

Toyo Tanso Carbon Products

Contributing to the Manufacturing of Semiconductors



Semiconductor Market Outlook and ToyoTanso's Growth Strategy

Development of digital society (5G, IoT, AI, etc.) and progress of vehicle electrification

Increased demand for both Si (silicon) and SiC semiconductors

Si (silicon) wafer market CAGR (2021→2026) 5% or more

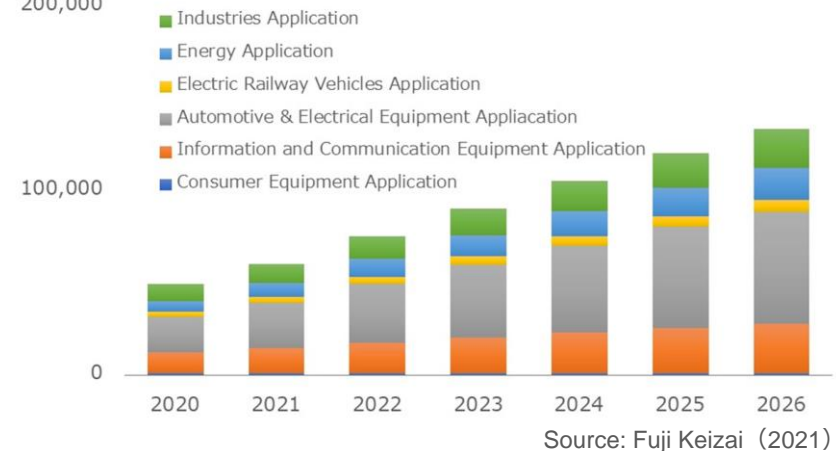
Unit: Pieces, thousands



- Semiconductor manufacturers are planning large capital investments. As a result, the average annual growth rate of the wafer market is expected to be **5% or more**.
- Even **higher growth is expected for Epi wafers** in particular, due to increased demand for logic semiconductors.

SiC devices market CAGR (2021→2026) 20% or more

Unit: Yen, millions



- Adoption is progressing for applications such as EVs and high-voltage devices, and the market size of SiC devices is expected to **grow by more than 20% per year**.

Increasing the Ratio of Semiconductor Sales in the Medium-term Management Plan

Sales for semiconductor applications are expected to expand

FY2021 (actual) 30% → FY2026 (plan) 40%

Unit: Yen, billions	FY2021	FY2022 (forecast)	FY2026 (target)	CAGR FY2021–FY2026
▶ Special graphite products	17.1	19.7	25.9	8.6%
Carbon products for general industries (for mechanical applications)	3.7	3.6	5.6	8.5%
Carbon products for general industries (for electrical applications)	5.7	5.0	6.7	3.2%
▶ Compound materials [3 major products]	7.8	9.8	14.5	13.2%
Other* ("compound materials and other products [other products]" and "related goods.")	3.3	4.6	1.8	(11.5)%
Total	37.7	43.0	54.5	7.6%

▶ Semiconductor applications

- Special graphite products ("electronics applications" and "others")
- Compound materials [3 major products] (SiC-coated graphite products, C/C composite products, graphite sheet products)

Note: The above also includes applications other than semiconductors.

Special graphite products Electronics applications

Pursue greater competitive strength and secure profitability through stronger sales in high value-added domains

- **Products for single-crystal silicon manufacturing applications**
We have attained some degree of market share, but with regional differences. We aim to increase our share through strategies appropriate to each region.
- **Products for compound semiconductor manufacturing applications (for SiC semiconductor applications)**
We will build a firm position in growing markets by leveraging our global sales network to swiftly ascertain customer needs.

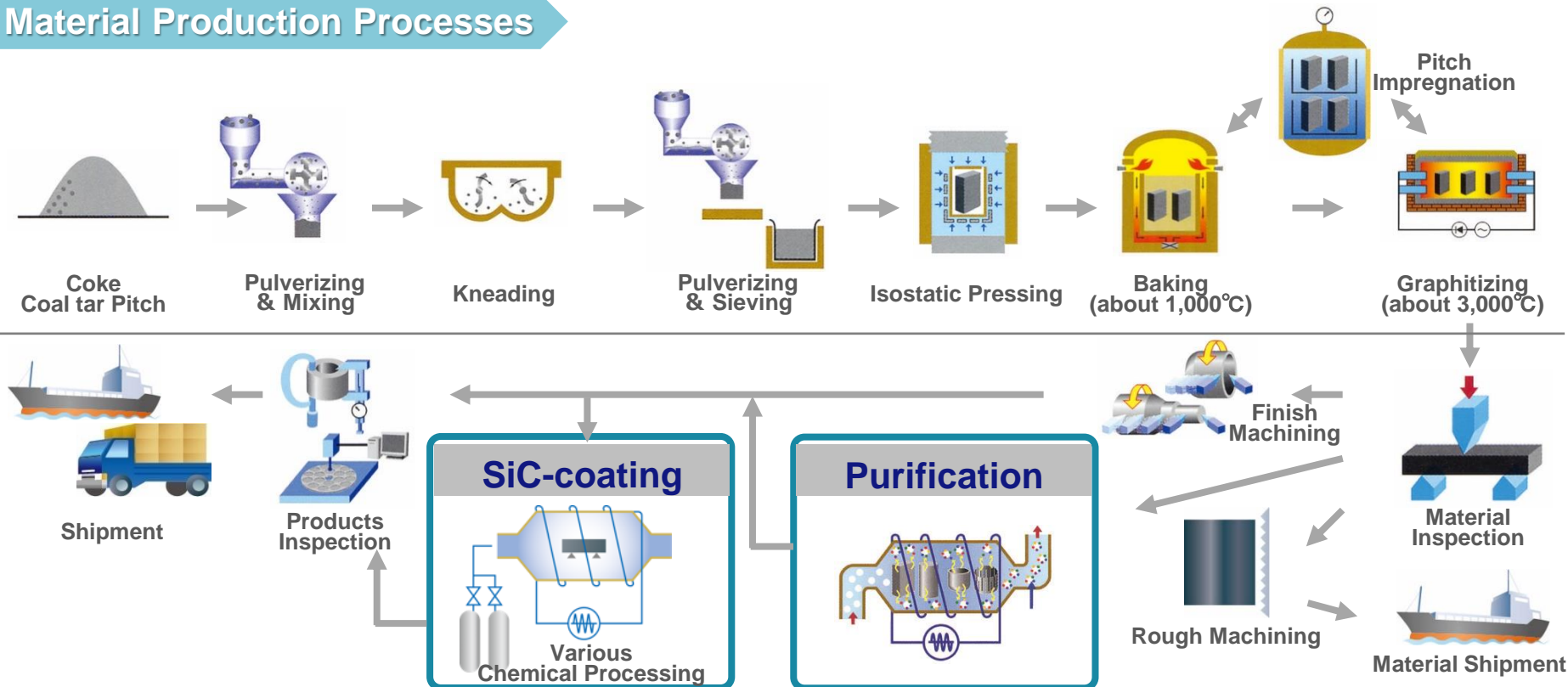
Compound materials [3 major products] SiC-coated graphite products

Fully utilize increased capacity (completed in 2021) to achieve rapid growth as a core value-added business

- **For silicon epitaxial growth**
Establish a top-level share of the market globally, responding to strong expectations from our main customers.
- **For SiC epitaxial growth**
We will aim to maintain and expand our market share by capturing consumables demand, in addition to demand for installation in new equipment.
 - We will promote innovations in manufacturing techniques in pursuit of productivity, quality, and cost savings, to further strengthen profitability.We will also take on the challenge of developing manufacturing methods and quality to match the needs of the market for the next decade.

Increasing Capacity for Value-added Processes for Semiconductors

Material Production Processes



**Engineering capabilities
1.5 times each (vs FY2022)**

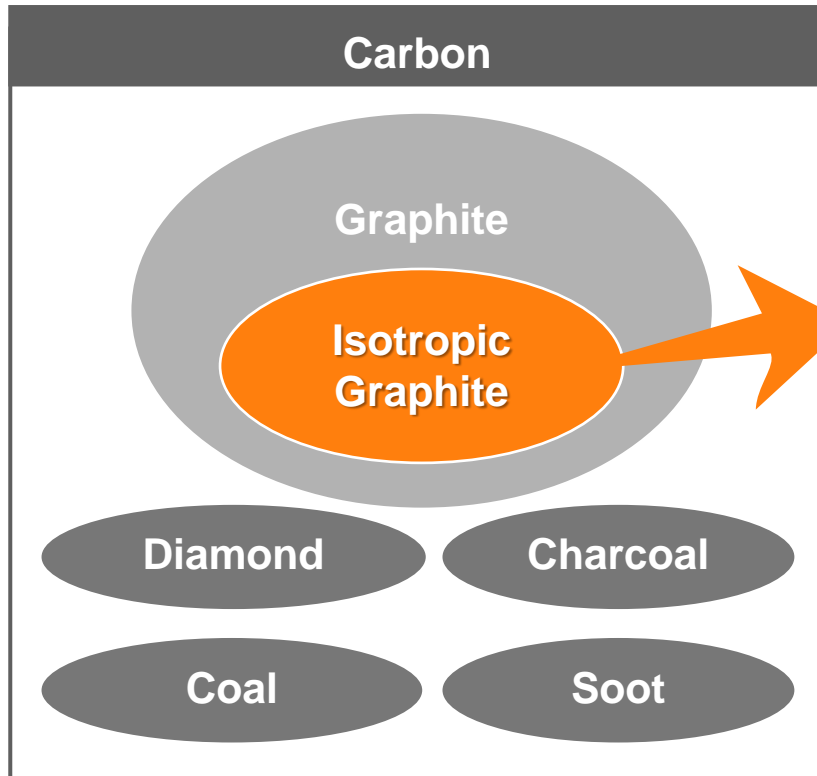
Value-added processes

	SiC-coating (Technology Center)	Purification (Takuma Division)
Investment details	SiC coating furnace	High-purity treatment furnaces and buildings
Investment amount	About 2 billion yen	About 5 billion yen
Completion period	2024	2025



Introduction of Si/SiC semiconductor applications

Properties of Isotropic Graphite



Features of graphite

High heat resistance
Excellent thermal and electrical conductivity
Lightweight and easy to machine
Friction and wear are less likely to occur

- Properties such as thermal expansion are uniform in all directions
 - Temperature changes are unlikely to damage graphite components
- High density and high strength with fine grain structure
 - Low consumption
- Very small variation in material properties
 - Contributing to customers' stable production and yield improvement



Heat treatment in a halogen gas atmosphere to remove impurities contained in graphite materials

**High purity and stable quality under high temperature
= Essential for semiconductor manufacturing processes**

Graphite Essential for Semiconductor Manufacturing

- SiC-coated Graphite Products

Properties of SiC-coated Graphite Products

SiC-Coated graphite products

SiC coating

Isotropic
Graphite

* Dense SiC film coated on graphite surface
using thermal CVD (chemical vapor deposition)

Features of SiC film

Excellent oxidation, corrosion, and chemical resistance
Extremely hard film, stable at high temperatures
High purity for graphite base materials as well
High thermal conductivity and excellent heat uniformity

- Coated with a dense SiC film
 - Prevents release and dispersion of graphite powder and release of gases and impurities from the graphite base materials.
- Material design enables use at high temperatures
 - Prevents cracking and peeling of the SiC film through the selection of a graphite base material with temperature variation equivalent to that of the SiC film, and maintains high dimensional accuracy even at high temperatures.

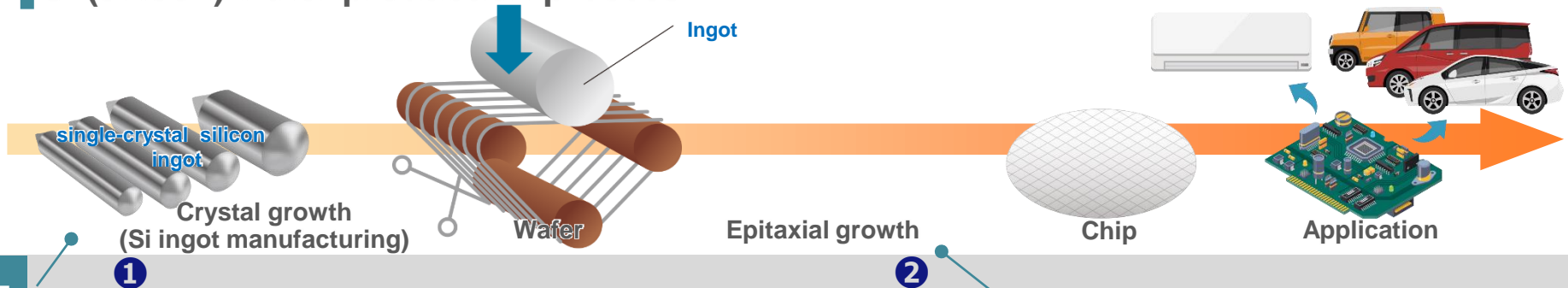


Materials that do not affect the quality of semiconductor products
(Si: silicon and C: carbon)

**Higher purity than isotropic graphite, stable quality under high temperature
= Essential for semiconductor manufacturing processes**

Graphite Products Used in the Manufacturing Process of Semiconductor Devices

Si (silicon) wafer production process



Parts for single-crystal silicon manufacturing equipment



Special Graphite (Electronics)

Crucibles, heater, jigs

Compound (CC)

Crucibles

Compound (Sheet)

Protective materials

Parts for SiC crystal manufacturing equipment



Special Graphite (Electronics)

Materials for the insides of furnaces

Parts for epitaxial growth equipment



Compound (SiC-coated)

Susceptors

Crystal growth (SiC ingot manufacturing)

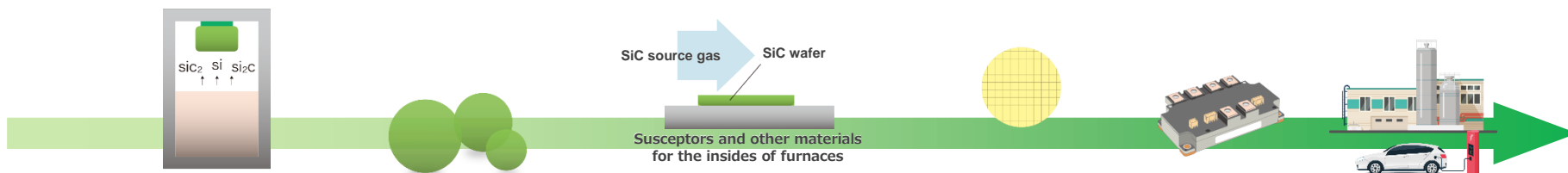
Wafer

Epitaxial growth

Dicing

Modularization

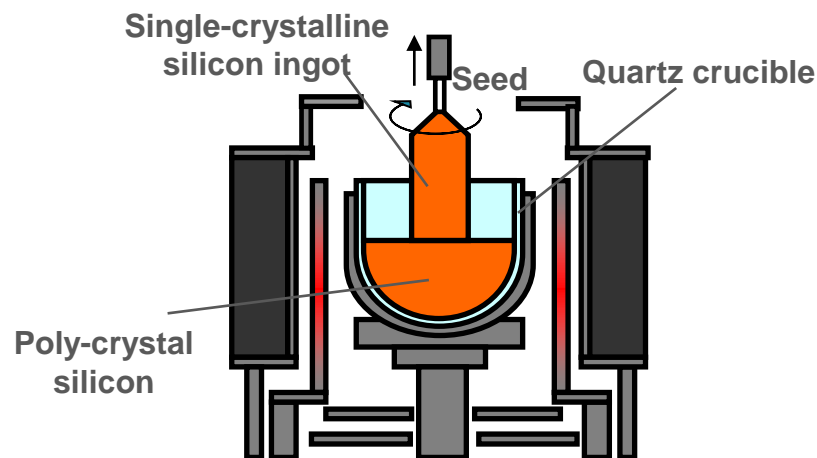
Application



SiC wafer production process

Single-crystal Silicon Growth Method

CZ (Czochralski) method

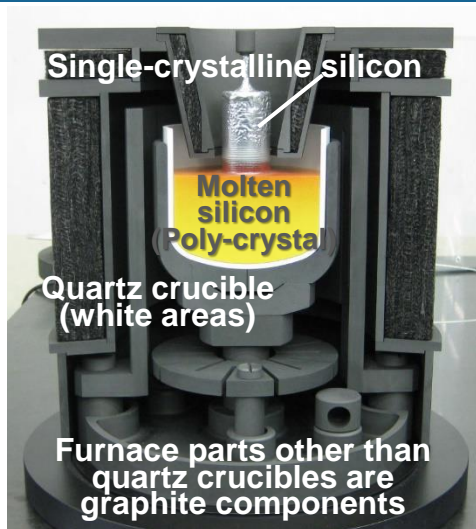


This is a typical method of single-crystal silicon growth.

Ultra-pure poly-crystal silicon that has been coarsely crushed in a quartz crucible is melted in a heating furnace, and a small seed single-crystal is gradually pulled up while rotating to grow a single-crystal. Single-crystal silicon ingots with constant crystal orientation and no crystal disorder are produced.

The furnace parts other than the quartz crucibles and insulation materials are composed of graphite components, and a large amount of graphite products are used.

※ Crystal growth: Manufacturing process to increase crystals based on supporting crystal substrates and seed crystals that are single crystals.



Why Graphite ?

Since the melting temperature of poly-crystal silicon is extremely high at about 1500°C, **isotropic graphite with excellent heat resistance is used in furnace parts.**

- **Crucible:** Graphite crucibles that hold quartz crucibles require **high purity and strength.**
- **Heater:** **Thermal conductivity** is required as a heating element.
- **The demand for purity in graphite components tends to increase further** with the progress of process rule miniaturization and multilayering (3D).

Why Toyo Tanso ?

Global Top Market Share

- **A pioneer that continues to lead the graphite industry**

Since Toyo Tanso's isotropic graphite was adopted in single-crystal silicon manufacturing equipment in 1980, the shift from anisotropic graphite to isotropic graphite has progressed.

We will continue to develop further and meet the demand for graphite materials, which are becoming more sophisticated with the times.

- **World-class production capacity**

We have established a stable supply system.

- **Proposal capabilities and advanced machining technology**

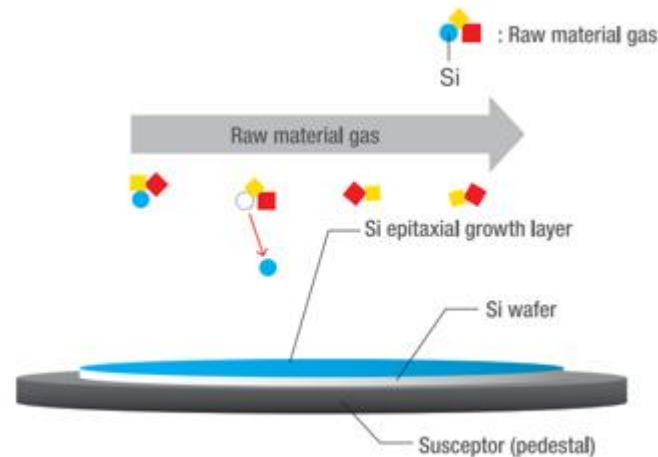
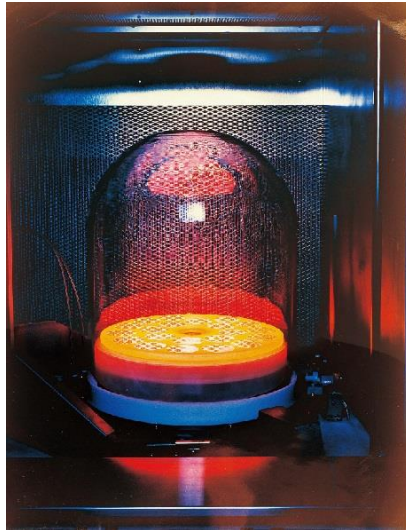
We can propose heater designs according to usage conditions and machine complex shapes.

- **Ability to manufacture "large" graphite materials, which are difficult to produce**

We can produce large graphite materials with stable quality for larger-diameter crucibles .

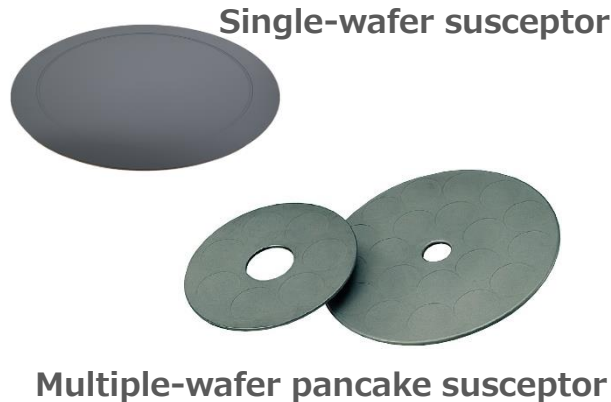
Silicon Epitaxial Growth

Image of Silicon Epitaxial Growth (Si-Epi)



Silicon epitaxial growth is a process for growing single crystal silicon thin films on silicon wafers. A silicon wafer is mounted on a SiC-coated graphite product (susceptor) and heated to about 1100°C in an epitaxial furnace. A single-crystal silicon thin film is vapor-phase grown on the surface of the silicon wafer by passing vaporized Si-based raw material gas through the furnace.

For critical applications such as logic semiconductors, which require high quality, it is necessary to improve the integrity of crystals by silicon epitaxial growth.



Why SiC-coated Graphite ?

If a quality defect occurs in a single-crystal silicon wafer, it will cause performance degradation or defects in the semiconductor, so **high-dimensional accuracy and purity are required for the parts that come into contact with the wafer.**

Therefore, **SiC-coated graphite products with high purity and stability at high temperatures** are used.

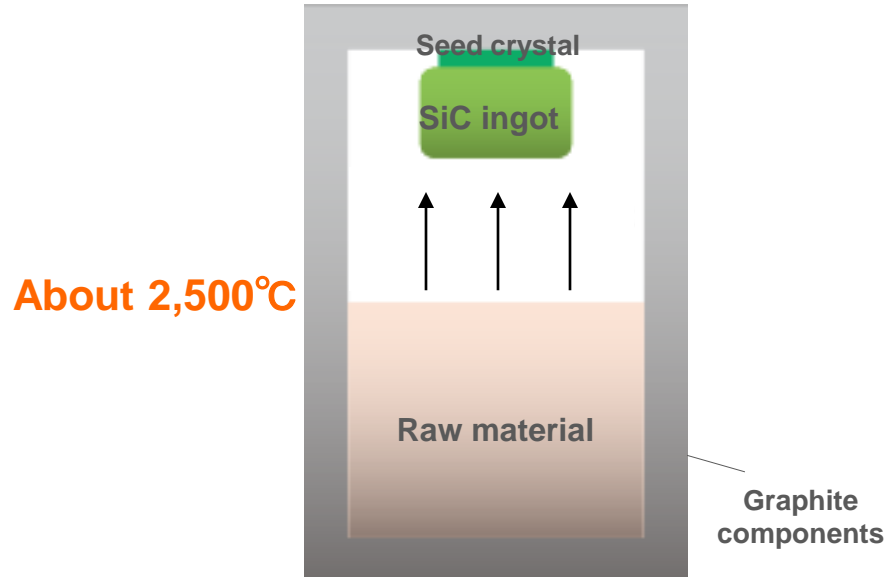
Why Toyo Tanso ?

“Unsurpassed” Global Market Share

- **Integrated manufacturing system from graphite materials to SiC-coating processing**
Enabling the stable supply of high-quality products.
- **Technical services based on Toyo Tanso’s technology and abundant experience cultivated over many years**
Responding to evolving customer quality requirements and backing up customers' stable semiconductor production and quality improvement.
- **Insatiable pursuit of quality and technology**
Contributing to customers’ stable production (long life and cost reduction) by improving the quality of graphite and SiC-coated graphite materials and developing new materials, manufacturing methods, and process innovations.
- **Taking on the challenge of the shift to high value-added products**
Contributing to customers' quality improvement by increasing the value added to SiC-coated graphite products in terms of dimensional accuracy, surface cleanliness, etc.

Single-crystal SiC Growth Method

Image of sublimation method



The sublimation method is the most common single-crystal SiC growth method. The raw material is sublimated at high temperature and recrystallized. Other manufacturing methods include the solution growth method and the high-temperature CVD method. Compared to the CZ method, which is the most common method for single-crystal silicon ingot production (See p. 11.), it takes more time to grow crystals* and the resulting ingot size is smaller, so many manufacturing furnaces are required. In addition, it is difficult to use the components repeatedly, so a very large amount of graphite is required.

* Crystal growth: Manufacturing process to increase crystals based on supporting crystal substrates and seed crystals that are single crystals.



Crucible for sublimation

Why Graphite ?

Since the temperature for crystal growth in the sublimation method is extremely high, at about 2,500°C, **graphite with excellent heat resistance** is used for the furnace components.

Some components require dimensional changes equivalent to those of single-crystal SiC at high temperatures, and **graphite components with a low coefficient of linear thermal expansion (dimensional change with temperature)** are used.

Why Toyo Tanso ?

Top-class Global Market Share

■ World's top-level production of isotropic graphite

The sublimation method uses a large amount of graphite, so it is important to establish a stable supply system.

■ High quality stability honed in the semiconductor industry

Production of stable quality graphite materials cultivated through the supply of single-crystal silicon manufacturing materials.

■ Strengths as a pioneer in isotropic graphite

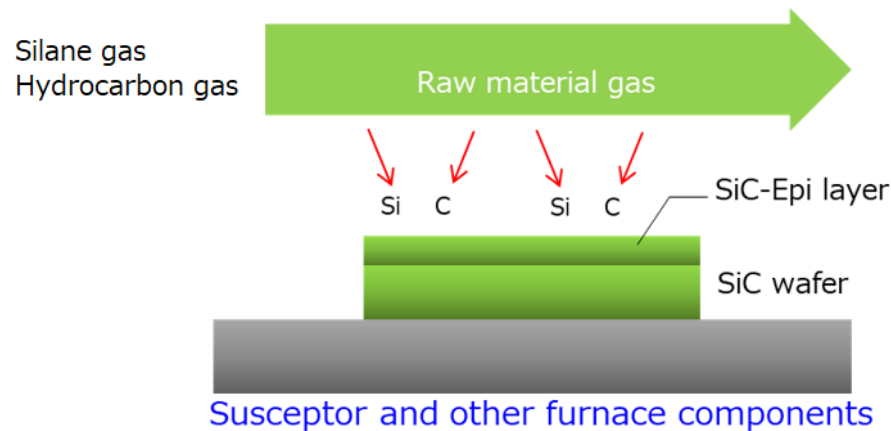
Depending on each customer's manufacturing conditions, we can propose various materials, sizes, designs and machining. We develop groundbreaking materials to meet increasingly sophisticated customer needs.

■ Global sales system

Single-crystal SiC is often manufactured overseas. Toyo Tanso , which has machining and high-purity equipment at its major overseas bases, supports the global supply chain.

SiC Epitaxial Growth

Image of SiC epitaxial growth (SiC-Epi)



In SiC epitaxial growth, a single-crystal SiC wafer is mounted on a susceptor (SiC/TaC coated graphite material) and heated to about 1600 °C in an epitaxial furnace. Vaporized raw material gas is injected into the furnace, whereby a single-crystal SiC thin film is vapor-phase grown on the surface of the single-crystal SiC wafer.

The challenges of single-crystal SiC wafer production include the reduction of crystal defects, the improvement of yield, and the increase of diameter. It is difficult to reduce crystal defects in the crystal growth process, and epitaxial growth forms a film with few crystal defects.



SiC-coated
graphite products



TaC-coated
graphite products

Why Coated Graphite ?

The film deposition temperature is extremely high at about 1600°C, and since particles from the graphite base material are unacceptable, coated graphite components are used.

Optimal coating materials such as SiC and TaC (tantalum carbide) are selected for graphite components, depending on the environment and conditions in which they are used.

Why Toyo Tanso ?

“Unsurpassed” Global Market Share

■ Integrated manufacturing system from graphite base materials to machining and coating

By controlling the characteristics of the graphite base material, we can provide products of stable quality that meet the characteristics required by customers.

■ Achievements cultivated in the semiconductor industry

Providing technical services based on the experience cultivated in silicon semiconductor applications.

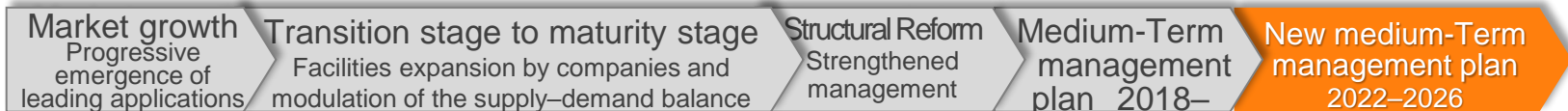
■ Extensive lineup

In addition to proposing film type such as SiC and TaC (tantalum carbide), we offer materials, machining, and surface treatment according to customer requirements, such as selecting the optimal graphite base material from a wide selection of grades.

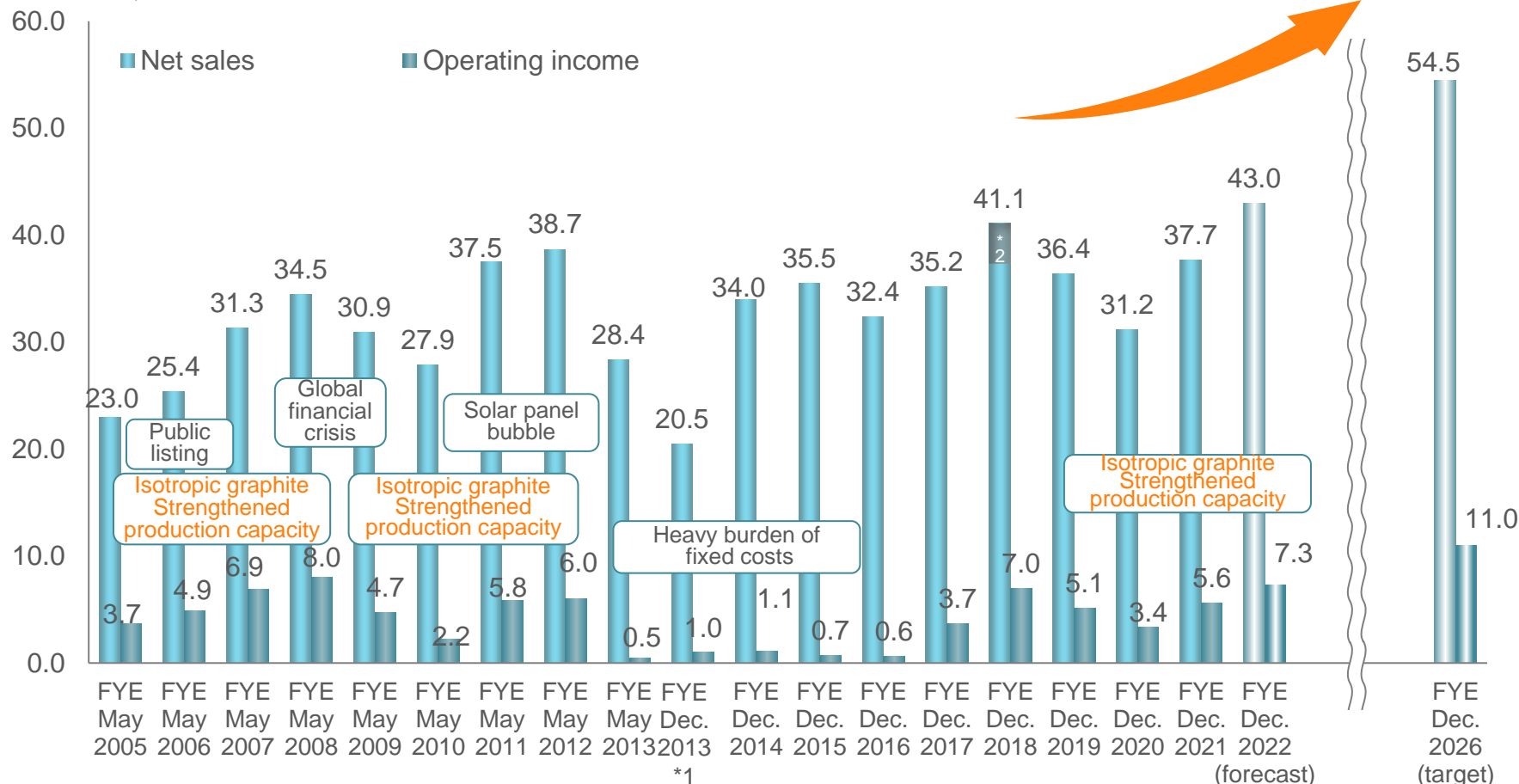


APPENDIX

Fluctuations in Sales and Operating Income



(Unit: Yen, billions)



*1 The final day of the fiscal period was changed from May 31 to December 31 as of the fiscal year ended December 31, 2013. For this reason, the fiscal year ended December 31, 2013 was an irregular seven-month fiscal period.

*2 Net sales for FY2018 include 3.2 billion yen in net sales for China's high-temperature reactor-pebble-bed modules (HTR-PM).

Targets for the new medium-Term management plan

- 5-year plan spanning 2022 to 2026
- Expand core businesses, strengthen the shift to higher value-added products and promote globalization to achieve net sales above the 50 billion yen mark
- Further enhance profitability through the shift to higher value-added products, to achieve record-high profits and an operating income ratio of 20%

	FY2021	FY2022 (forecast)	FY2026 (target)
Net sales	37.7 billion yen	43.0 billion yen	54.5 billion yen
Operating income	5.6 billion yen	7.3 billion yen	11.0 billion yen
Operating profit ratio	15.0%	17.0%	20.2%
ROE	6.4%	7.0%	9.0%

TOYO TANSO's Fundamental philosophy

**Contributing to the world through the pursuit
of the possibilities inherent in carbon (C)**

Business outline	Production of specialized, highly functional carbon products
Corporate profile	
Capital	7,947 million yen (as of December 2021)
Sales	37.7billion yen (year ended December 2021/consolidated)
Employees	Non- consolidated: 831 Consolidated: 1,640 (as of December 2021)
President	Naotaka Kondo Representative Director, Chairman & President, CEO



Head
Office

Takuma Division



History

- 1947** Founded Kondo Carbon Kogyo (now TOYO TANSO). Started manufacture of carbon brushes.
- 1974** First in industry to succeed with the mass-production of large isotropic graphite
- 1985** Establishment of manufacturing base for isotropic graphite (now Takuma Division)
- From 1987** Establishment of local corporations around the world (We currently have bases in 12 countries, including in the US, Europe, and Asia)
- 2006** Listed on the first section of the Tokyo Stock Exchange.

Areas for Business Expansion

Advanced technology field

- Nuclear power
- Aerospace
- Medical care



Electronics field



- Semiconductors
- Photovoltaic cells
- LEDs
- Next-generation semiconductors
- Optical fiber



Machines for general industries field



- Die manufacturing • Industrial furnaces • Metal casting
- Industrial machine parts • Hot presses

Transportation equipment field



Photograph: provided by East Japan Railway Company

- Automobiles
- Rail • Shipping



Electrical field

- Power tools
- Home electronics

Highest market share as the only manufacturer dedicated to special graphite products

No.1

✓ **Top share** in a wide range of applications

- Crucibles for single crystal silicon production furnace (40% share of global market)
- Pantograph sliders (70~80% of JR's existing lines)
- Graphite for nuclear power (only company whose graphite has been authorized)

GNT
100

✓ As a manufacturer of isotropic graphite materials, Toyo Tanso is proud to provide the industry's highest level of service in terms of quality and volume. In 2014, we were selected for METI's **Global Niche Top 100 Companies**.*

* METI selects and awards those companies breaking into international markets that have a high market share in specific fields and practice good management.

Integrated manufacturing system from materials to processing and high value-added processing (coating, advanced purification, etc.)

✓Materials are produced in ultra concentrations in Japan

- Pursuit of stable quality
- Ensuring production efficiency
- Knowledge management
- Cost competitiveness maintained

Baking furnace



24hour centralized control system

✓Close connections with domestic and overseas customers built in processing and sales

- We have built close relationships with customers through our direct sales system and rapidly identify needs
- We have succeeded in producing small volumes of many different products to meet the needs of diverse clients
- Quick delivery



SHANGHAI TOYO TANSO CO., LTD.



TOYO TANSO USA, INC.

We specialize in high-performance, high-quality fields and utilize our expertise to expand our design proposals and technical guidance on a global basis

✓Processing and sales sites in 16 areas around the world so that we can fully meet local customers' needs

- We do not just process and sell products, but provide solutions from every angle, such as design proposals and technical guidance.
- We are currently augmenting the processing capacity of our overseas sites to further expand sales.





Note: This presentation contains “forward-looking statements” and forecasts of business results. These statements are not historical facts but instead represent the Company’s beliefs regarding future events, many of which, by their nature, are inherently uncertain and beyond the Company’s control. It is possible that the Company’s actual results may differ, possibly materially, from the anticipated results and financial condition indicated in these forward-looking statements.

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