1.7	250	60	-0.9	7.7	73	1.2
	Pitch ultra-high modulus grade	1.7	320	90	-0.9	9.0	115	1.2
	Pitch high thermal conductivity grade	1.7	540	102	-0.9	9.7	480	1.2
Other Materials	SUS303	8.0	200	200	17.3	17.3	15	15
	Aluminum(1200H18)	2.7	69	69	23.6	23.6	220	220
	PPS-GF(40%)	1.6	8	8	—	—	—	—



FM4910 solutions for Critical Environments

<Features>

FM4910 Certified transparent ESD (Electro Static Discharge) controlled

<Applications>

- ✓ Windows for Semiconductor Manufacturing Equipment
- ✓ Panels for Cleanroom
- ✓ Windows for Data Center as Safety Components

HISHIPLATE™ Anti-Static Plate

- ✓ The excellent anti-static property represented by surface resistivity of 10^6 - $10^8 \Omega$ added.
- ✓ As it has a good durability, the anti-static property lasts for long time.
- ✓ Has a non-flammability (self-extinguish).
- ✓ Since the orange colored and yellow colored sharply cut the light of specific wave length, suitable for optical applications.
- ✓ SEP series has the excellent chemical resistance of rigid polyvinyl chloride.
- ✓ SEP series can heat processing just as well as ordinary rigid PVC plate and the appearance prior to the forming can be maintained.

Technical Information

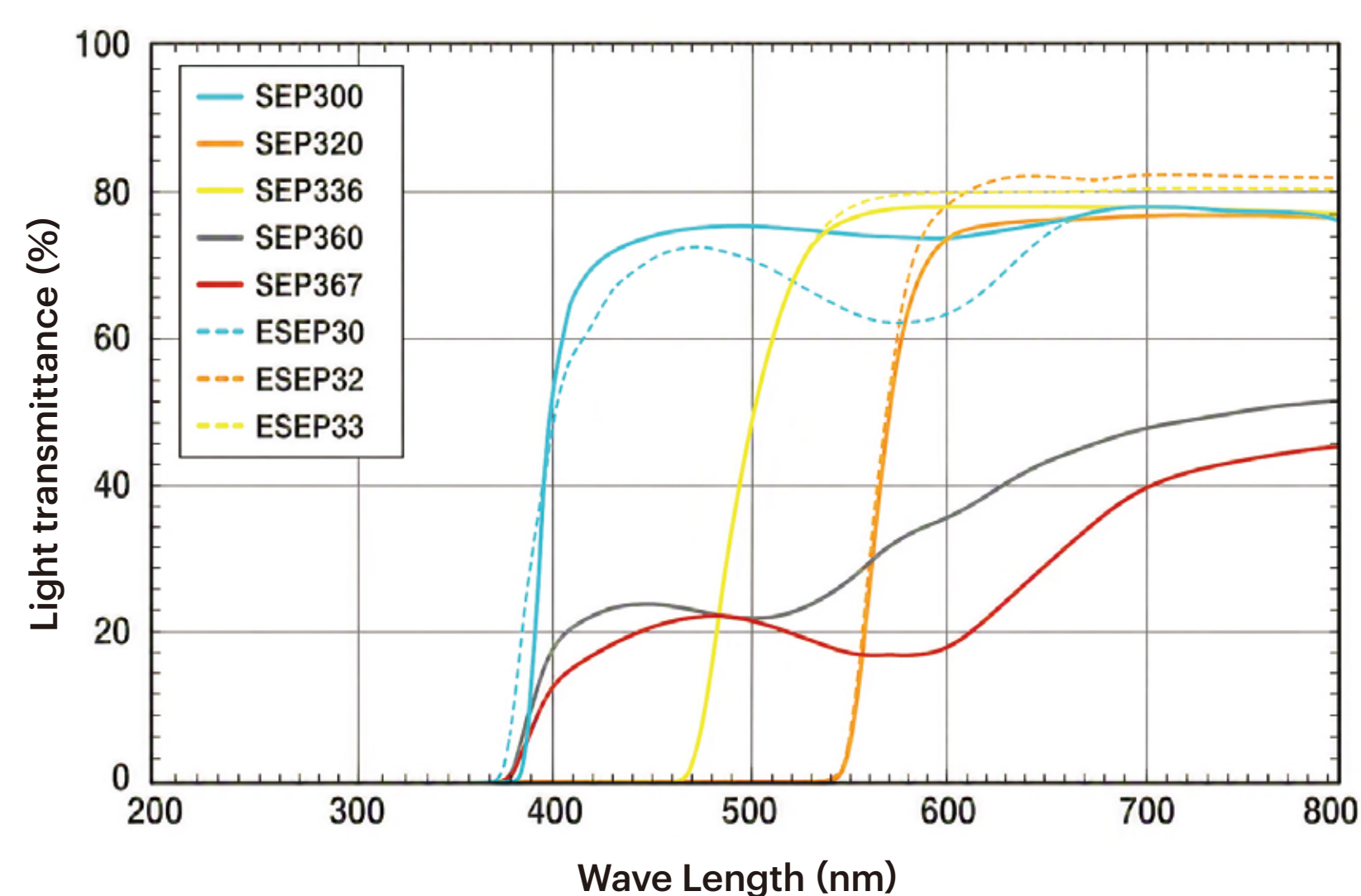
Product Lineup

Manufacturing Method	Grade	Item No.	Color	Size (mm)	Thickness (mm)						
					2	3	4	5	6	8	10
New Press	SEP	SEP300	Transparent	1,000×2,000	6	4	3	2	2	1	1
				1,212×2,424		3		2		1	1
		SEP320	Orange transparent			4		2			
		SEP336	Yellow transparent			4		2			
		SEP360	Gray Smoke	1,000×2,000		4		2			
Extrusion	ESEP	SEP367	Brown Smoke			4		2			
		ESEP30	Transparent	1,000×2,000		4	3	2	*	*	*
				1,212×2,424		3	2	2	*	*	*
		ESEP30 Pallet packaging		1,000×2,000		100	*	60	*	*	*
				1,212×2,424		60	*	40	*	*	*
		ESEP32	Orange transparent	1,000×2,000		*	*	*			
				1,212×2,424		*	*	*			
		ESEP33	Yellow transparent	1,000×2,000		*	*	*			
				1,212×2,424		*	*	*			
		ESEP37	Brown Smoke	1,000×2,000		*	*	*			
				1,212×2,424		*	*	*			

Fabricating Notes

When adhesion or welding is required, the antistatic layer on the top surface must be shaved off.

Spectroscopic light transmittance of HISHIPLATE Anti-static plate (5.0mmt)





Mitsubishi Chemical Group provides a very wide range of materials for semiconductor transport and packaging.

Engineering plastics are used for structural components, while elastomers and functional resins enable sealing and peelable applications.

<MCG solutions>

XANTAR™ : Polycarbonate (PC) - Structural components(FOSB), Carrier tape

NOVADURAN™ : PBT - FOSB rear retainer,

DURABIO™ : Bio-based Engineering plastics - Structural components(FOSB)

Tefabloc™ TPC / TPS : Thermoplastic Elastomers – Gaskets / Seals

Modic™ Peelable : Functional resin – Cover tape / Peelable applications

For FOSB/FOUP Body, Door & Seal Applications

Materials for semiconductor transport containers, designed to maintain high cleanliness and protect devices.

Low out gassing, low ionic, and low metal content help minimize contamination risks during transport and storage.

XANTAR™ (PC)

Body / Door parts

High cleanliness, Low outgassing,
Sliding grades available for
improved wear performance.

NOVADURAN™ (PBT)

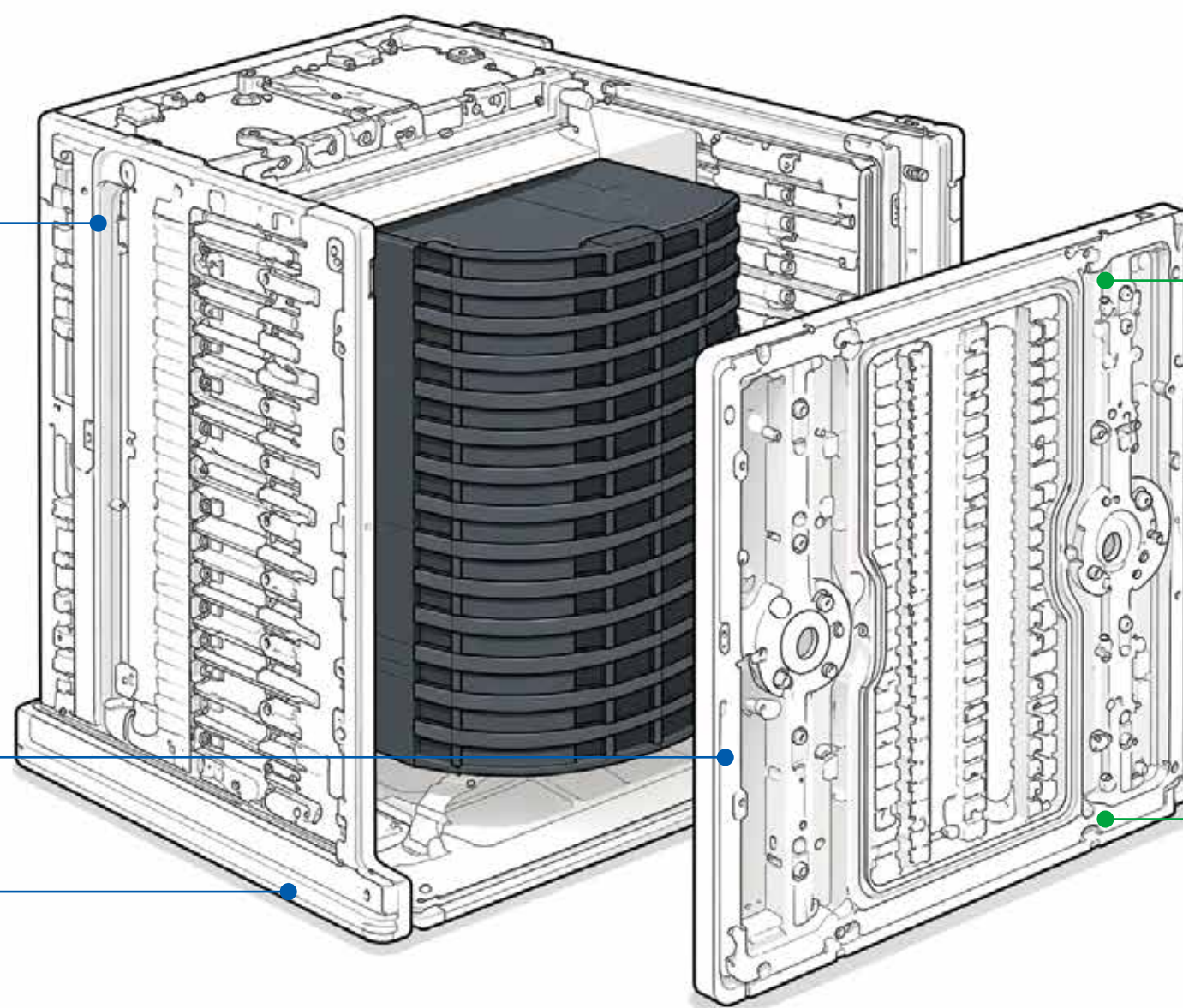
Door parts / Retainer

High cleanliness,
low outgassing,

DURABIO™ (Bio-based)

Body / Door parts

High cleanliness, High transparency
Bio-based material for advanced
material solutions.



Tefabloc™ TPC (Polyester type) Gasket / Seal

High cleanliness, Low outgassing
Excellent Sealing, Flexibility,
Low contamination

Tefabloc™ TPS (Styrene type) Gasket / Seal

Low outgassing
Sealing / Flexibility (wide range)
Low moisture absorption for
improved sealing stability.

Semiconductor Carrier Tape & Cover tape

Materials for semiconductor carrier and cover tapes, designed for precise device handling and stable peel performance.

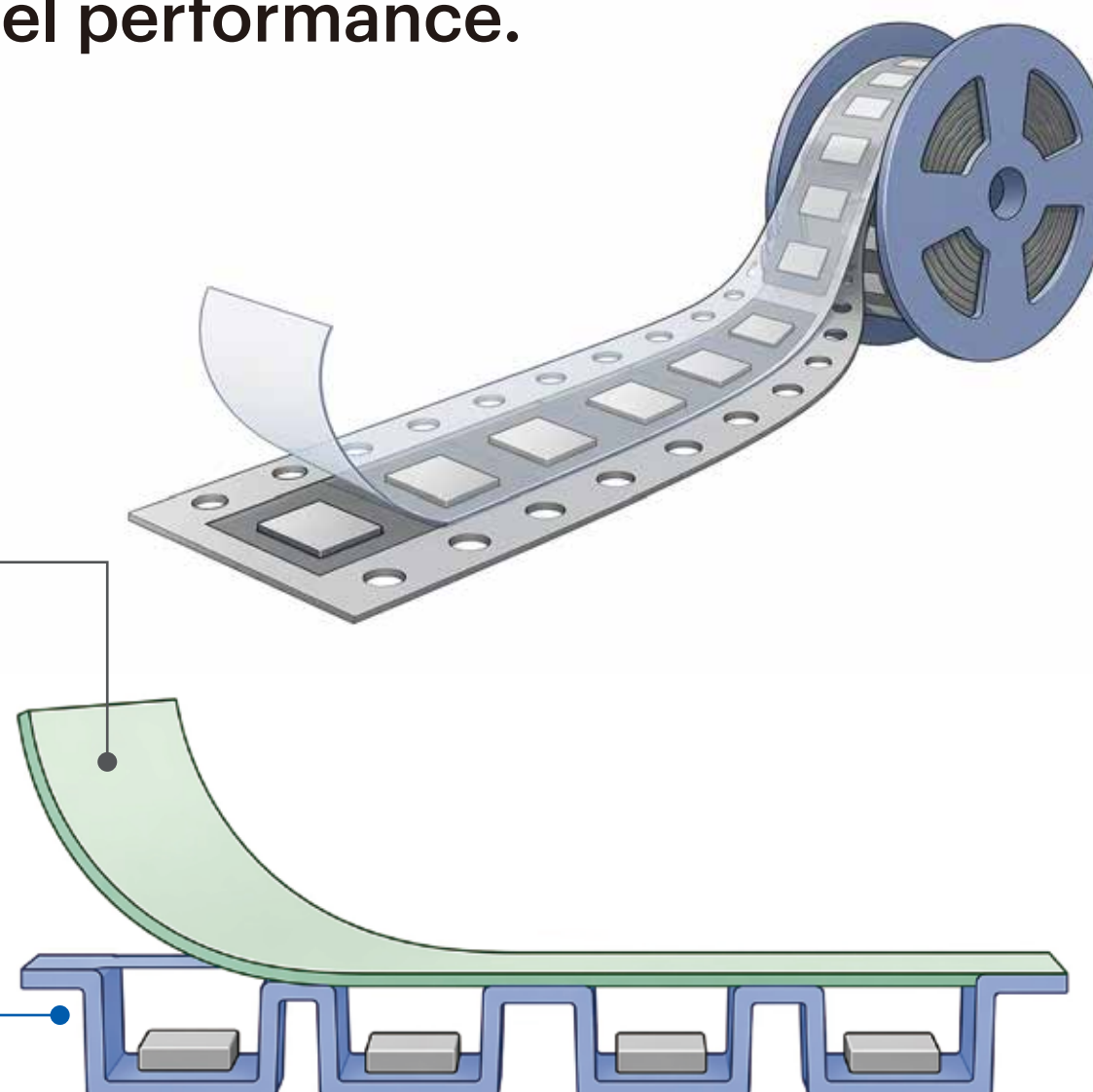
Modic™ (Easy peel sealant resin) Cover tape

Controlled peeling strength
Interfacial peel for clean removal
Compatible with PS, PC, PET etc
Heat sealable without pre-coating

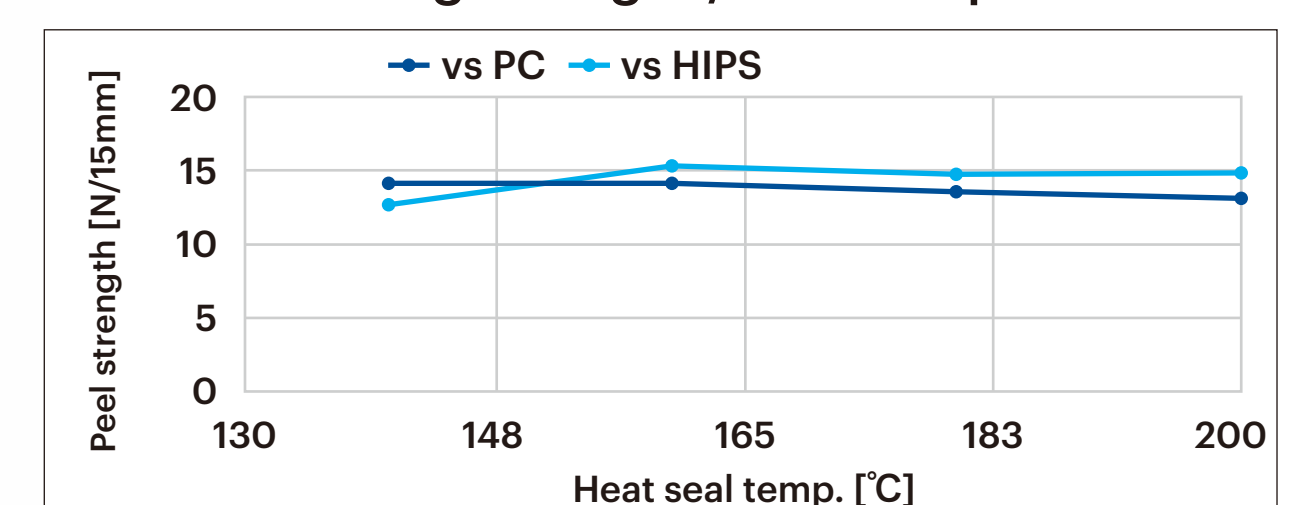
XANTAR™ (PC)

Carrier tape

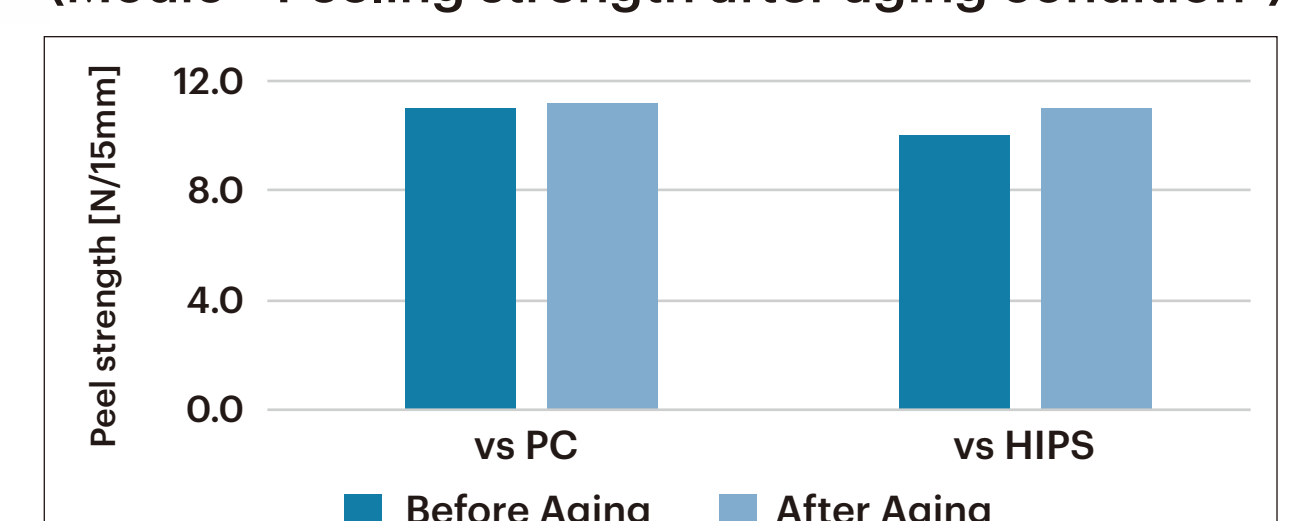
Dimensional stability,
Heat resistance
Impact strength for reliable device
protection



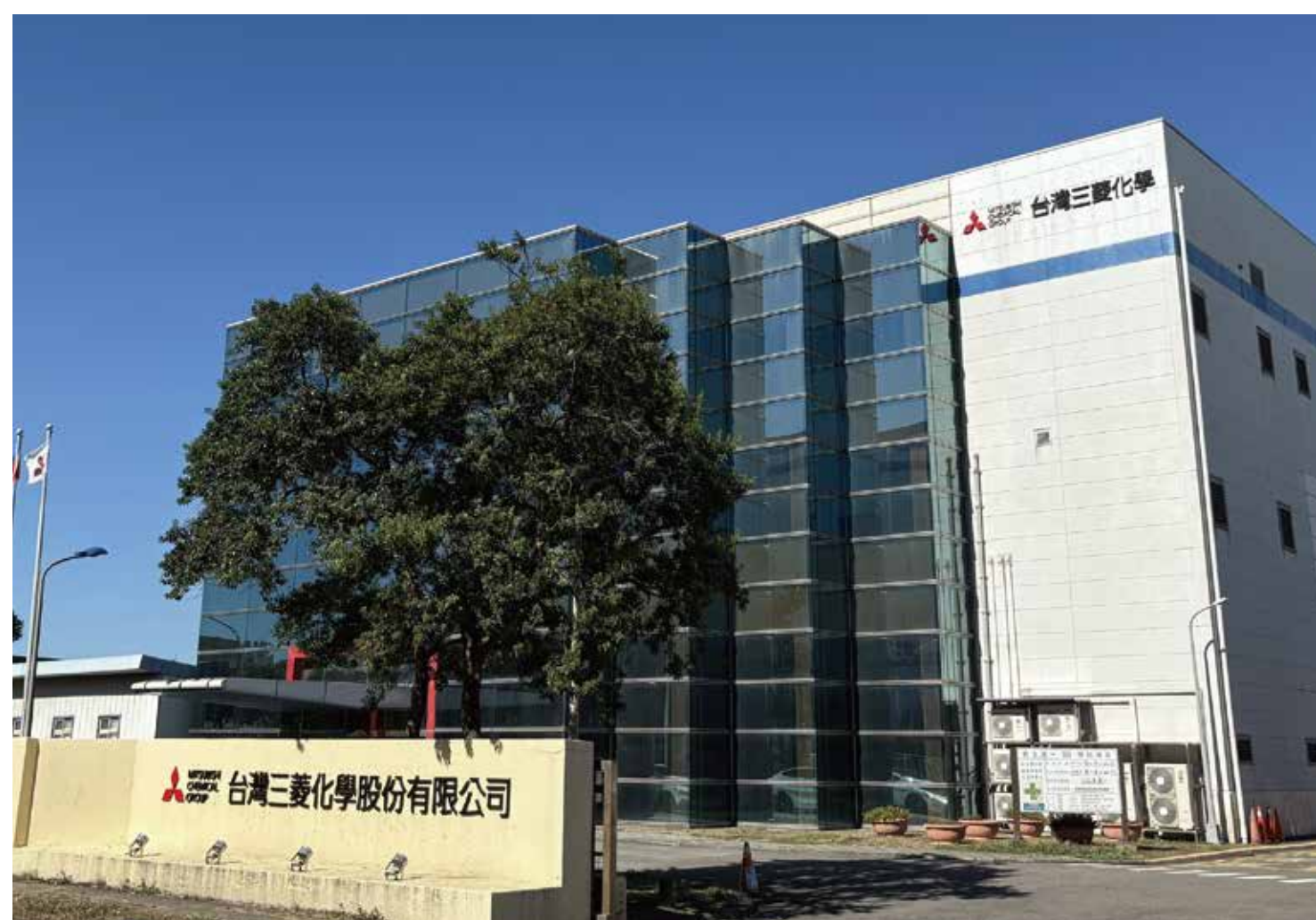
<Modic™ Peeling strength / Seal temp>



<Modic™ Peeling strength after aging condition*>



*Aging condition : 60°C, 85%RH : 1week



新竹總公司：新竹縣湖口鄉光復路62號

高雄分公司：高雄市大寮區華中路42號

台北聯絡處：台北市中正區衡陽路51號10F-10

在台創新實驗室暨行銷服務處：新竹縣竹北市台元街18號5F-1

- 半導體製造用高純度化學品之製造與販售
- 半導體製造用設備零件之精密洗淨
- 離子交換樹脂之製造與販售
- 平面顯示器製造用化學品之販售
- 顯示器材料（彩色光阻液）之販售
- 工程塑膠之販售



事業部門介紹

電子工業用高純度製程藥品

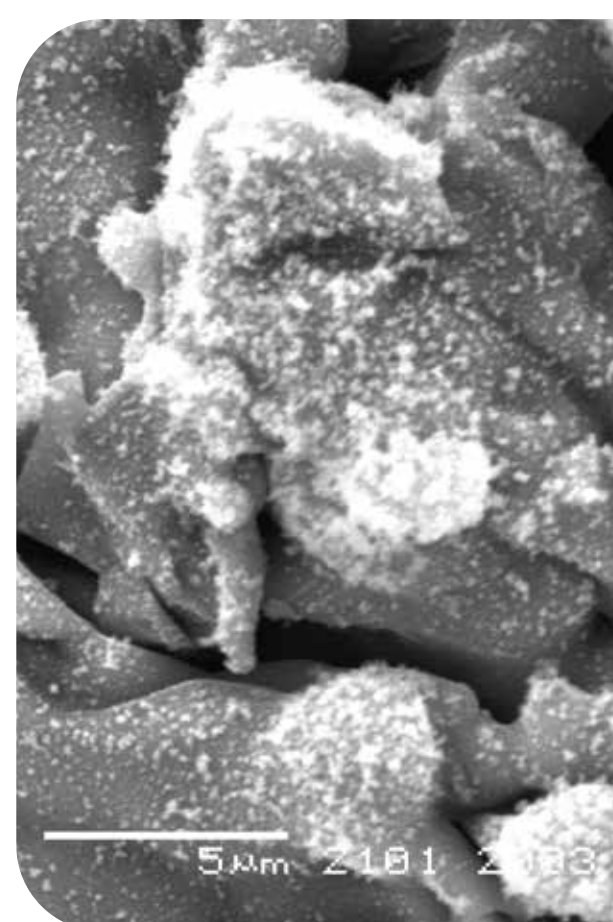
硫酸、氨水、Si蝕刻液、其他



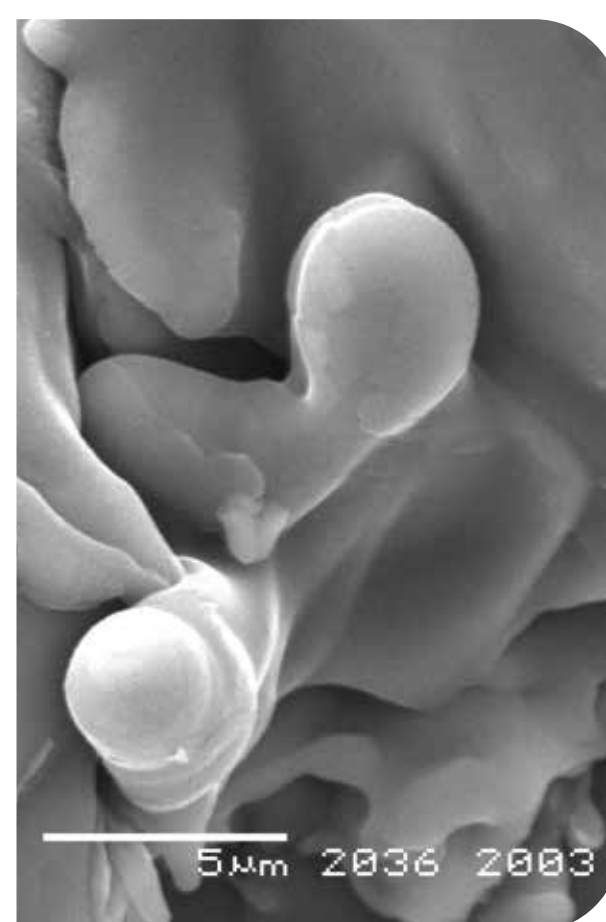
半導體設備零組件清洗

精密洗淨技術

洗淨前

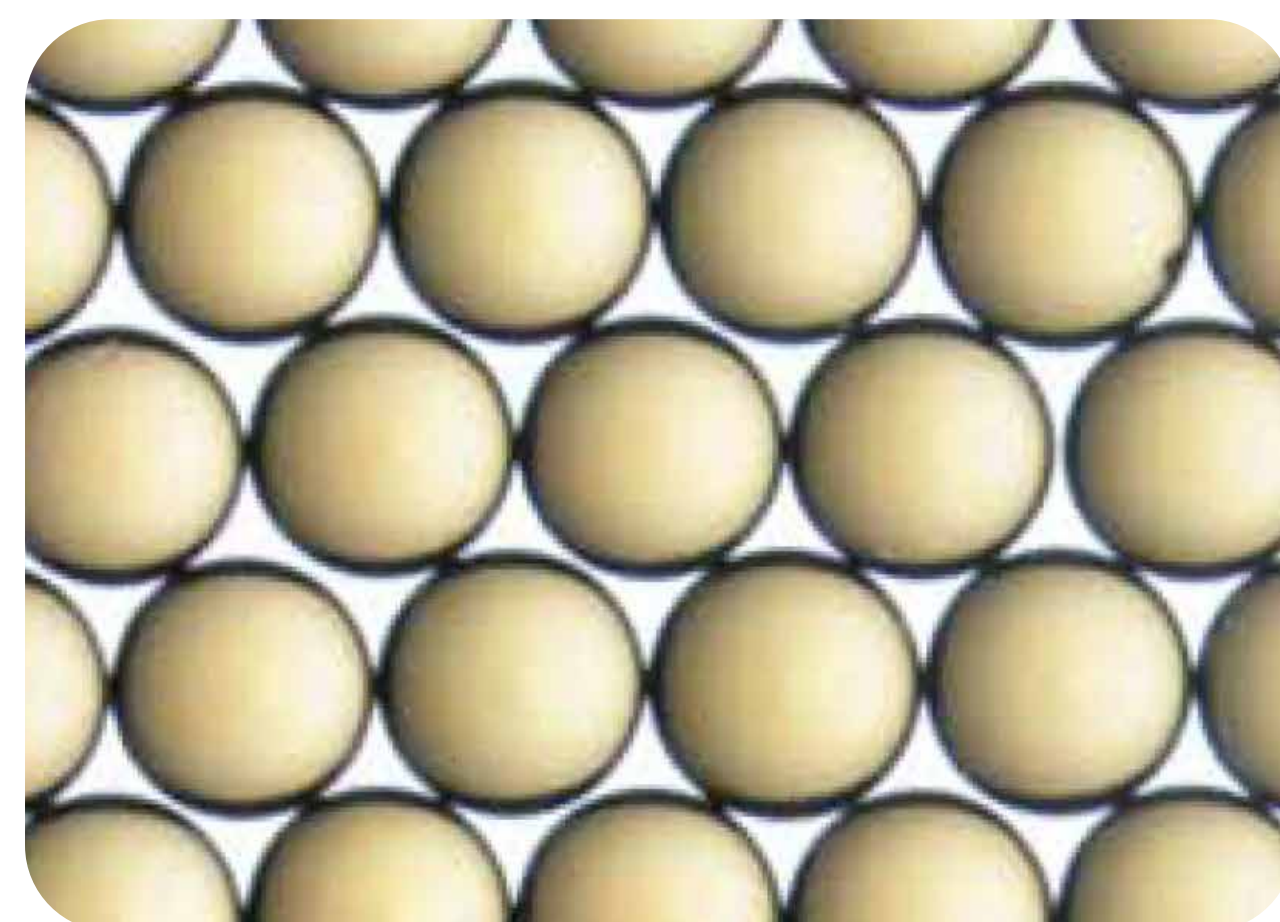


洗淨後



DIAION™ 離子交換樹脂

超純水製造, 中水回收, 廢水處理,
有價物回收, 電子級溶劑純化等



液晶顯示器用彩色光阻

平面顯示器產業
COLOR FILTER主要材料
彩色/黑色光阻



汽車連接器&消費性電子

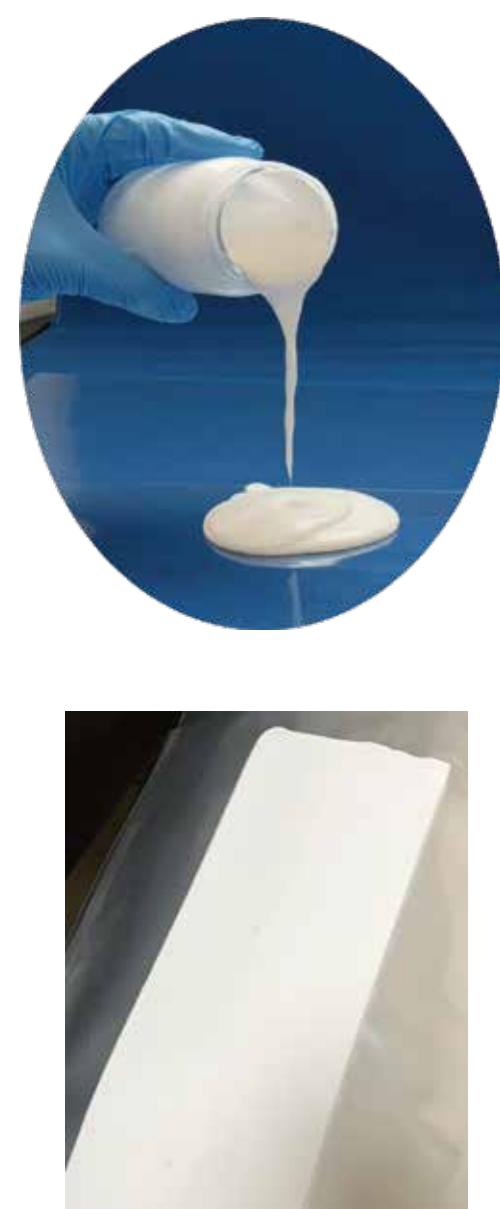
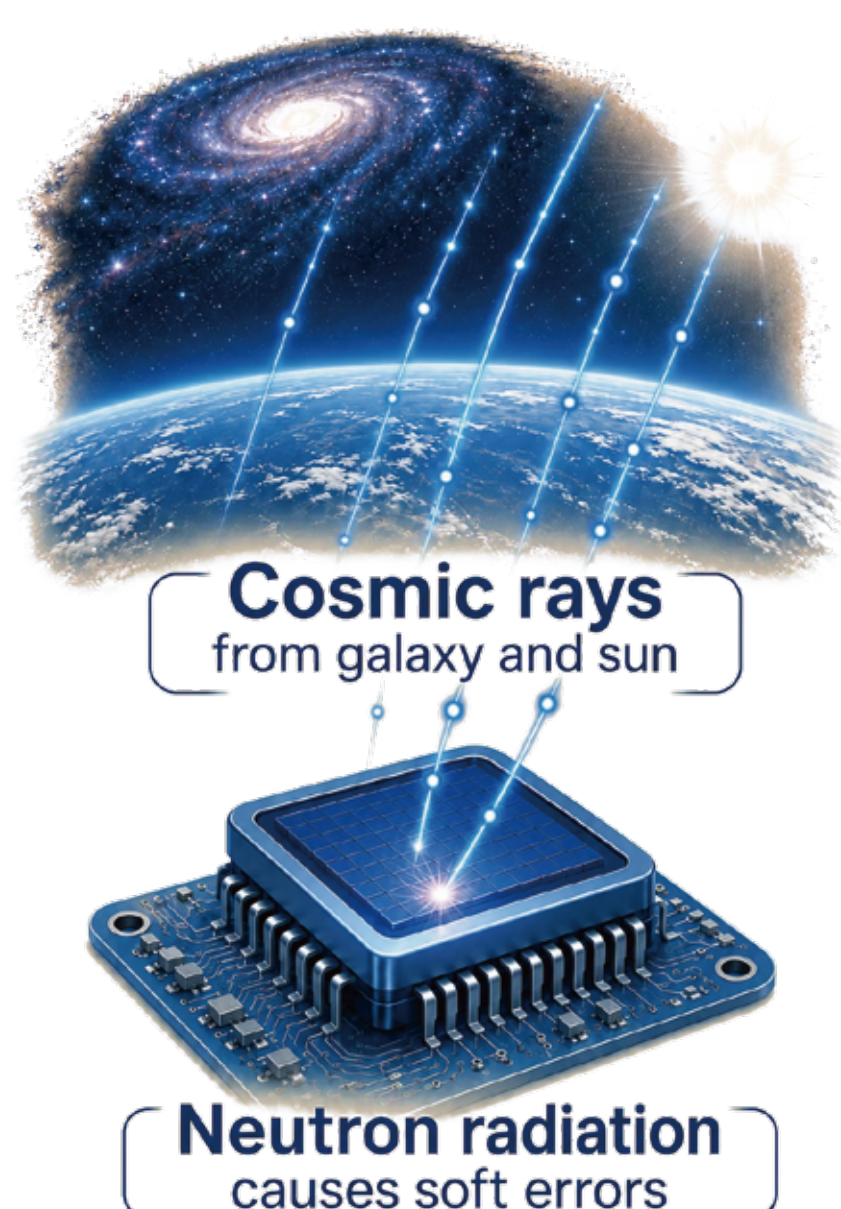
PC & BIO PC & PBT & PPS



創新實驗室暨行銷服務處

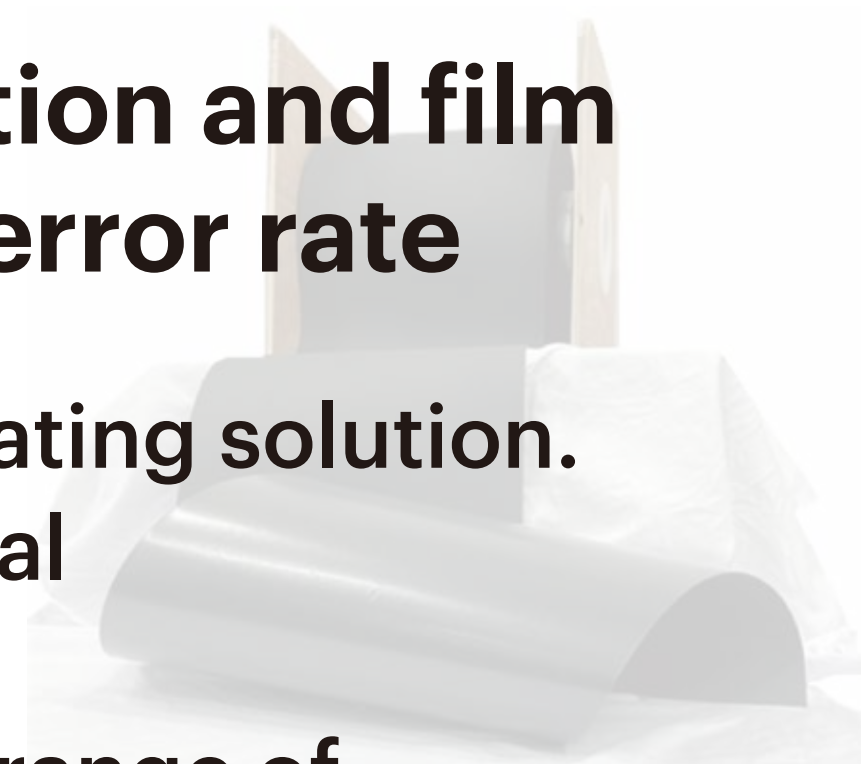
選擇性蝕刻液
前驅物
後段製程材料





We have developed coating solution and film that effectively reduces the soft error rate

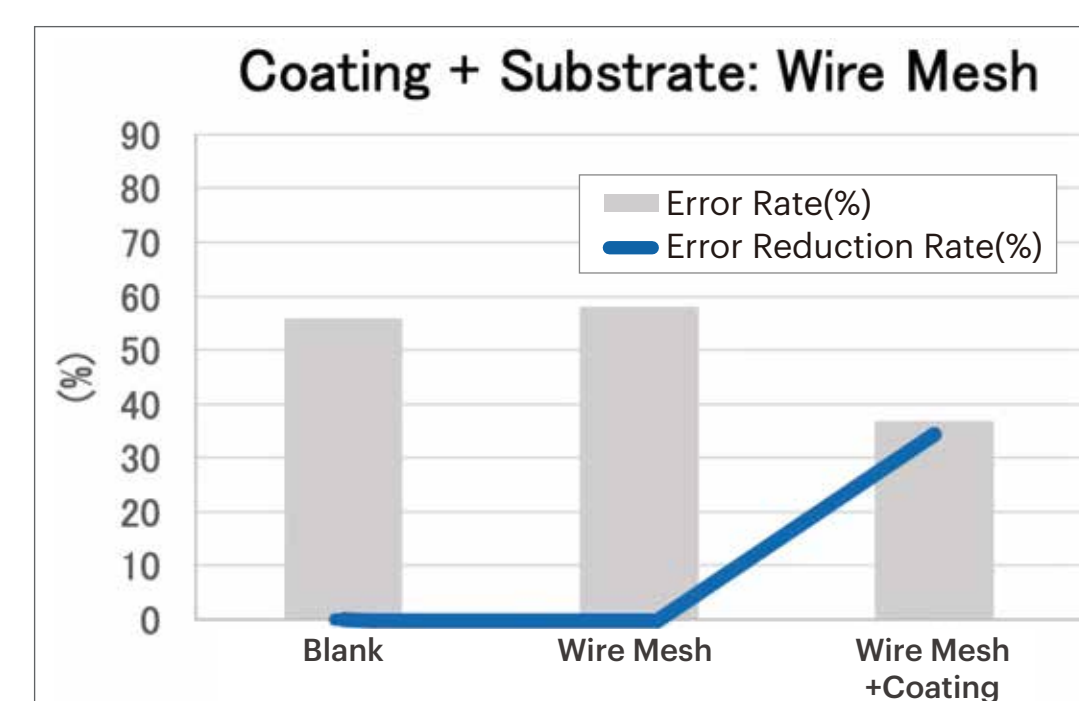
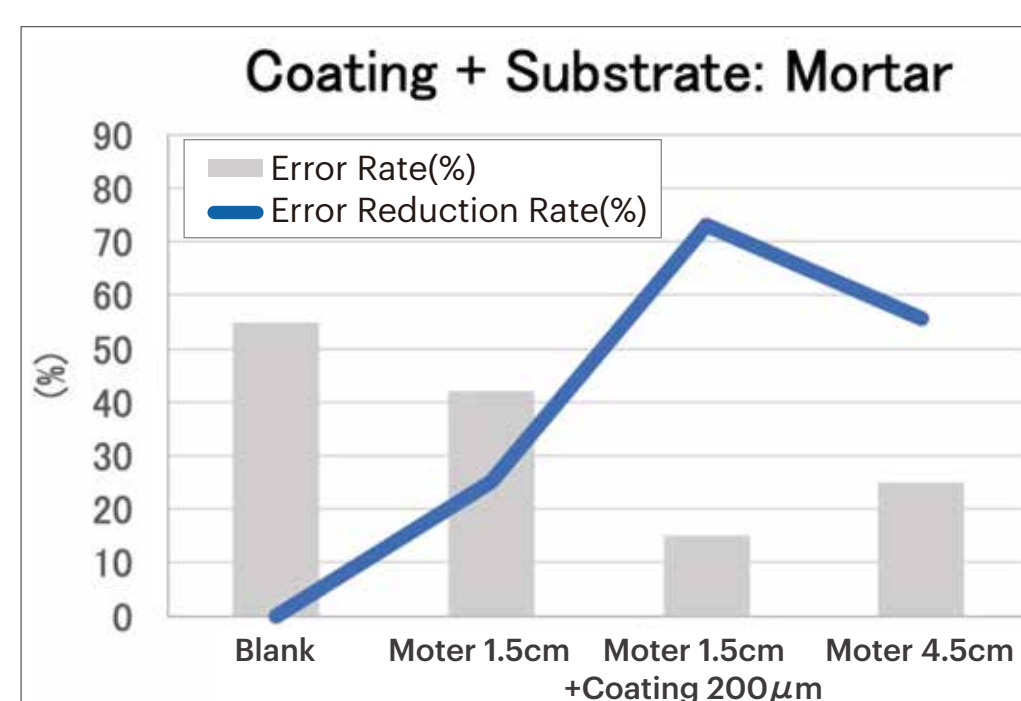
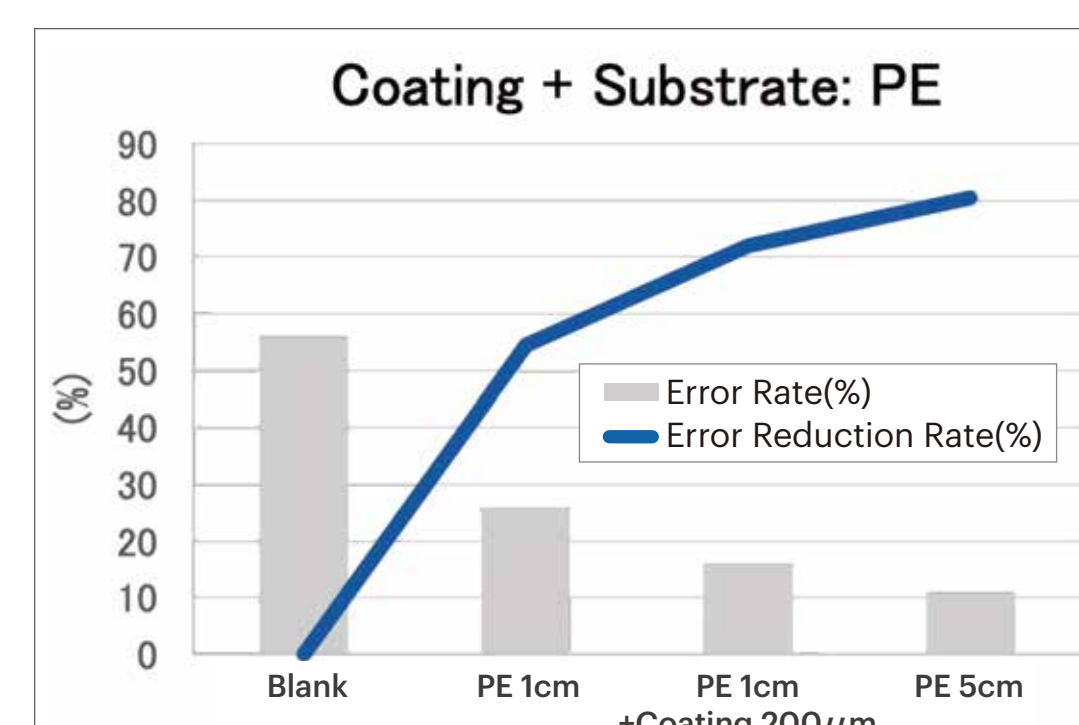
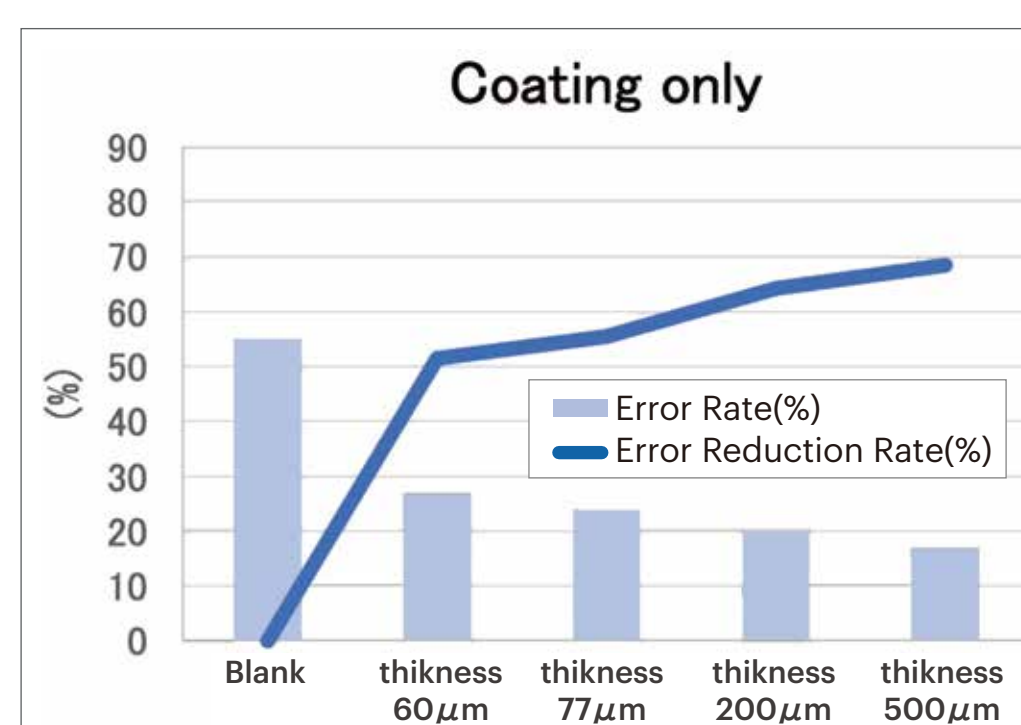
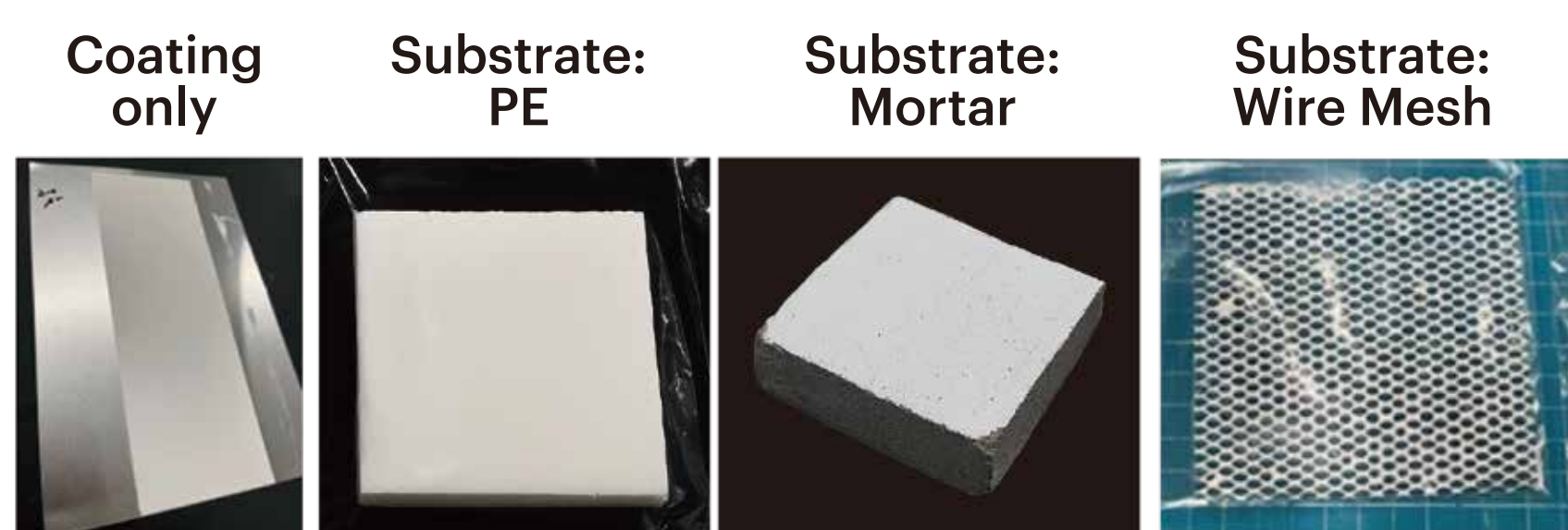
- ✓ Made of eco-friendly, water-based coating solution.
- ✓ Supports high loading levels of thermal neutron-absorbing fillers.
- ✓ Delivers excellent adhesion to a wide range of substrates, including metals, mortars, and plastics.
- ✓ Enables quick installation with minimal labor and easy removal owing to its pre-formed sheet design.



Performance Data of Coating

Evaluation Results of Soft Errors

- Our shielding coating reduces soft errors with a thinner film than conventional materials (see figure on the right).
- When applied on a substrate (PE, mortar, wire mesh), the thickness of the substrate could be significantly reduced by applying only 200 μm of coating to shield thermal neutrons.

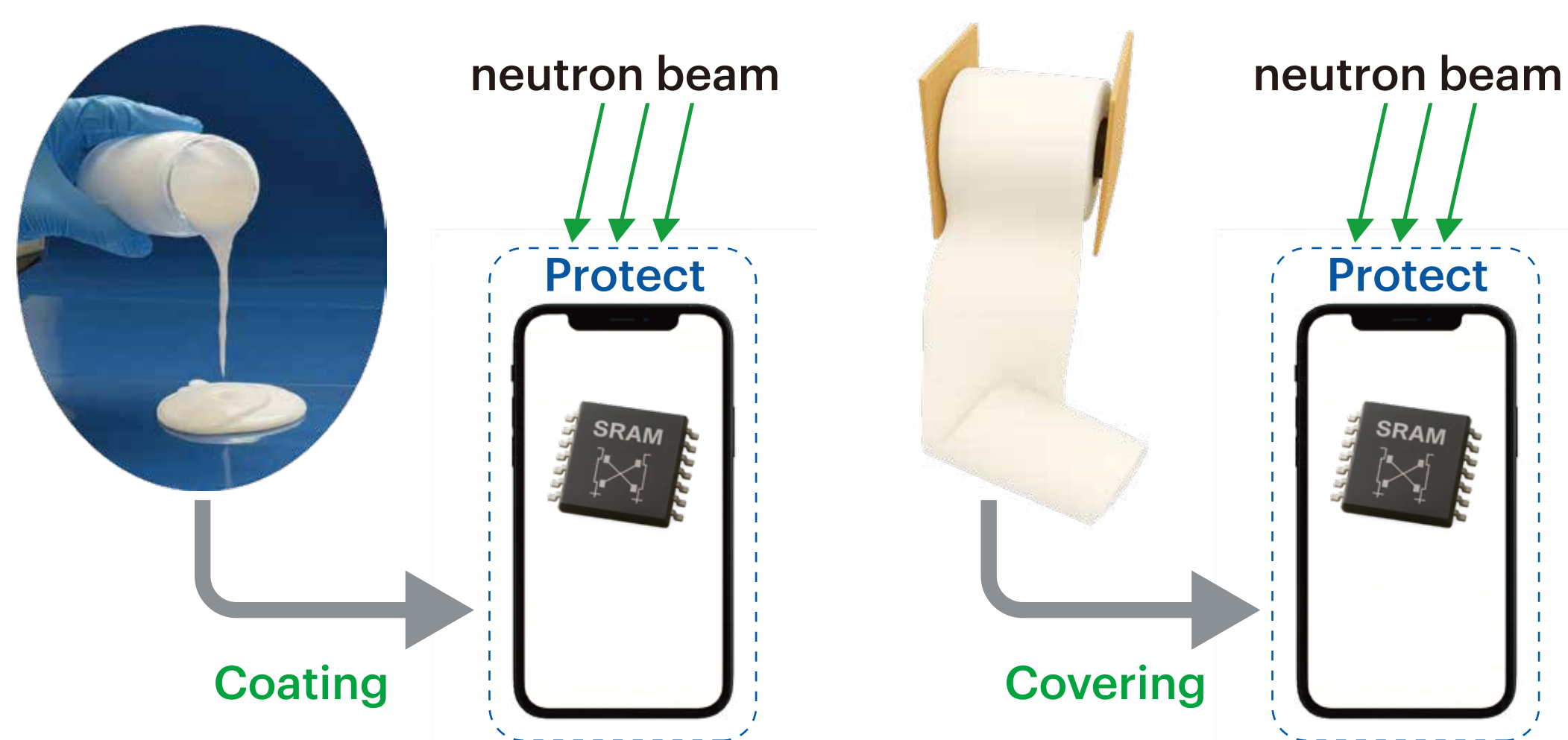


Product Features

Easily adaptable to a wide range of materials

- Using this developed product around semiconductor equipment can significantly reduce soft errors.
- Installing it on walls and ceilings can prevent indoor soft errors.

Easy installation



*For illustration purposes only.

Protect various semiconductor devices from soft errors.





Miracle Handling!!

High Thermal Conductivity & High Insulation BN Resin Sheet

•Target application

Heat dissipation in power modules, such as those used in inverters.

•Key feature

The sheet can be bonded to cooling plates for transfer-molded power semiconductor devices.

•Benefits

- Efficient heat dissipation
- Reduced total system cost / Simplified inverter structures
- Support for low-profile (thin) inverter designs

•Product lineup

- 15 W/mK thermal conductivity
- 18 W/mK thermal conductivity (In development. Higher heat dissipation.)

Property and test results

Sheet property

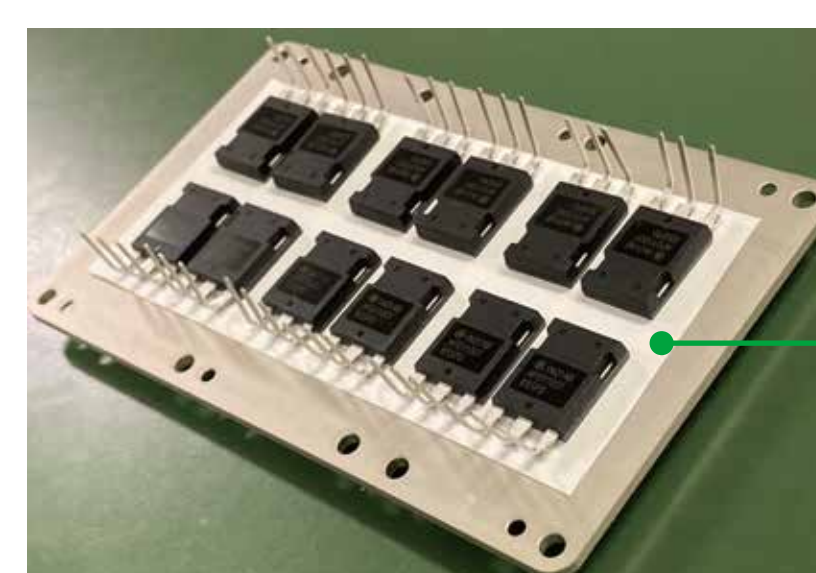
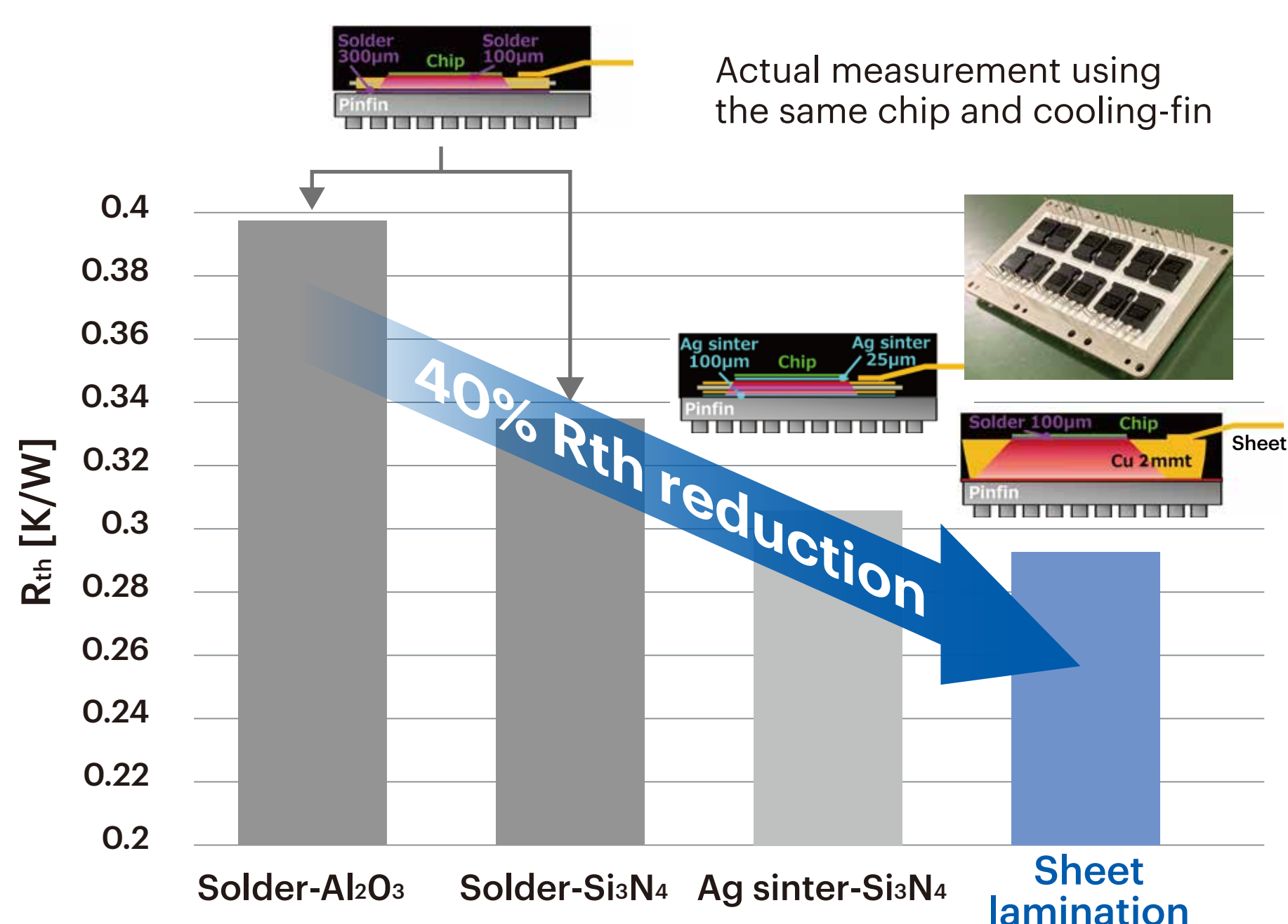
	SH-A204 (current product)	new grade (under development)
Sheet thickness	150 μm	150 μm
Thermal conductivity	15 W/mK	18 W/mK
Tg (DMA)	165 degC	180 degC
CTE (25-150 degC)	35 ppm/K	23 ppm/K
Breakdown Voltage	AC >7kV	AC >7kV

Test results

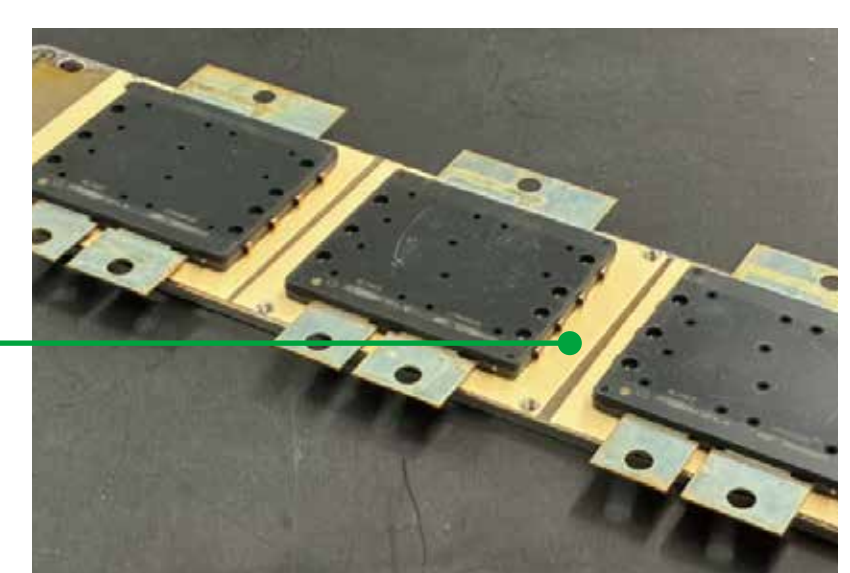
Item	Condition	Results
Initial BDV	In oil	AC >7kV
Initial shear test	R.T.	> 5MPa
	150 degC	> 5MPa
TCT	-40~150 degC 1,000 cycle	BDV: AC >7kV Shear test: >5MPa
H ³ TRB (AQG324)	85degC, 85%RH, 0.96kV	1,000 hours pass
HTS (AQG324)	150degC, 1,000 hours	BDV: AC >7kV
HTHH (AQG324)	85degC, 85%RH, 1,000 hours	BDV: AC >7kV
PCmin (AQG324)	Target Tjmax: 175 degC Target ΔT_j : 120 degC ton: 30 sec toff: 60 sec	>5,000 cycle (ongoing)

Value proposition

An innovative power module structure delivering high reliability, low thermal resistance, and high breakdown voltage - enabled by the resin sheet combining thermal conductivity, insulation, and adhesion.



TO247 lamination

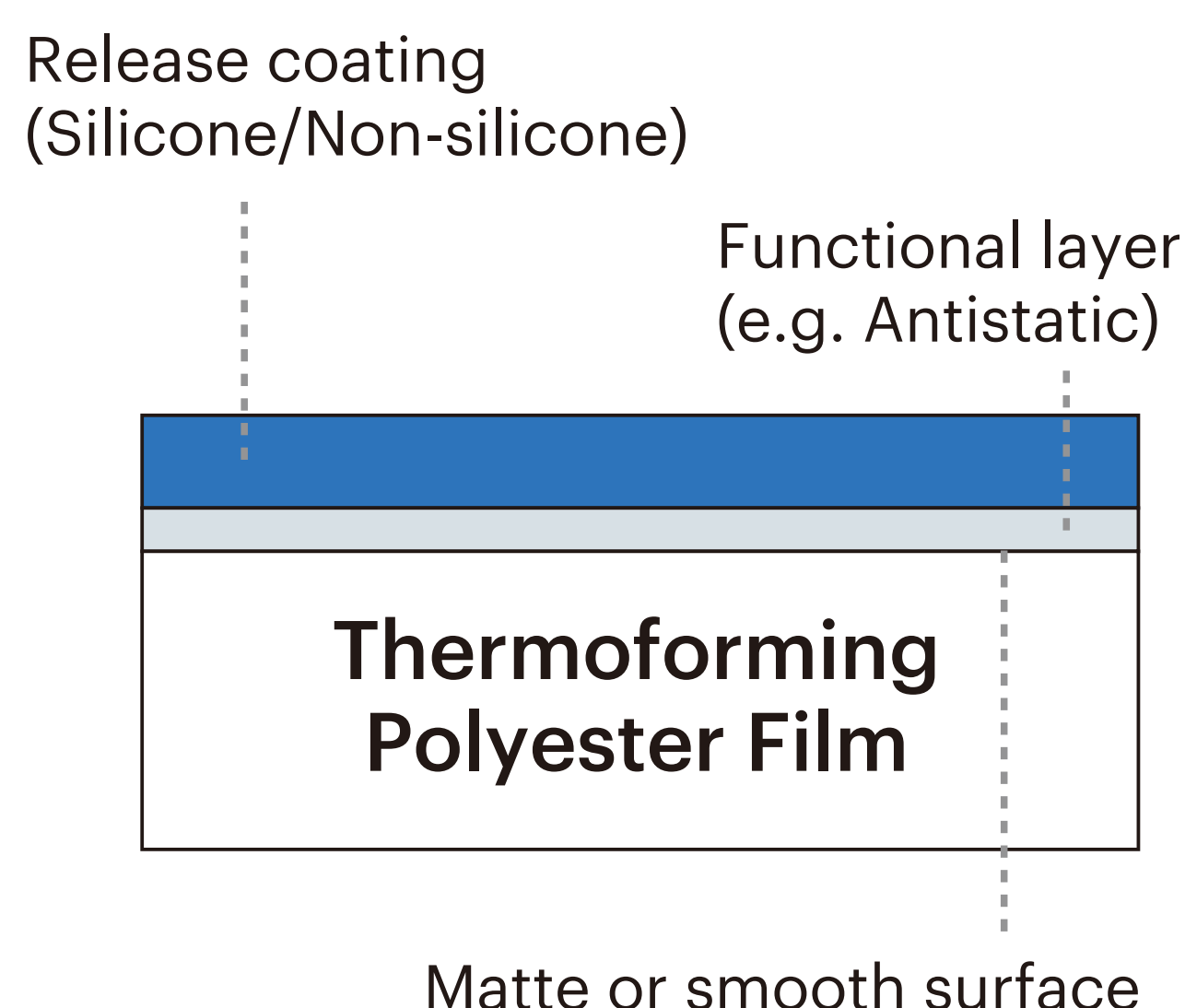


Non-insulated power module lamination



PCB lamination

MCC BN resin sheet



Polyester film with the following key properties

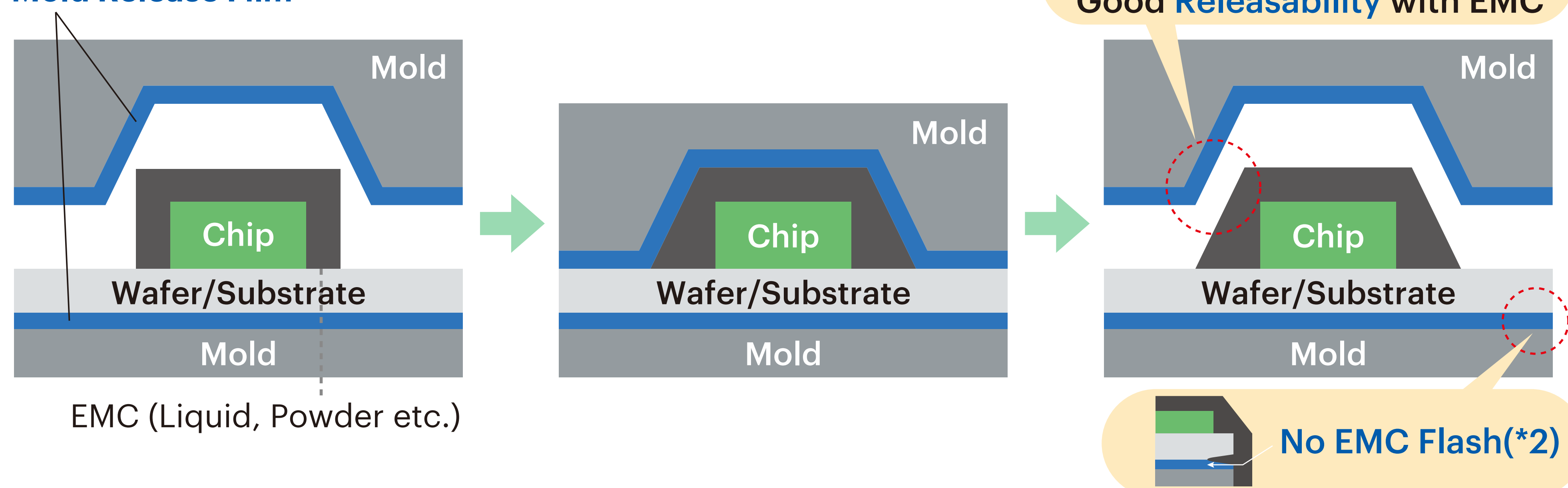
- ✓ Easy molding
- ✓ Releasability
- ✓ Eco-Friendly (**PFAS FREE**)
- +
- ✓ Functional primer
(Antistatic($10^{5\sim9}[\Omega/\square]$), Oligomer Block (*1) etc.)

*1. Oligomer is contained in PET and migrates to surface under heat condition

Application

■ With our film and coating technologies, we've developed new mold release films for compression mold especially for Advanced Semiconductor Packaging like WLP & PLP

Mold Release Film

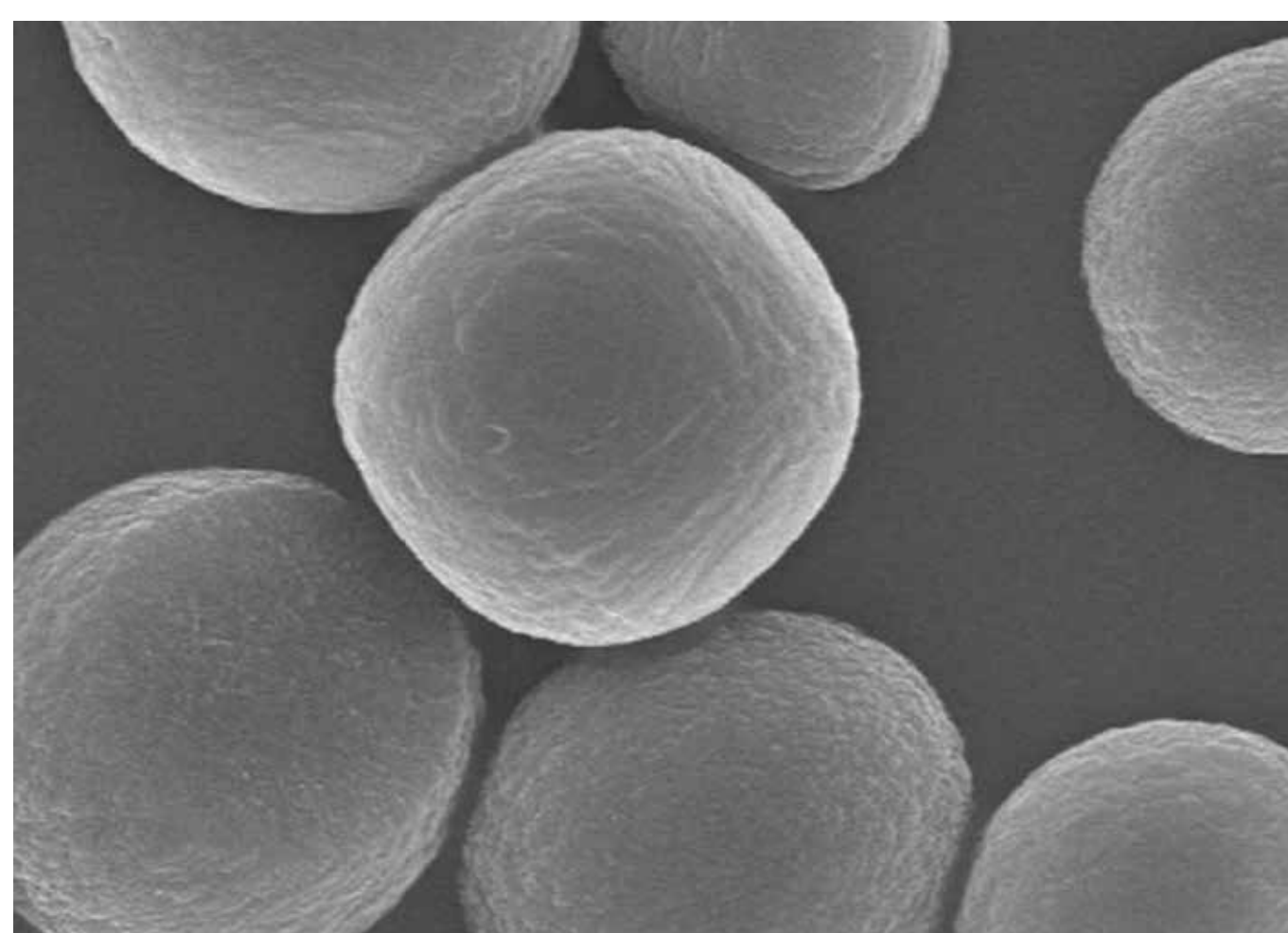


*2 EMC is leaking into the space between the wafer and the film

Features

■ Our thermoforming polyester film exhibits superior properties compared to others.

		Mitsubishi Chemical	Other Release Film - Competitor	ETFE Current product - competitor
Easy molding	High temperature	Good	Fair to Poor	Good
	Low temperature	Good	Poor	Good
Less EMC Flash		Good	Poor	Poor
Releasability		Excellent	Good	Good
Eco-friendly (PFAS FREE)		Good	Good	Poor



This Advanced Filler for semiconductor applications offers

- ✓ Stable negative thermal expansion over wide range of temperatures
- ✓ Lightweight & spherical shape
- ✓ Surface-treatable
- ✓ Low water absorption
- ✓ Low α -emission

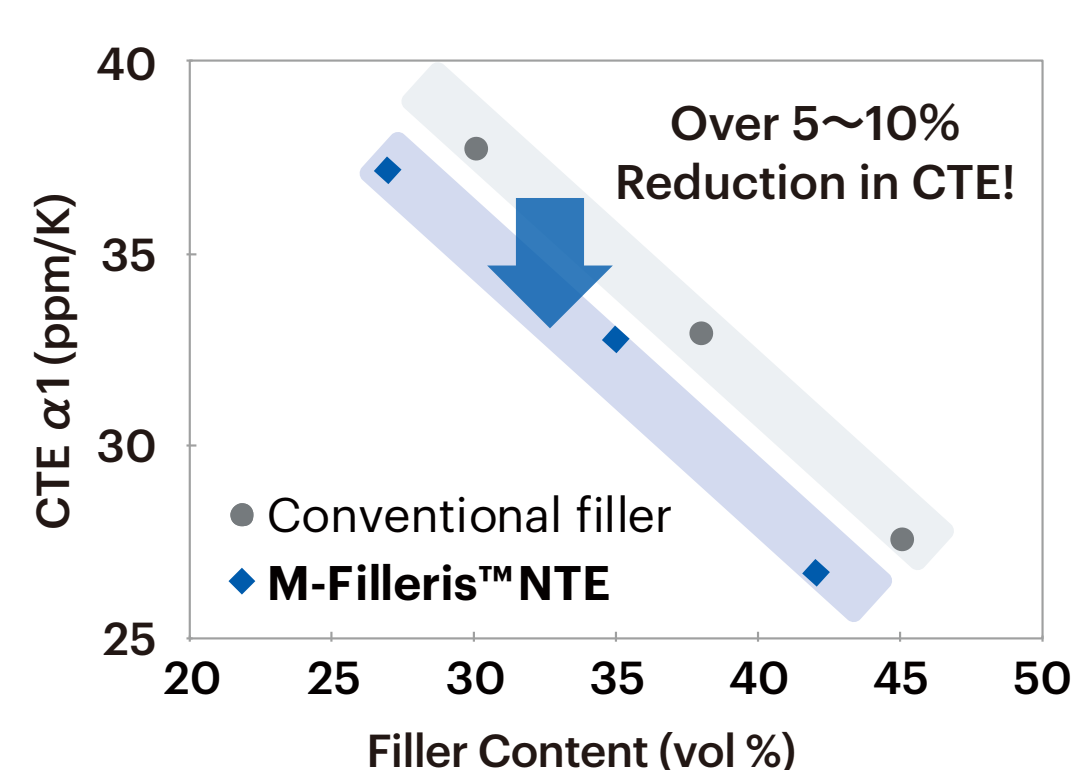
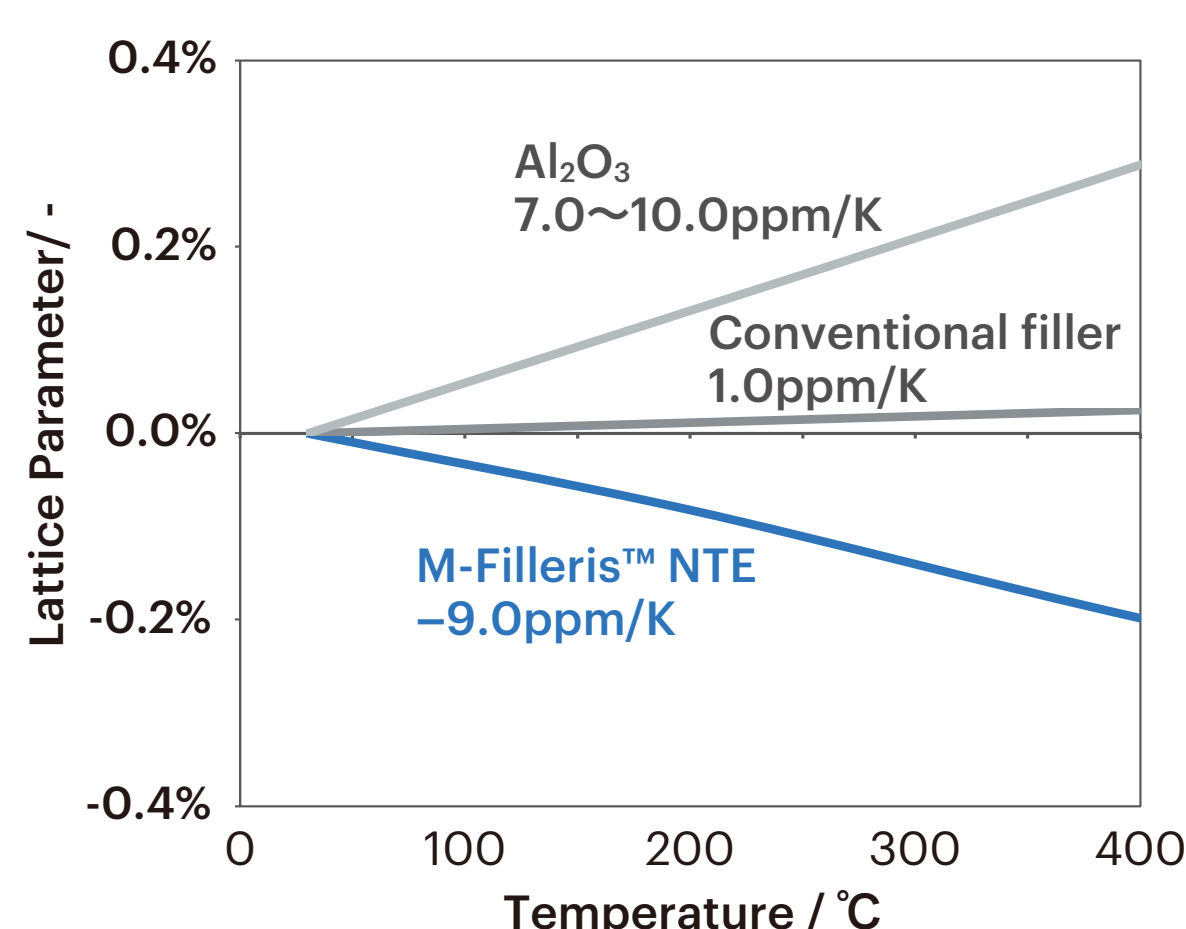
An innovative material solution for thermal control & low-expansion resin composites.

M-Filleris™ NTE Series

Basic Properties

Items		Conventional filler	M-Filleris™ NTE
CTE	ppm/K	1	-1 ~ -10
Filler size D50	μm	-	1 ~ 5
Temperature Range	$^{\circ}\text{C}$	R.T ~ 400	R.T ~ 400
Density	g/cm^3	2.2	1.9
Water absorption Rate (85 $^{\circ}\text{C}$ 85%RH 24h)	%	0.5	0.7
Shape		Spherical	Spherical

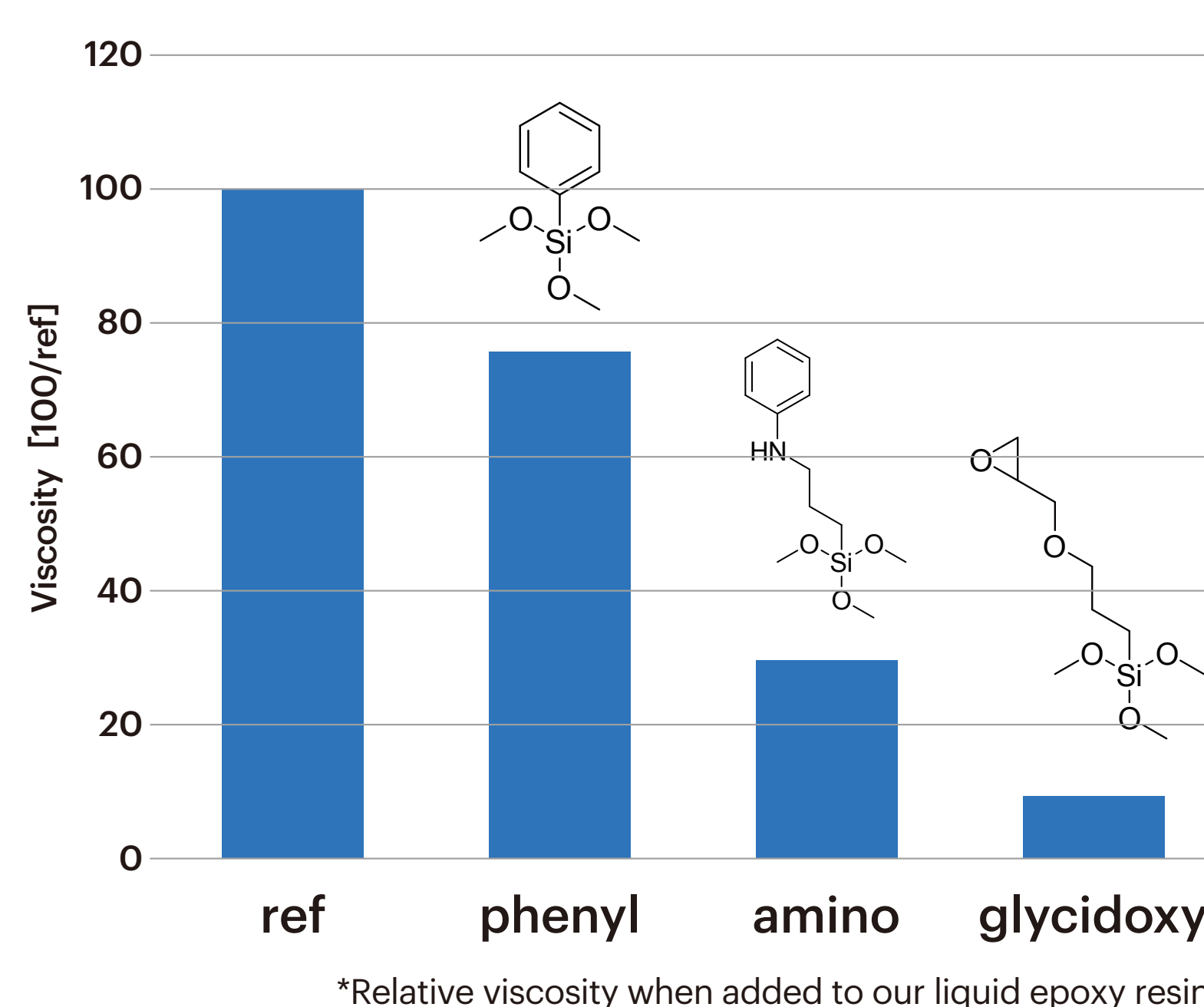
CTE Properties



*CTE properties when added to our proprietary liquid epoxy resin.

Surface Treatment

M-Filleris™ NTE can be used for various surface treatments and Improved compatibility.



*Relative viscosity when added to our liquid epoxy resin.

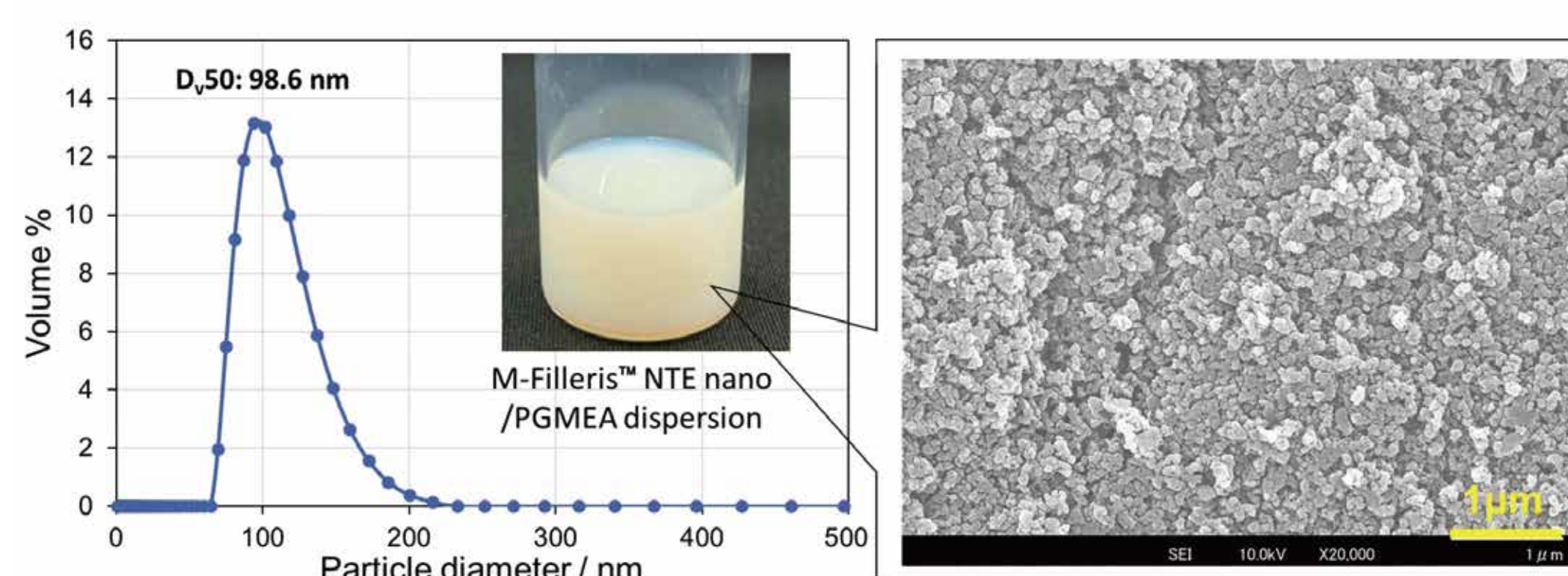
Application examples

- Encapsulation Materials
- Insulating Materials
- Substrates

M-Filleris™ NTE nano Series

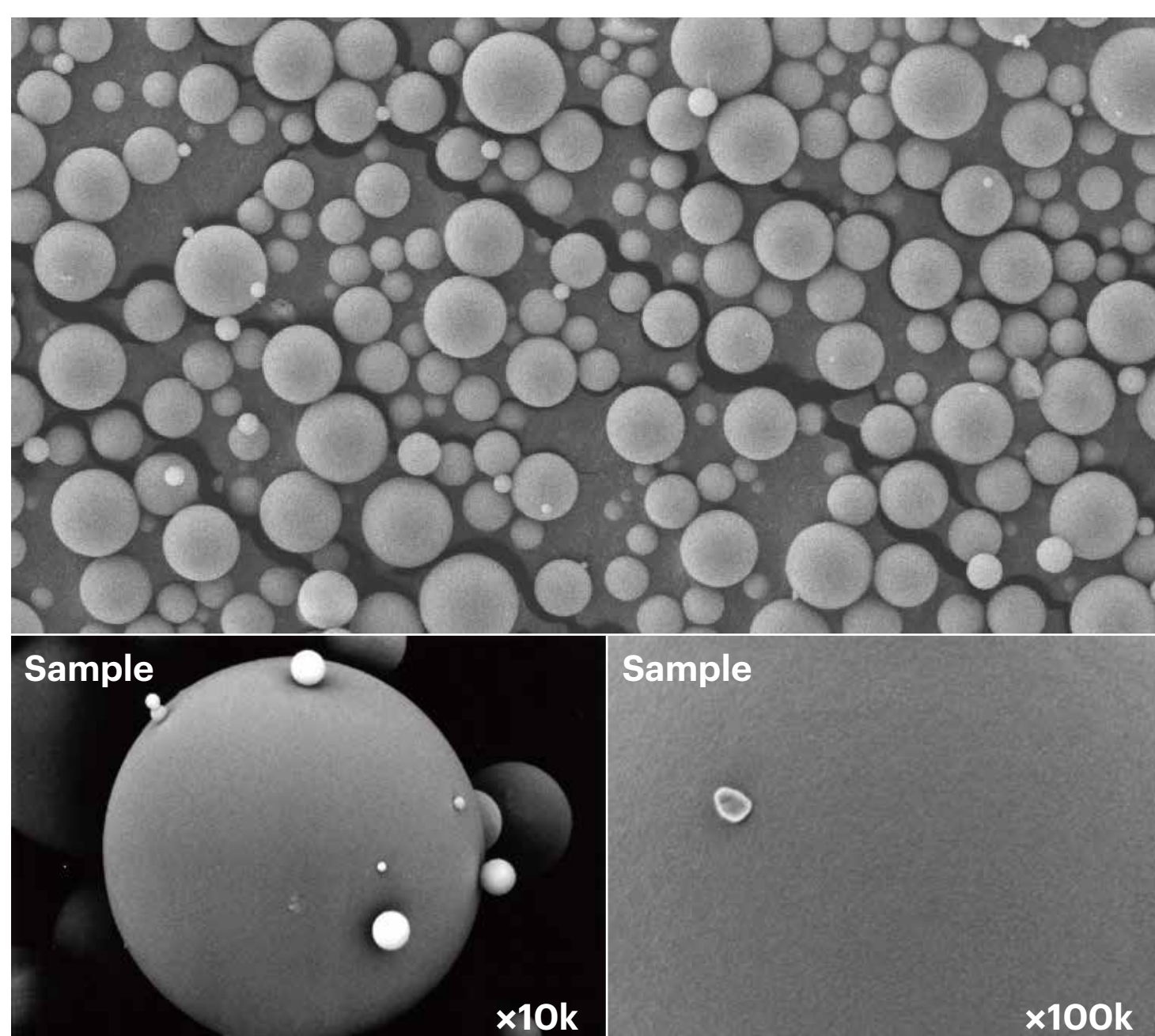
Basic Properties

Items		M-Filleris™ NTE nano
Density	g/cm^3	1.9
Concentration of filler	wt%	1 ~ 10
Filler Size D50	nm	50 ~ 100
Solvent	-	PGMEA or NMP
Effect on CTE (PI polymer / filler=100/10wt%)	%	-19



Application examples

- Photosensitive Materials
- Insulating Materials



Silica filler for semiconductor applications offers

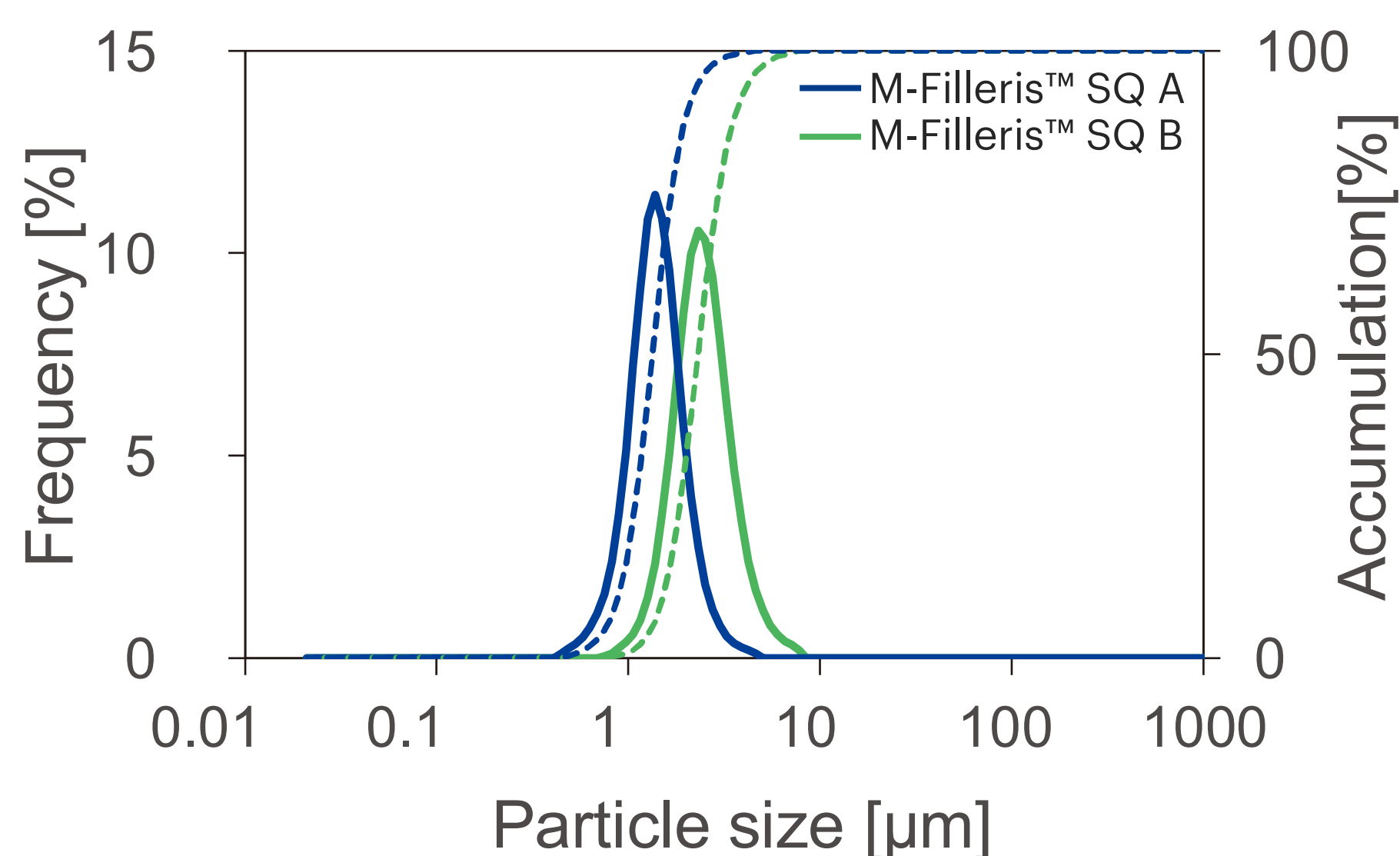
- High sphericity and smooth surface
- Fewer particles adhere to surface.
- Higher purity (impurity concentration <1 ppm)
- Narrow size distribution
- Size adjustable (1~10 μm)
- Low loss tangent at high frequencies

Product property①

Impurity concentration

Elements	[ppm]
Na	0.2
K	< 0.1
Fe	< 0.1
Ti	< 0.1
Ca	0.2
Al	0.2

Size distribution



	D50 [μm]	D100 [μm]
M-Filleris™ SQ A	1.5	5
M-Filleris™ SQ B	2.4	10

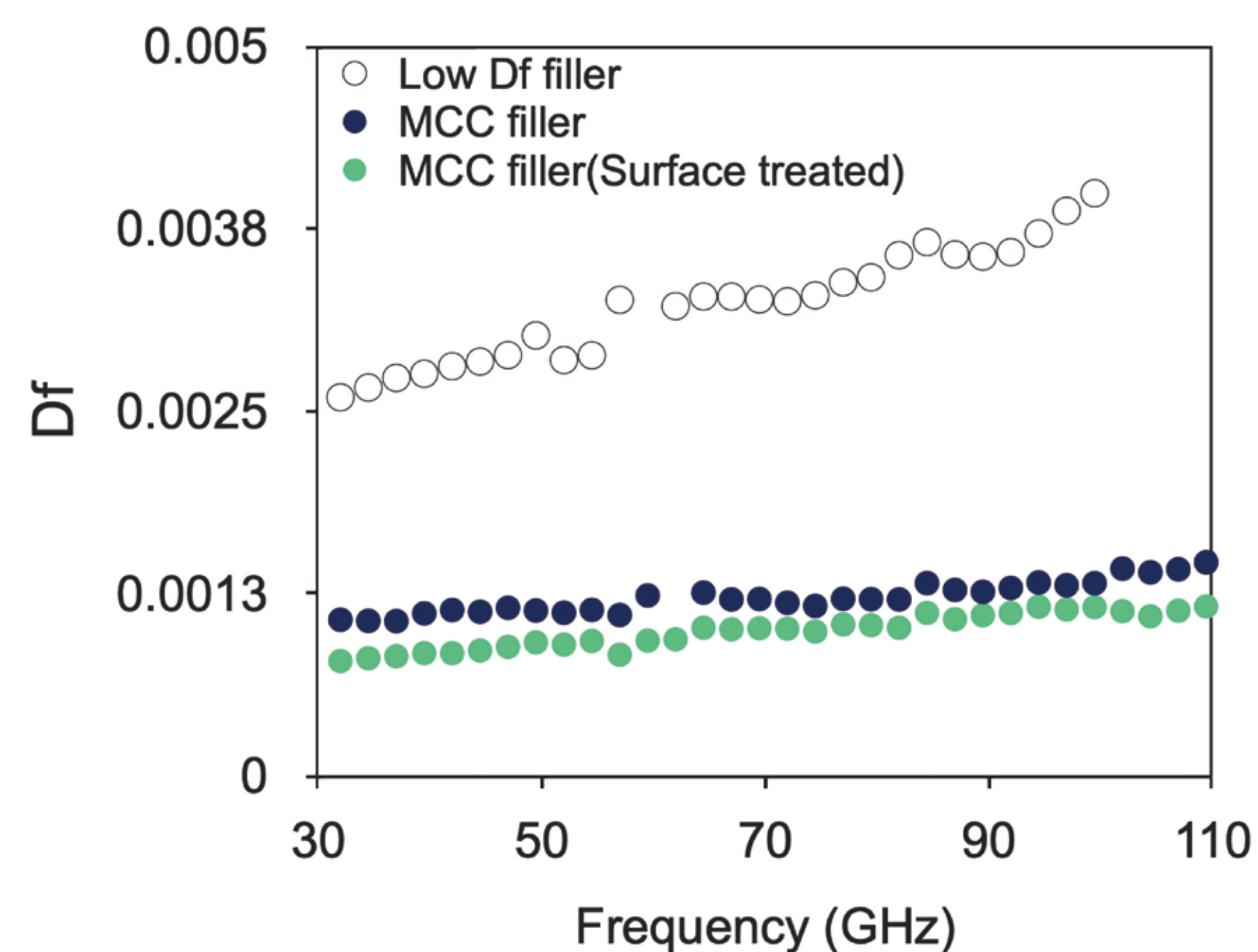
Features

- Low impurity elements concentration
- Manufacturing process suppresses the formation of coarse particles.
- Particle size can be precisely controlled.

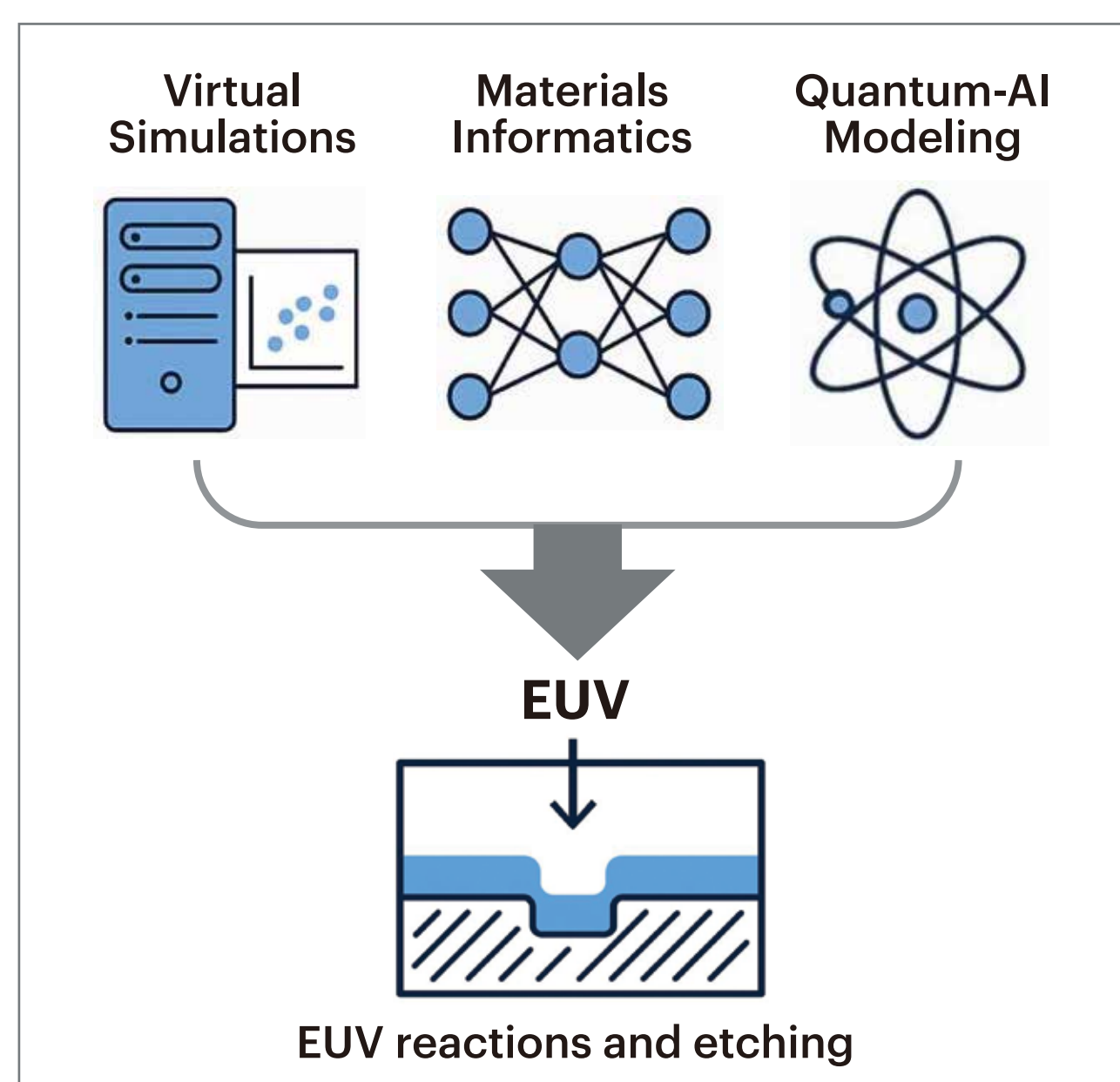
Product property②

Features

- Df measurement results obtained for the powder show that the MCC filler maintains a low dielectric loss even at high frequencies.
- Silane coupling agent-based surface treatment is available.



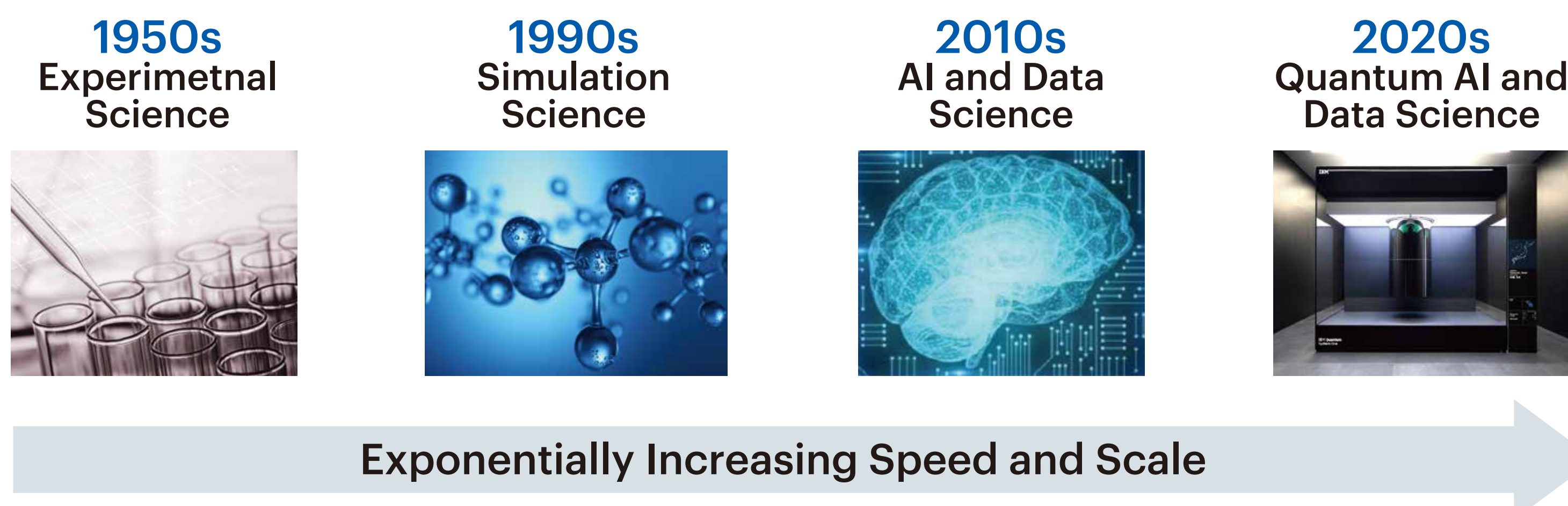
A Unified HPC-AI-Quantum Framework for Rapid Materials Discovery at Mitsubishi Chemical



- Mitsubishi Chemical is accelerating semiconductor material development through an integrated digital platform combining HPC simulation, materials informatics, and quantum-AI modeling.
- This approach enables faster screening of materials and provides new insight into EUV-induced reactions and selective etching.
- Early quantum-enhanced simulations show strong potential to improve EUV photoresist performance and shorten development cycles for next-generation manufacturing.

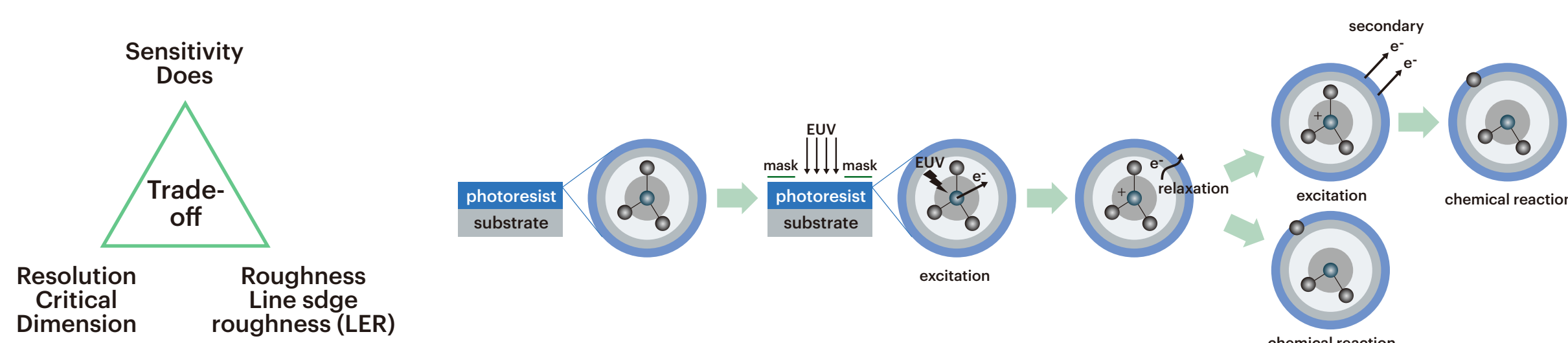
Paradigm of Material Discovery

- It used to take \$10-100million and 10 years to discover one new material.
- Acceleration of materials discovery was achieved by using simulations and AI.
- We expect to use quantum computing to make simulation and AI more efficient.
- Our ultimate goal is to speed up the discovery of new materials by >10 times.



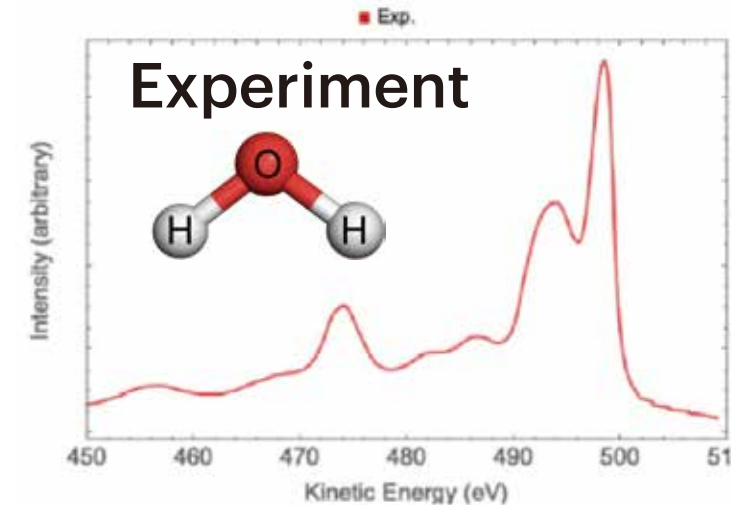
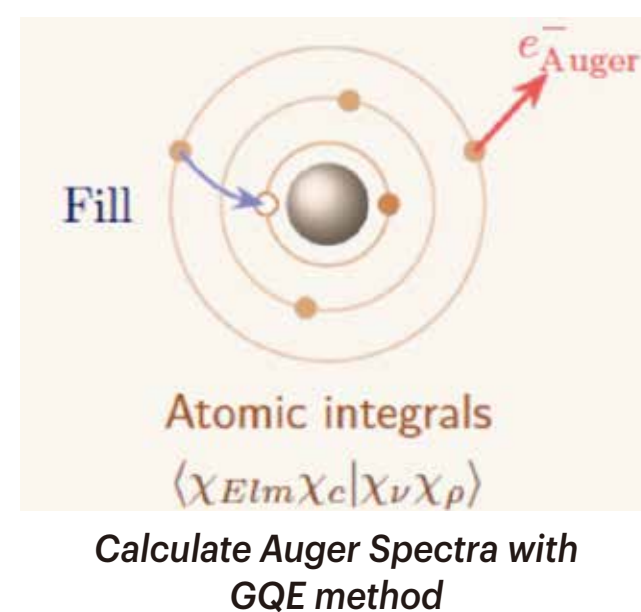
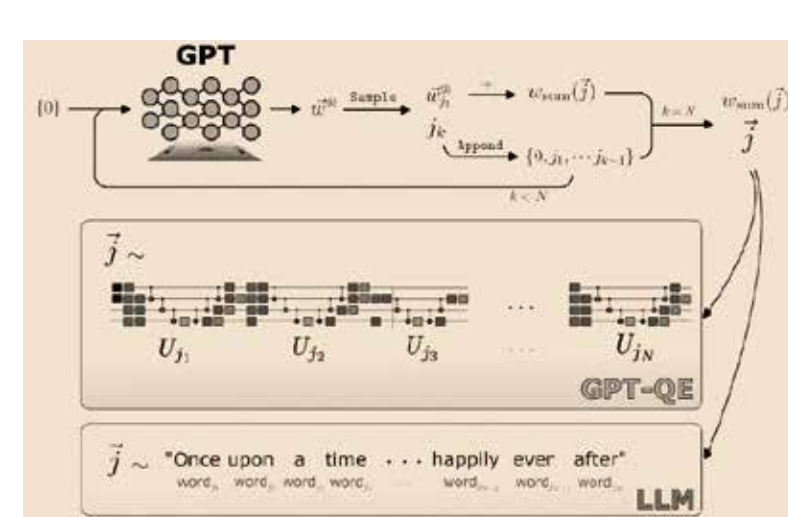
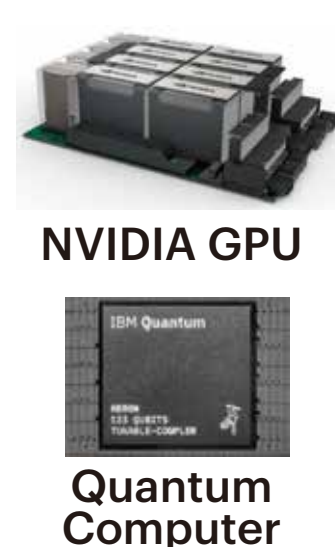
Design EUV photoresist molecules

- The EUV RLS tradeoff issue.
- Electron dynamics in the materials greatly influence the tradeoff.
- It is tough for classical computer to perform accurate electron dynamics simulations.
- Apply AI and Quantum Computing for simulation of exposure and processing chemistry with EUV Photoemission

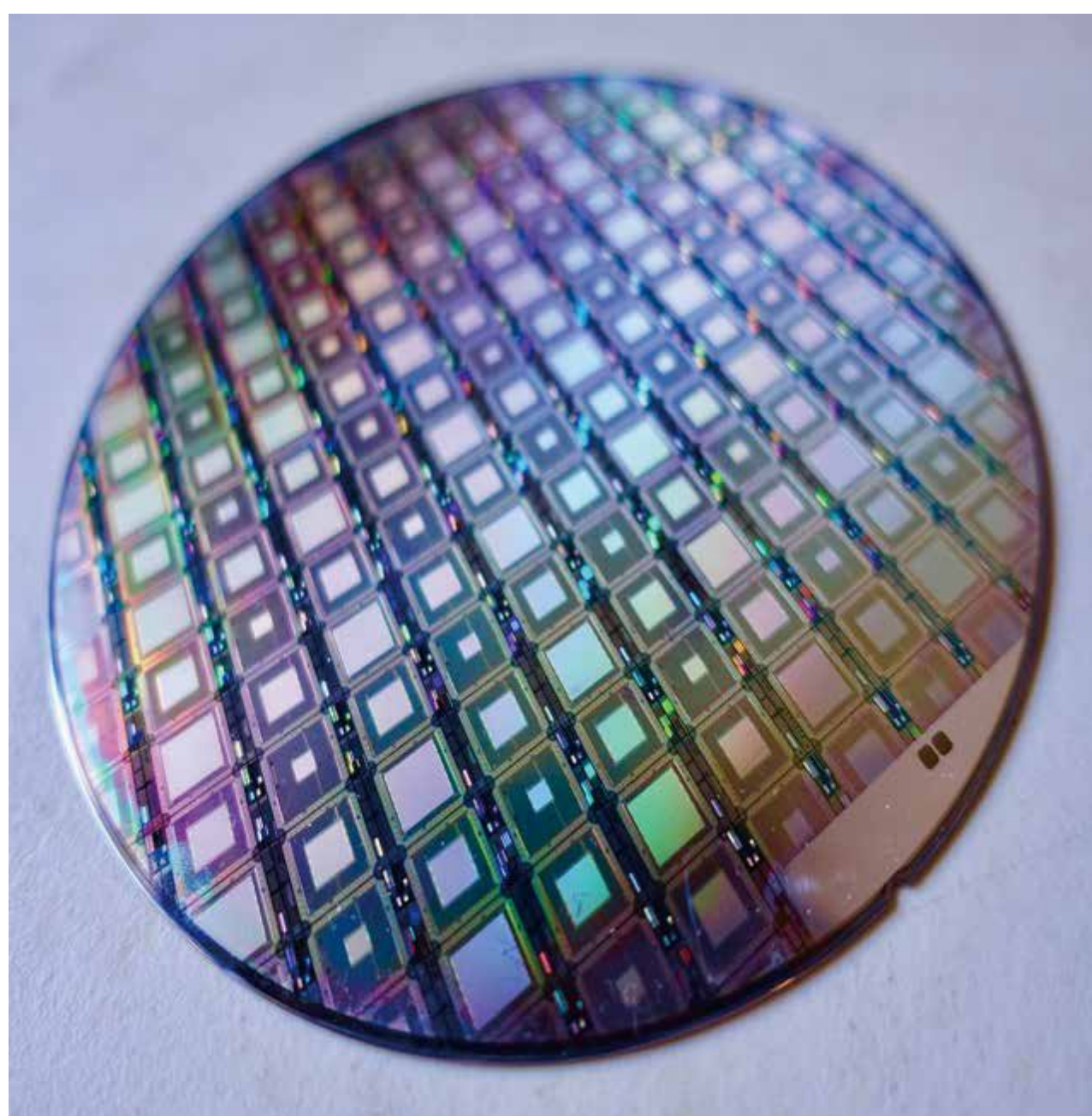


A uger Spectroscopy via Generative Quantum Eigensolver: A Quantum Approach to Molecular Excitations

Kimberlee Keithley,^{1,2,*} Shunsuke Yamamoto,^{3,*} Ryota Kenmoku,² Ikko Hamamura,⁴ Kouhei Nakaji,⁵ Shu Kanno,^{1,2} Takao Kobayashi,¹ Qi Gao,^{1,2} Shumpei Uno,⁶ Kohei Oshio,^{1,2} Naoki Watanabe,³ Takeshi Sato,⁶ Naoki Yamamoto,² Shunya Minami,⁷ Yohichi Suzuki,⁷ Yuma Nakamura,^{8,9,10} Jorge A. Campos-Gonzalez-Angulo,¹¹ Mohammad Ghazi Vakili,^{8,11} and Alán Aspuru-Guzik^{11,8,9,10,12,13,14,15,16}



Benchmark calculation results.



Advanced Materials for Selective Deposition and EUV Patterning

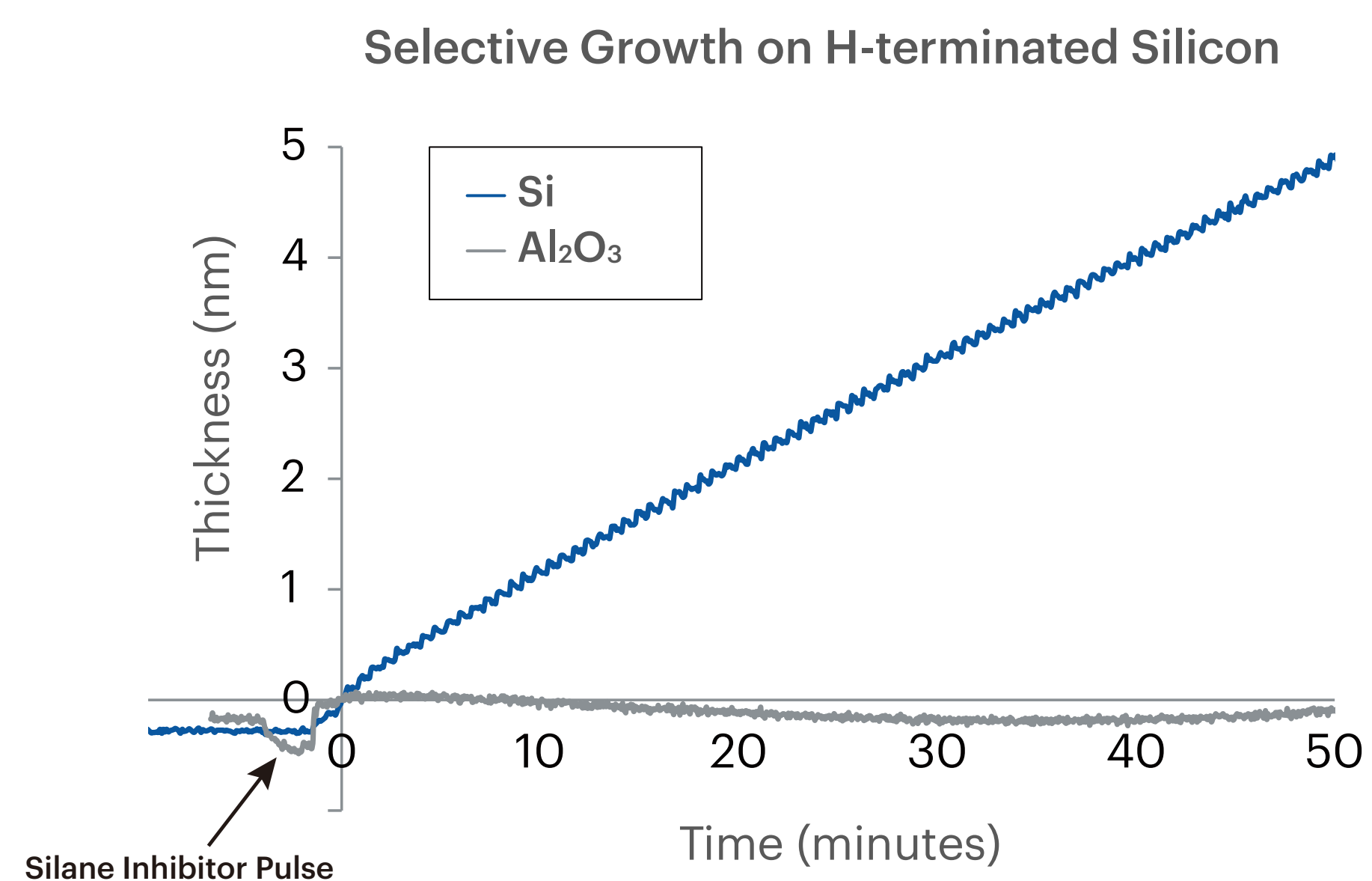
We develop materials that improve process control and reduce defectivity in advanced node manufacturing. Our platforms include inhibitors and precursors for area-selective deposition, and high-absorption metal-organic resists designed for EUV lithography.

Area Selective Deposition (ASD)

Selective deposition on patterned surfaces to remove process steps and reduce edge defects.

- Custom silane inhibitors for SiO_2 , Al_2O_3 , HfO_2 and metal surfaces
- Low temperature thermal SiO_2 deposition
 - Dielectric on Metal
 - Dielectric on Semiconductor
 - Dielectric on Dielectric
- Plasma SiO_2 Dielectric on Metal or Dielectric

Selective Growth of SiO_2 on hydrogen-terminated silicon vs Al_2O_3



Metal-Organic Dry Resist

Maintaining EUV resist performance balance at lower dose

- ✓ Metal-organic based precursors for next-generation nodes
- ✓ 3× better EUV absorption
- ✓ 3× wider focus / dose window
- ✓ 5–10× lower material usage and fewer process steps

