

TORAY IR Seminar
Toray Group's Initiatives for Digital Innovation Business

Overview of Semiconductor Inspection Equipment Business

September 13, 2024

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President, TASMITECH, Inc.
Kenji Sato

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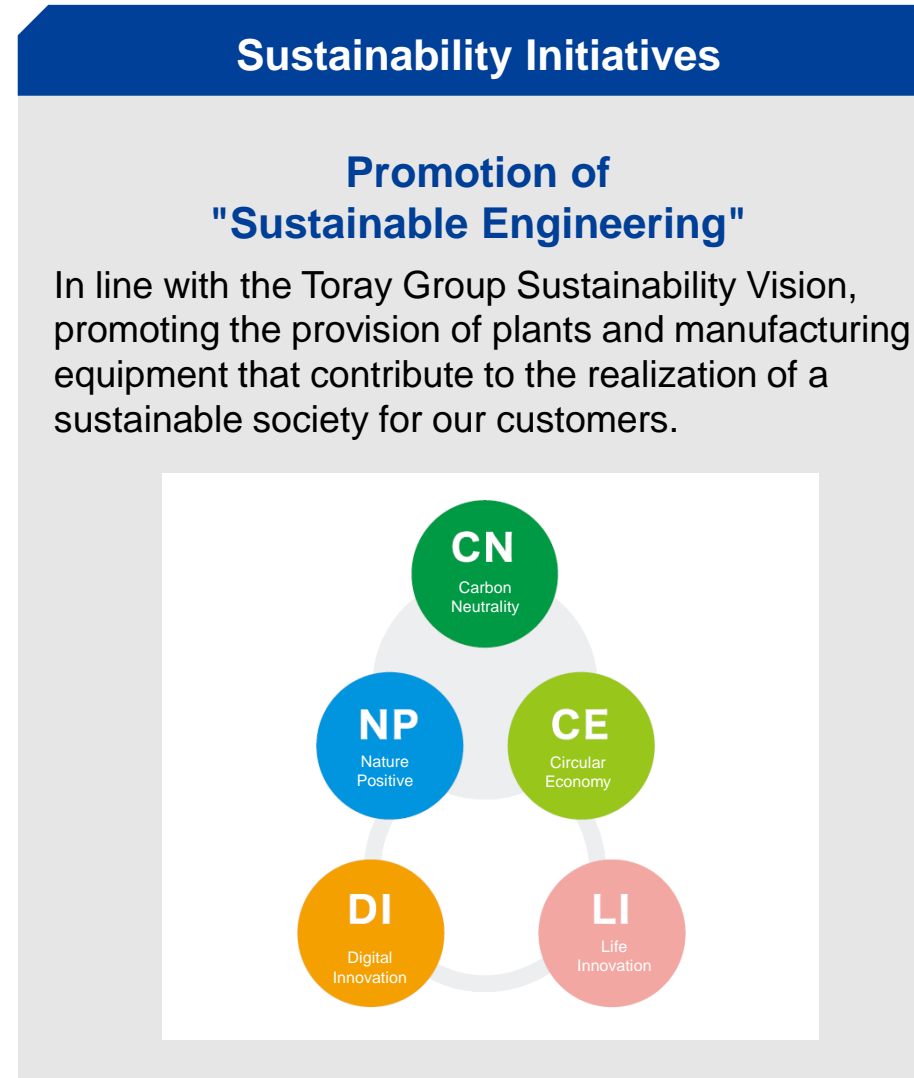
Toray Engineering's Semiconductor-related Business

1. Overview of Toray Engineering (TRENG)

Established	August 10, 1960		
Head Office	Head Office 6th Floor, Yaesu Ryumeikan Bldg., 3-22, Yaesu 1-chome, Chuo-ku, Tokyo	Representative	Takashi Iwade President and Chief Executive Officer
	Second Headquarters 1-1, Sonoyama 1-chome, Otsu, Shiga (Inside the Toray Industries, Inc., Shiga Plant)		
Paid-in Capital	1.5 billion yen	Number of Employees (consolidated)	2,088 (as of March 31, 2024)
Revenue (consolidated)	129.6 billion yen (FY 2023)		Main Business Locations <ul style="list-style-type: none">■ Seta Plant (Shiga)■ FA Innovation Center (Shizuoka)■ Yokohama Office (Kanagawa)■ Shanghai■ Seoul■ Taipei■ Munich

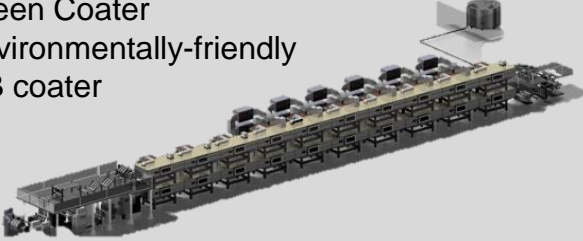








1. Overview of Toray Engineering (TRENG)

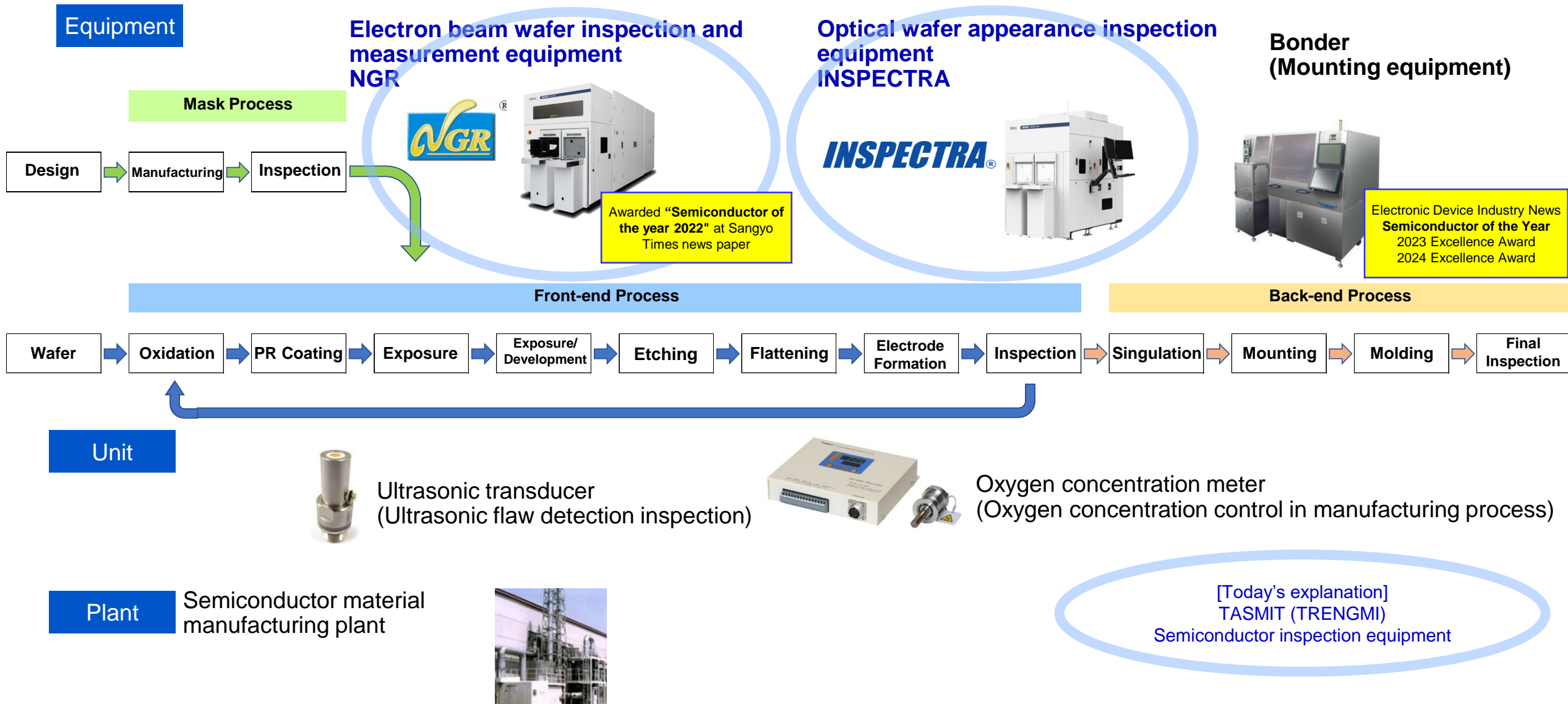


1. Overview of Toray Engineering (TRENG)

Key Areas for Business Expansion

Key Areas of TRENG	Main Products of the TRENG Group	
EV, FCV	<ul style="list-style-type: none"> LiB-related facility Power semiconductor inspection equipment Semiconductor molding equipment Fuel cell (FC) manufacturing equipment 	<p>Green Coater Environmentally-friendly LIB coater</p> 
Semiconductor	<ul style="list-style-type: none"> Flip chip bonder Semiconductor inspection system Laser micro trimming equipment Semiconductor material manufacturing plants 	<p>Semiconductor inspection system INSPECTRA and NGR</p>    
Pharmaceuticals, Medical	<ul style="list-style-type: none"> High potency bulk drug manufacturing plant Surgical support robot Nucleic acid drug manufacturing equipment 	<p>Surgical support robot, Saroa</p>  <p>High potency active pharmaceutical ingredient plant</p> 
Next Generation FPD	<ul style="list-style-type: none"> μLED manufacturing equipment 	

2. Semiconductor-related Business of Toray Engineering (TRENG)





Semiconductor Inspection and Measurement Equipment Business

1. Overview of TASMIT

- Company name: TASMIT, Inc. (TRENGMI)
- Major shareholder: Toray Engineering Co., Ltd. (TRENG)
- Business scale: Revenue 8.9 billion yen (FY 2023)
- Head office location: Yokohama, Kanagawa Pref.
- Domestic bases: Seta Office (Otsu, Shiga Pref.)
- Overseas bases: Utilizes Toray Engineering's overseas bases
- Main products:

1 μm = 0.001 mm
1 nm = 0.001 μm = 0.000001 mm

◆ Optical Wafer Inspection Equipment (INSPECTRA)

INSPECTRA[®]



High-speed, High-definition Inspection

- 3 μm sensitivity at 100WPH @300mm
- 100%, full-surface inspection to eliminate defective product outflow

Hybrid Inspection

- Capable of various inspections such as fluorescence inspection and differential interference inspection

Die to Statistical Image

- Comparison inspection with statistical image data of mass production products
- Algorithm with minimal over-detection

◆ Electron Beam Wafer Inspection and Measurement Equipment (NGR)

NGR[®]



Wide Field, Low Distortion Image

- Maximum field of view: 70 μm × 70 μm
- Image distortion within 0.01%
- Thousands of data points obtained in one measurement

High Sensitivity

- High resolution: 1.8nm
(= Detection sensitivity required for cutting-edge devices below 3nm)

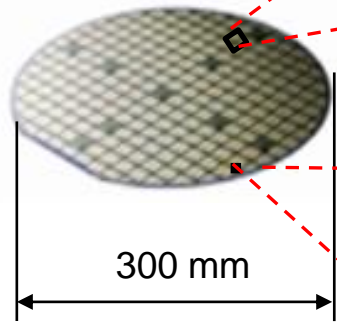
Die to Database algorithm

- Capable of high-speed, high-precision comparison and measurement between design data and SEM images

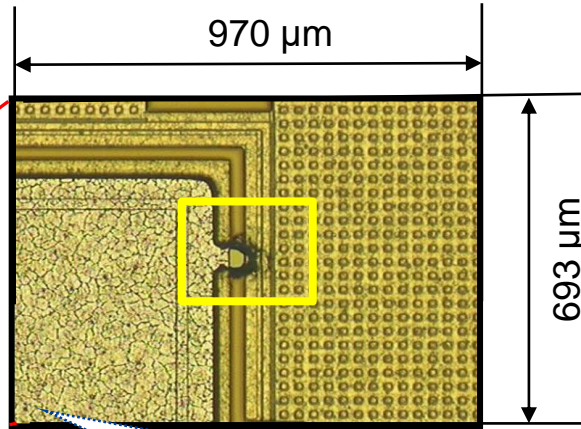
Optical vs. Electron Beam

Optical wafer inspection equipment

INSPECTRA®

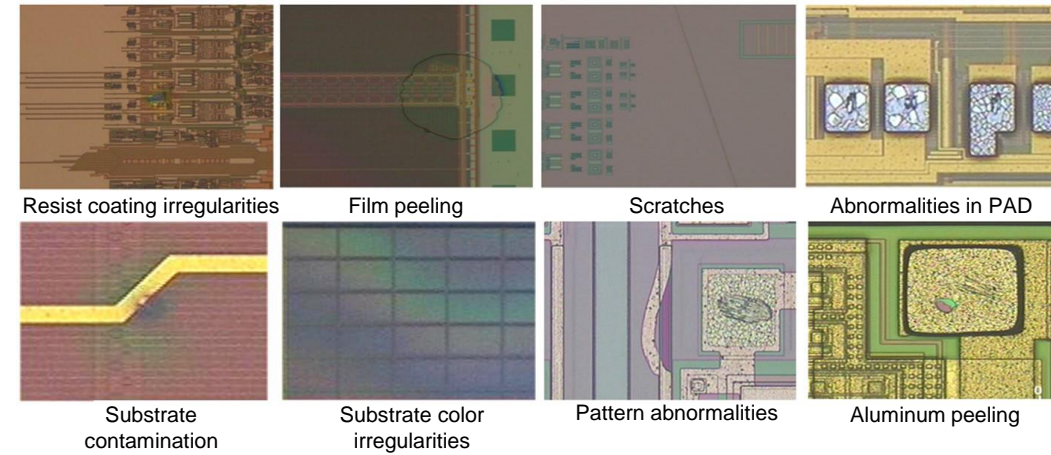


*1: FOV =

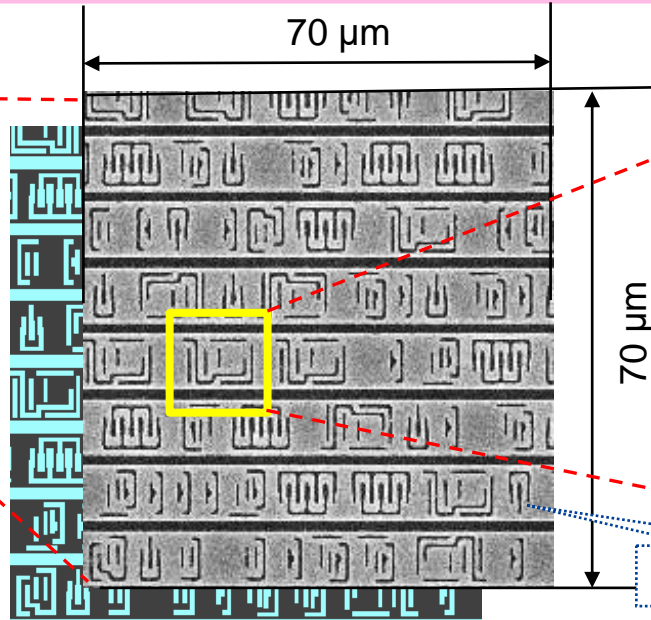


Resolution: 0.28 μm

*1 Relay lens: 0.81x, objective lens magnification 20x

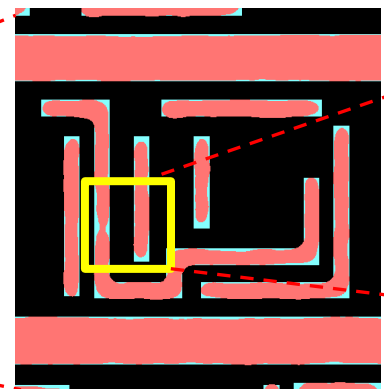


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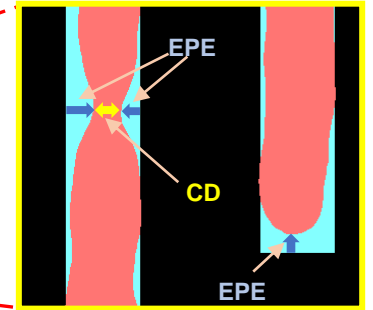


Resolution: 1.8 nm

Alignment



Pattern shape inspection and measurement

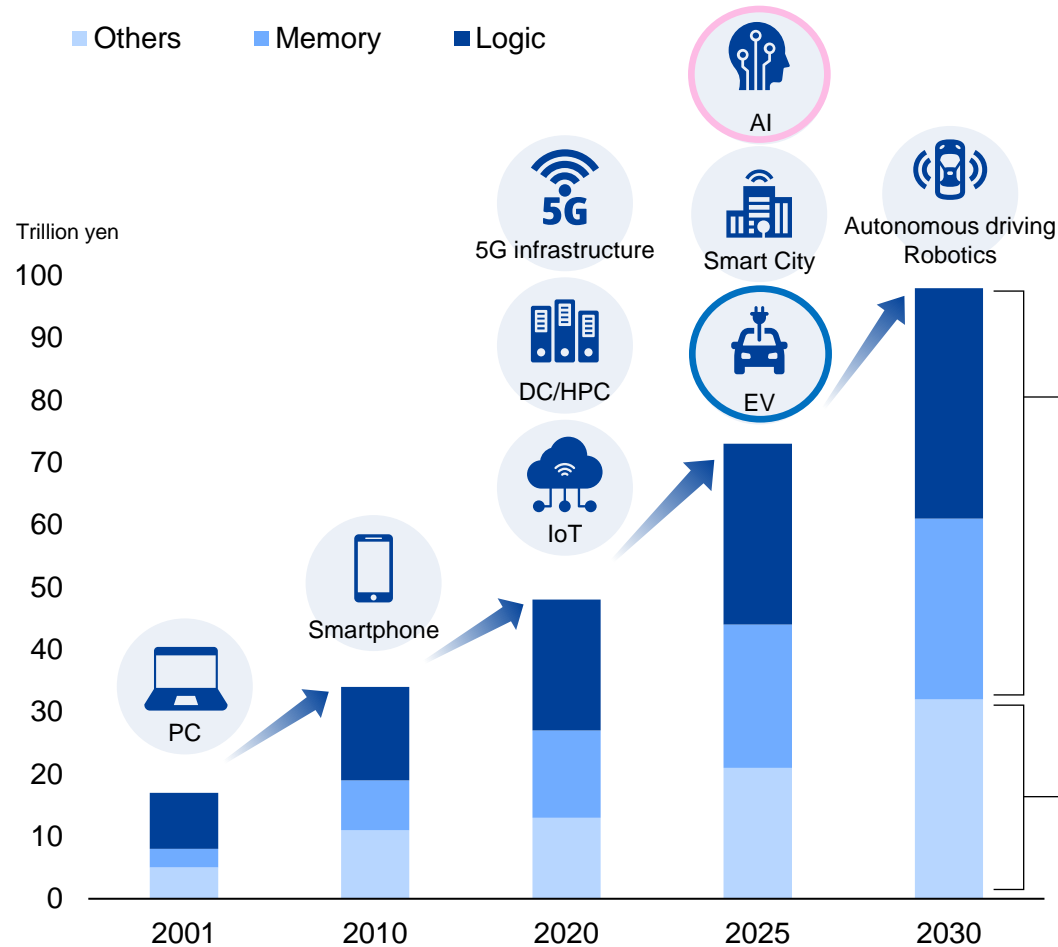


1 μm = 0.001 mm
1 nm = 0.001 μm = 0.000001 mm

Electron beam wafer inspection and measurement equipment


2. Growth of the Semiconductor Market and Our Inspection Equipment Business

Semiconductor Shipment Value Trends (Forecast)




Overview of Inspection and Measurement Equipment Business

Logic, Memory	
NGR	
Business scale	FY 2023 Performance: Revenue 3.0 billion yen
Features	Contributing to the development of cutting-edge semiconductors with a wide, low-distortion field of view and Die to Database technology.
Market	Aiming to expand adoption in various processes, not only development but also mass production, in factories for advanced semiconductors.
Key areas	Advanced semiconductors (logic IC, DRAM)



Others	
INSPECTRA	
Business scale	FY 2023 performance: Revenue 5.9 billion yen Top share in Japan
Features	Enables full inspection with the world's fastest throughput.
Market	High market share in Japan. Working to expand overseas business by operating demo centers in various overseas locations.
Key areas	Power semiconductors for vehicles, μ LED, communication filters



Source: Compiled by the Ministry of Economy, Trade, and Industry, using data from Omdia, SEMI, TrendForce, Fuji Keizai Co., Ltd., Global Net Corp., and various company financial reports. (*Figures: as of 2019, exchange rate: 1 USD = 110 yen, 1 euro = 125 yen)

2. (1) Electron Beam Wafer Inspection and Measurement Equipment (NGR): Core Technologies

Core Technology 1: Wide Field Low Distortion Imaging

Our proprietary Scanning Electron Microscope makes it possible to obtain nanometer-level images with a wide field of view and low distortion.

CRT: Cathode Ray Tube

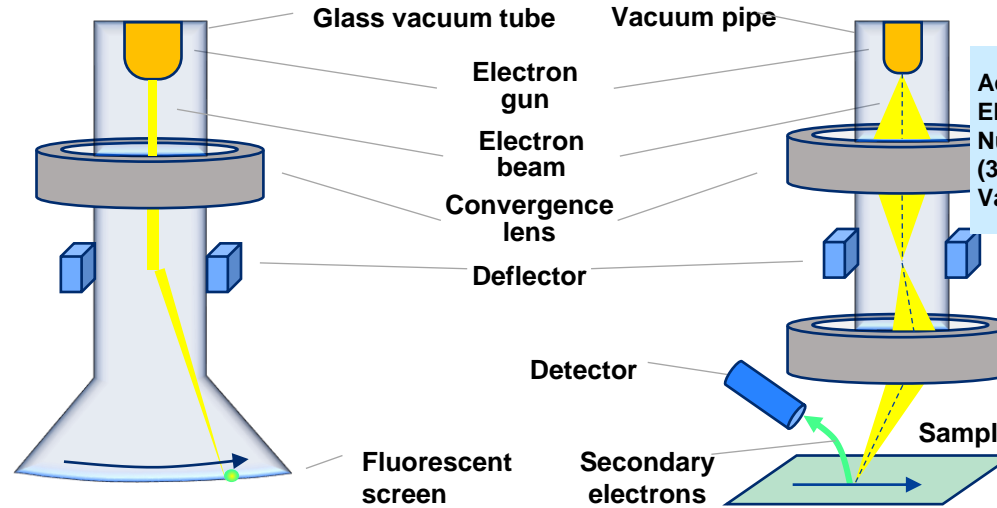
Accelerating voltage: 20kV
 Electron beam diameter: 0.3mm
 Number of pixels: 345,600
 Vacuum: 1.0 Pa



Modulates the amount of electron beam and draws an image

SEM: Scanning Electron Microscope

Accelerating voltage: 15 - 50 kV
 Electron beam diameter: 1.5 nm
 Number of pixels: Up to approx. 1 billion
 (30 times larger than 8K TV)
 Vacuum: 1.0×10^{-5} Pa

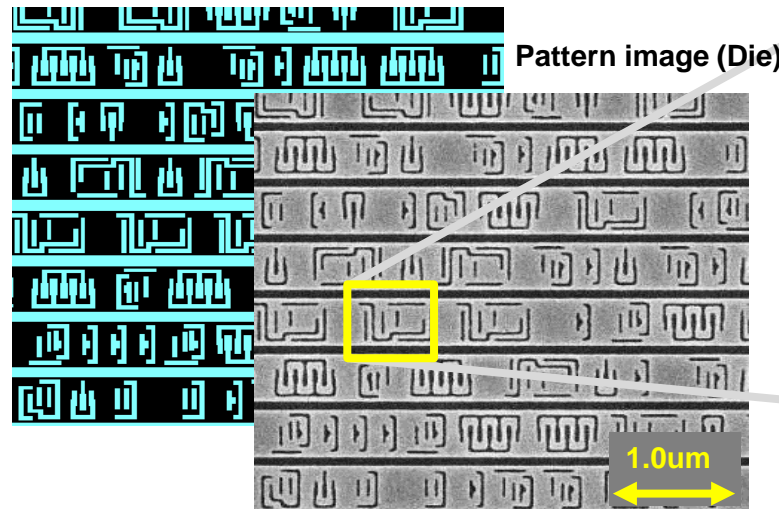


Detects and images secondary electrons generated on the surface

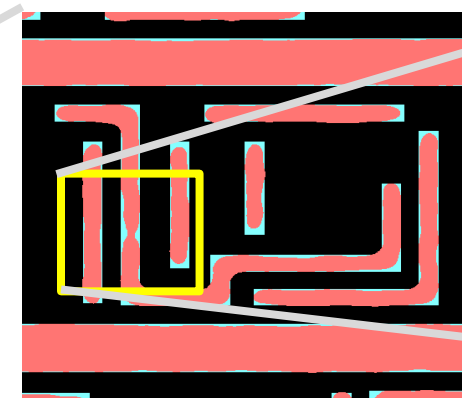
Core Technology 2: D2DB Algorithm

The "D2DB = Die to Database" technology enables high-speed, high-precision measurement of complex 2D patterns.

Design data (Database)

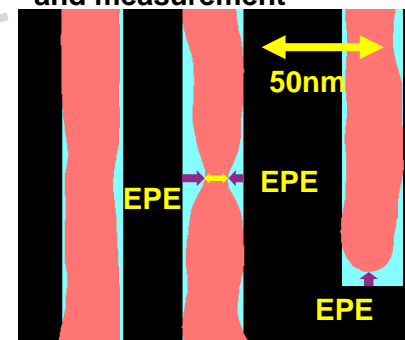


Alignment



Identifies all patterns to be measured based on the design data.

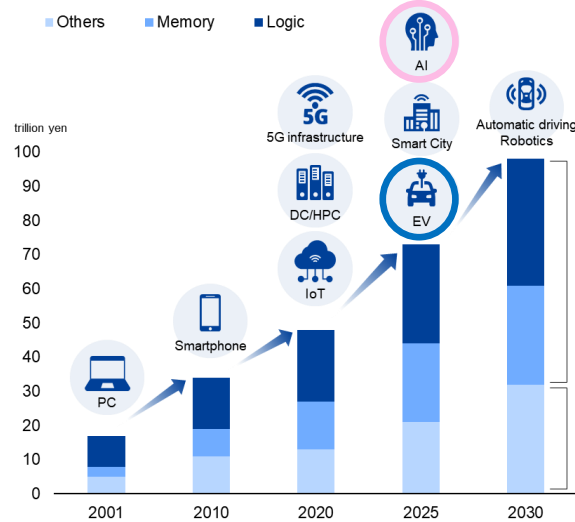
Pattern shape inspection and measurement



Measures pattern misalignment and pattern edge variation (EPE).
 (EPE: Edge Placement Error)

2. (1) Electron Beam Wafer Inspection and Measurement Equipment (NGR): Key Market

Semiconductors for AI will drive semiconductor market growth



AI server at a data center



Technology

- Machine learning
- Natural language processing
- Computer vision
- Speech recognition
- Robotics

Market

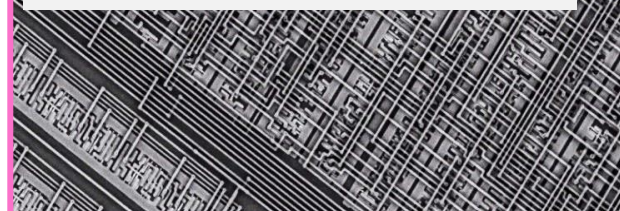
- Finance, retail, manufacturing
- Healthcare
- Transportation, agriculture
- Education
- Energy, etc.

Hardware for processing large amounts of data simultaneously and at high speed

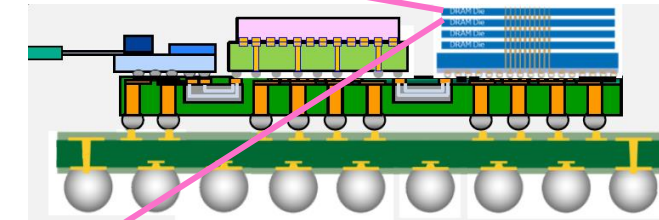
GPU



Microscopic image of semiconductors



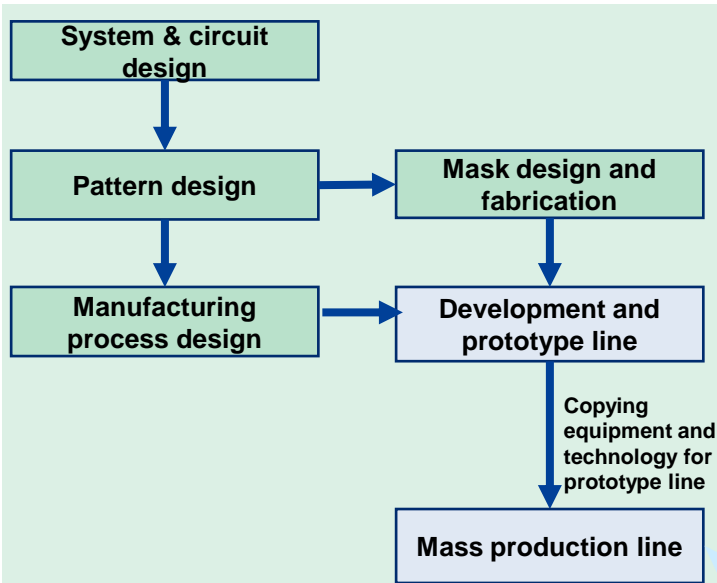
- Over 100 billion transistors
- Contacts that connect transistors and wiring
- Wiring that connects contacts to input/output



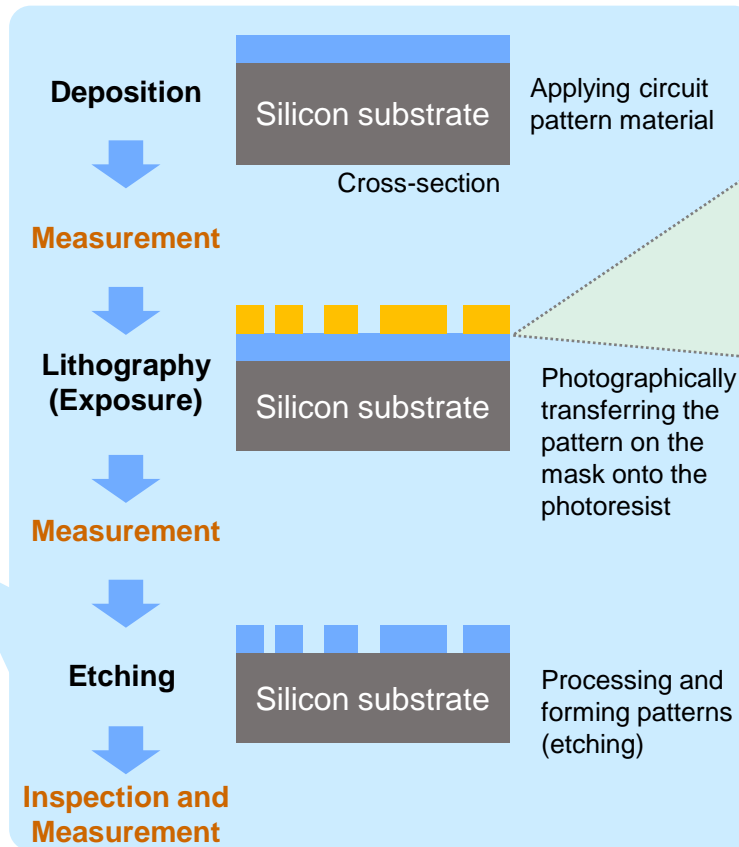
The use of AI is expanding across all fields, and AI semiconductors are expected to drive the future growth of the semiconductor market. Advanced logic and memory devices are used in AI semiconductors.

2. (1) Electron Beam Wafer Inspection and Measurement Equipment (NGR): Challenges in Advanced Semiconductor Manufacturing

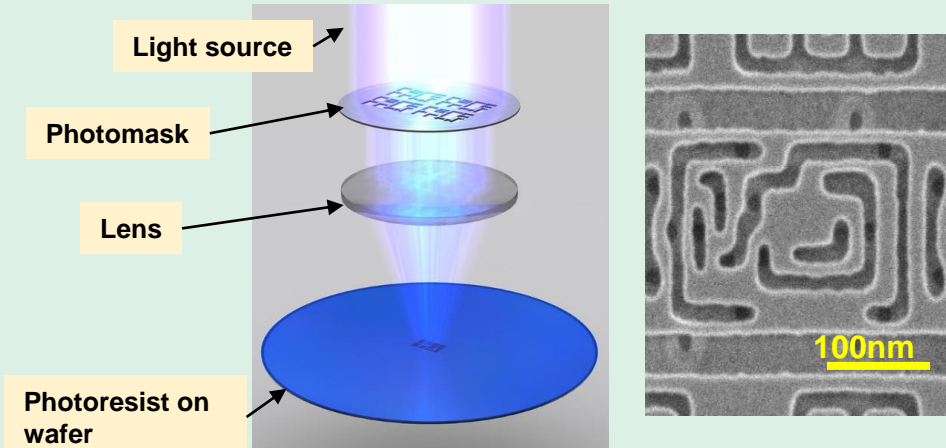
Flow from Semiconductor Design to Development, Prototyping, and Mass Production



It is crucial to increase the yield of high-margin advanced devices and start stable mass production as quickly as possible.



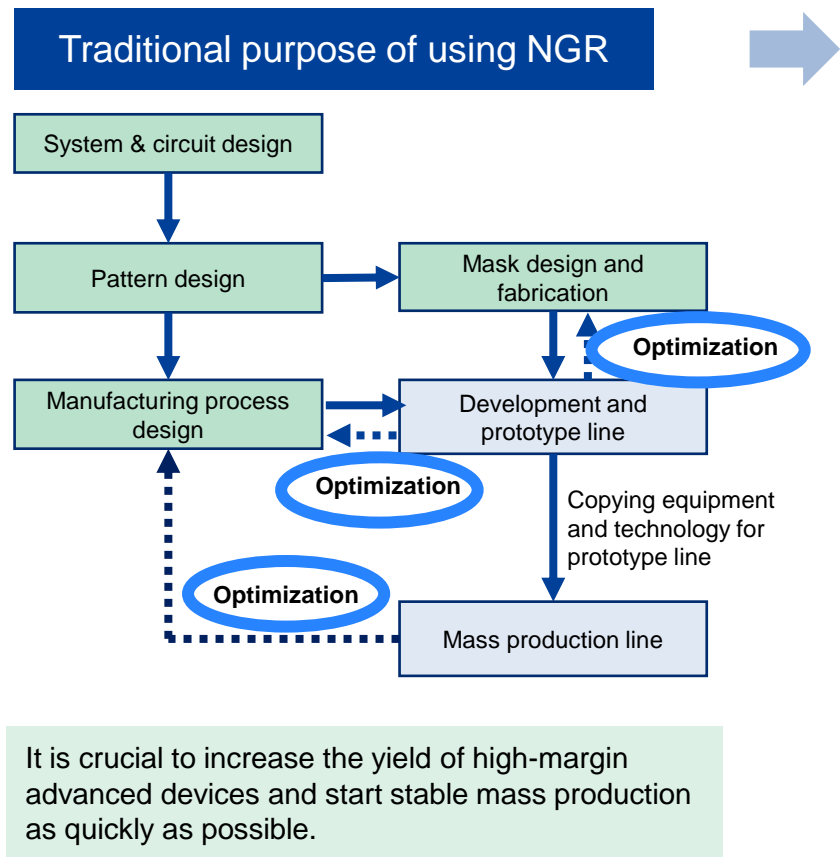
Exposure Equipment



It takes more than 10 weeks to manufacture with over 300 processes. The key to improving the yield of advanced devices is the exposure machine.

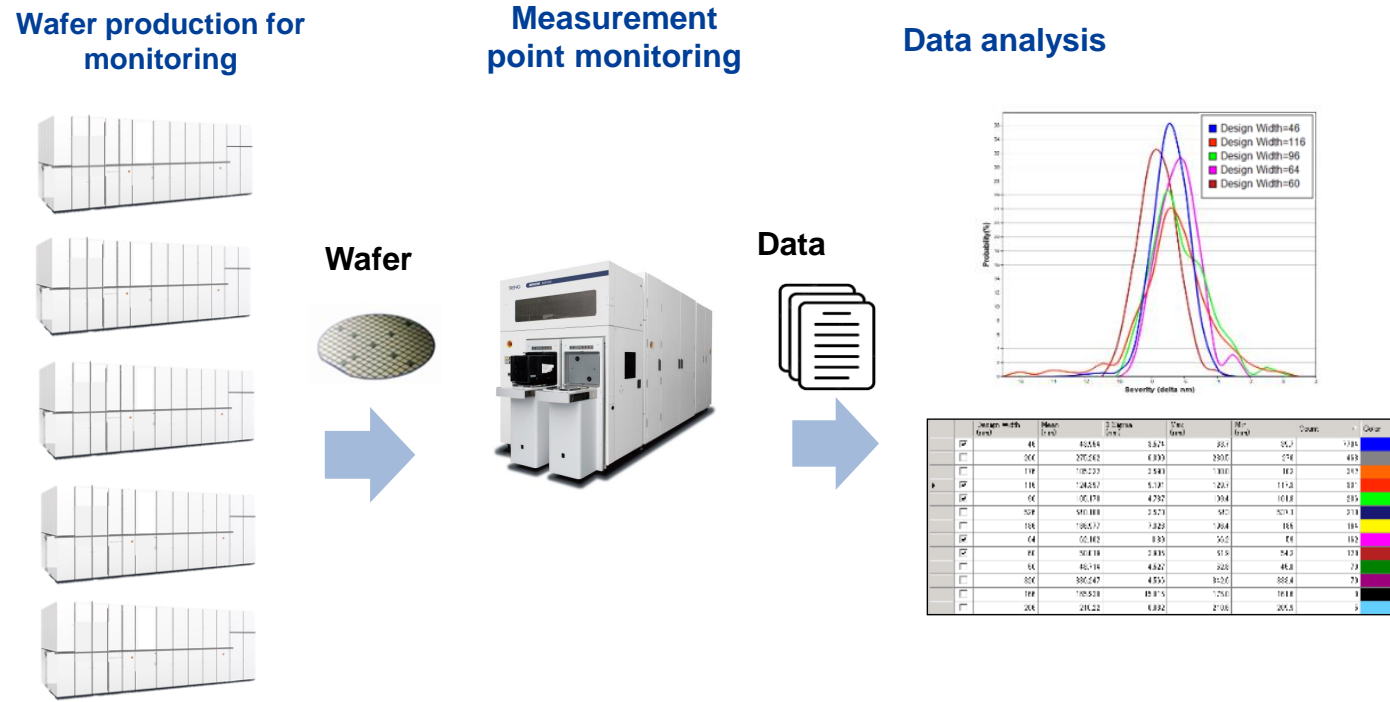
Because micro patterns are exposed at the resolution limit, even slight process variations can cause defects, leading to lower yields. Manufacturing advanced semiconductors is a battle with yield.

2. (1) Electron Beam Wafer Inspection and Measurement Equipment (NGR): Efforts to Expand Business



Purpose of using NGR equipment

New Market Development:
Monitoring the state of exposure equipment in mass production factories

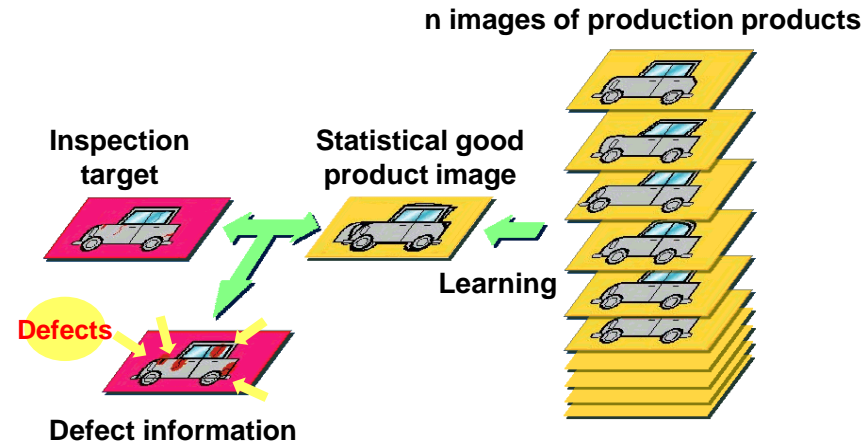


Through collaborative projects with customers, methods for monitoring the state of exposure equipment that are optimized for each factory's devices have been established and operationalized. This is expected to be deployed as a standard tool in the future.

As one strategy for expanding the use of NGR equipment toward business expansion, methods for monitoring the state of exposure equipment were established and operationalized. This is expected to contribute to yield improvement in customers' factories in the future.

2. (2) Optical Wafer Inspection Equipment (INSPECTRA): Core Technologies

Core Technology 1: DSI: Die to Statistical Image (Good Product Learning Algorithm)



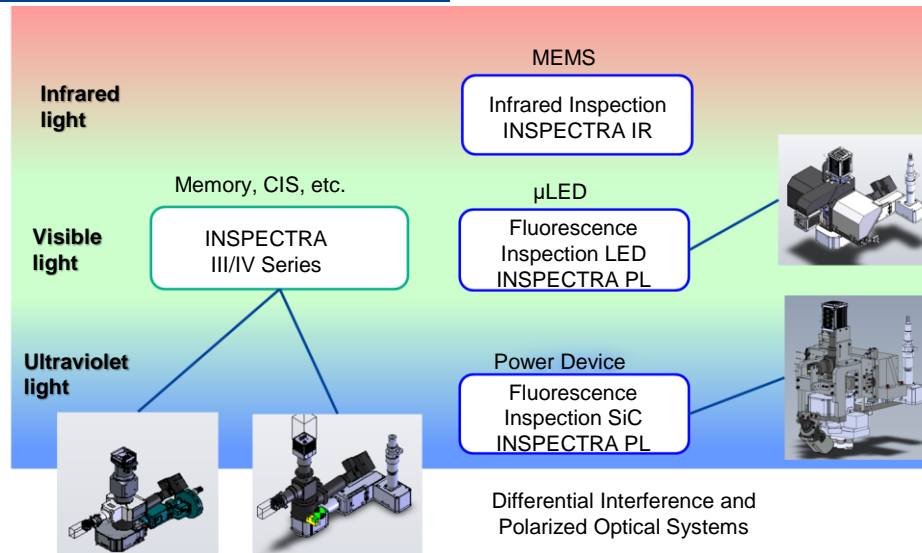
- Automatically learns the variation trends of production products
- Determines OK/ no good, based on the average level of products
- Automatically sets according to variations in parts



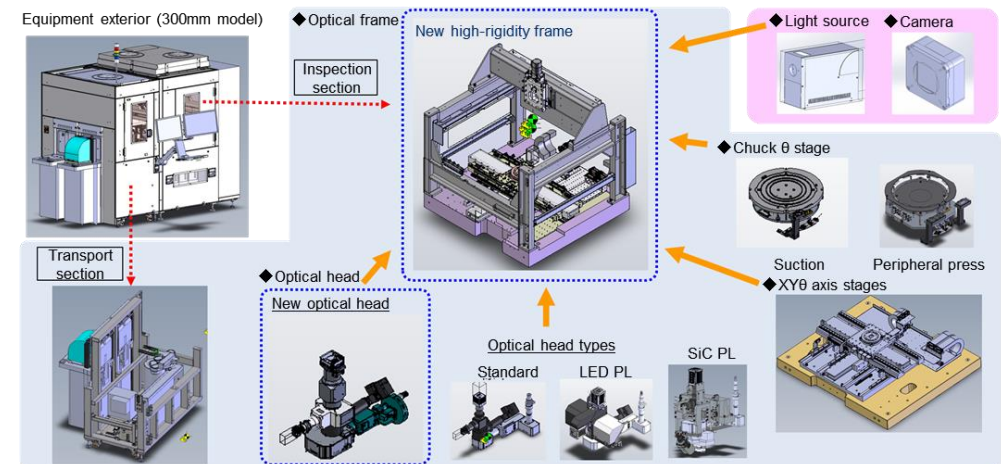
**Realize high-speed,
high-precision inspection!
Easy sensitivity setting!**

Core Technology 2: Advanced Defect Detection Technology

- Making full use of various wavelengths and optical technologies.
- Defects are detected using more advanced image processing technology.
- Achieves highly accurate defect classification using AI-ADC (AI-based automatic defect classification). Also contributes to yield improvement.

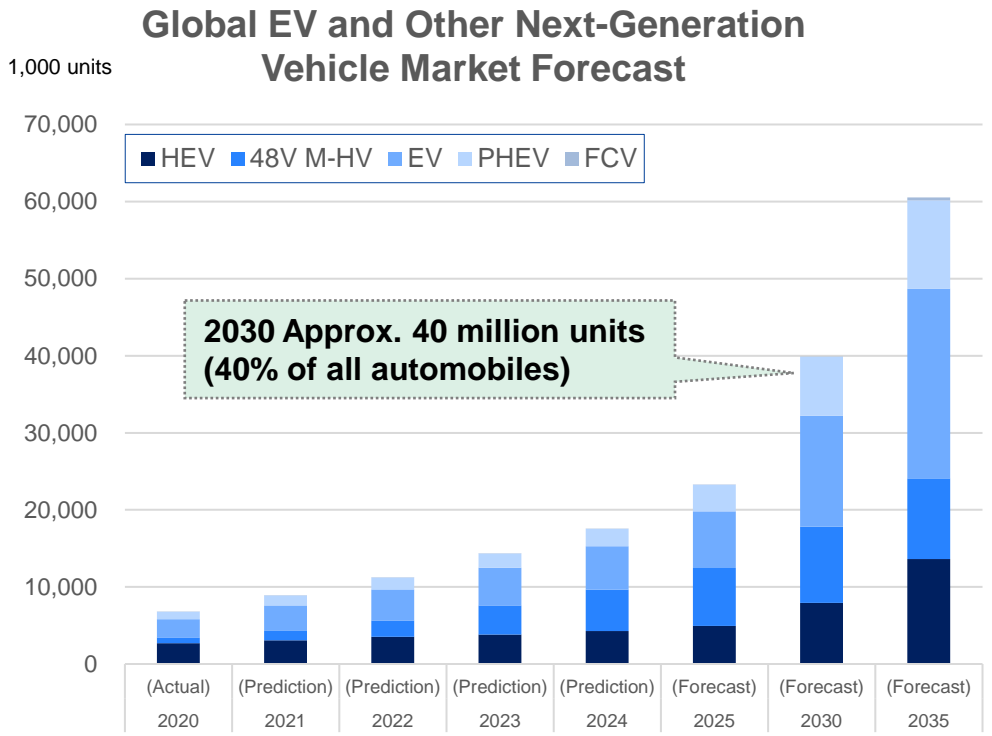


Standardization of platform for multiple models In the process of building a system to efficiently deliver products and respond to various customer requests at the same time

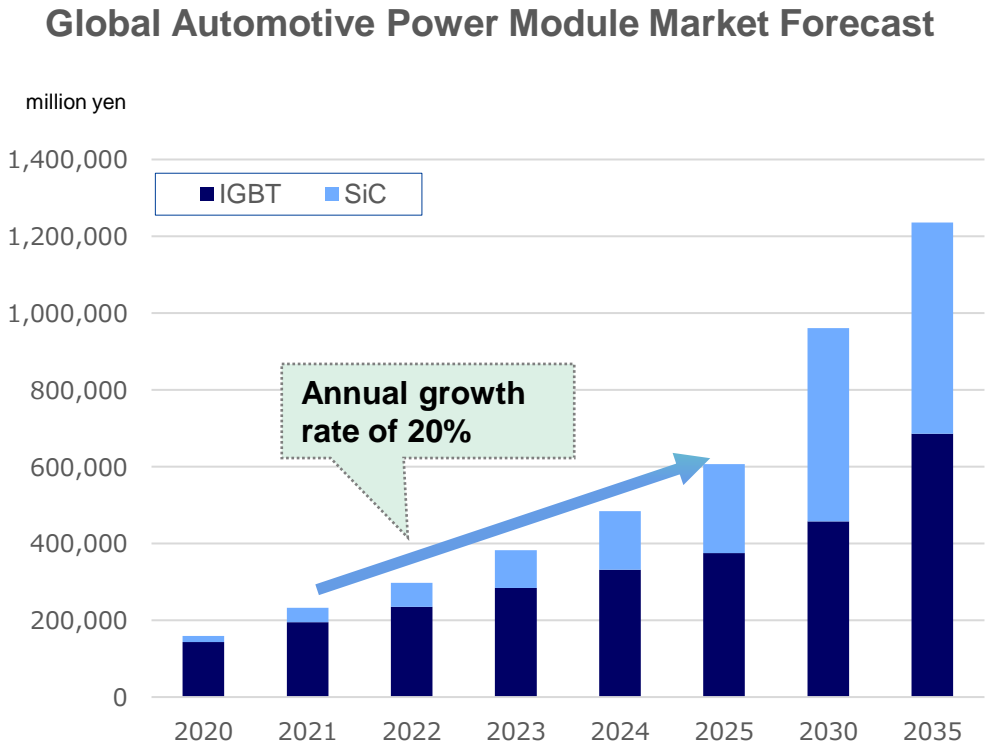


2. (2) Optical Wafer Inspection Equipment (INSPECTRA): Key Market

Due to the electrification of automobiles, the automotive power semiconductor market is expected to grow at an annual rate of 20%



Source: Graph created from "2021 Edition: In-depth Analysis of HEV and EV-related Markets" (Fuji Keizai) published on May 28, 2021



Source: Graph created from "2022 Edition: In-depth Analysis of HEV and EV-related Markets" (Fuji Chimera Research Institute, Inc.) published on March 8, 2022




The automotive power semiconductor market, which is expected to grow significantly, is the most important market for INSPECTRA.

2. (2) Optical Wafer Inspection Equipment (INSPECTRA): Efforts to Expand Business

Expanding the application of INSPECTRA to each process in power semiconductor manufacturing



Wafer process	Power chip process		Thinning process			Electrode formation	Singulation	Final test
Epitaxy	Gate oxide film trench processing	Electrode formation	Surface grinding/TAIKO support substrate bonding	Backside doping Backside patterning	Support substrate removal	Front and backside plating	Dicing	Chip appearance inspection Electrical testing

INSPECTRA series appearance inspection equipment	 SR-III with SiC-PL	Crystal defect inspection		Thin wafer handling Double-sided inspection			Chipping inspection Crack inspection	
	 SR-IV, SR-III, FR-III	Metal defect inspection		Thin wafer handling Double-sided inspection			Chipping inspection Crack inspection	
	 CR-III	Zero defect escape is essential for automotive devices → The reliability of inspection in each process is important						

We have expanded the application process from appearance inspection to pre- and post-processes, and built a track record with major Japanese manufacturers.

2. (2) Optical Wafer Inspection Equipment (INSPECTRA): Efforts to Expand Business

Based on our track record of power semiconductor and various device inspections in Japan, we are working to expand our business in overseas markets.

Bases in Japan

[TRENG Seta Plant]
TRENGMI
Seta Office



Development,
Design,
Manufacturing,
Maintenance, Demo
center



[TRENG in Yokohama Office]
TRENGMI Head Office

Development, Design,
Manufacturing,
Maintenance, Demo center

Overseas Expansion

Overseas bases

Pre-sales tests and the establishment of a maintenance system are essential for selling inspection equipment. Toray Engineering has opened demo centers at three overseas locations to expand business in Asia and Europe

Shanghai Demo Center
(Since 2021)



Beijing
Chengdu
Shanghai
Shenzhen

Hsinchu Demo Center
(Since 2020)



Hsinchu
Taipei
Taichung
Tainan

TRENG
South Korea

Bungdang/
Dongtan
Cheonan
Gumi

E.U Demo Center
(Since 2023)



Munich



Conclusion

Conclusion

- ◆ As part of the Toray Group, Toray Engineering (TRENG) Group will collaborate and contribute to creation of innovation for the semiconductor industry which is enabled by integrating the three capabilities: materials, equipment and analysis.
- ◆ Toray Engineering (TRENG) Group positions the semiconductor-related business as one of its key businesses and is working on expanding its operations.
- ◆ TASMIT (TRENGMI) will continue to provide solutions that address the challenges of semiconductor manufacturers as a specialized manufacturer of semiconductor inspection and measurement equipment, contributing to the future growth and expansion of the semiconductor market.
- ◆ We work on business expansion, positioning the key areas for the respective equipment: for TASMIT's electron beam wafer inspection and measurement equipment (NGR) , the logic IC and DRAM fields for AI semiconductors, and for the optical wafer inspection equipment (INSPECTRA), the automotive power semiconductor field.

The descriptions of performance forecast and business plans in this document are based on assumptions such as predictions of future economic conditions at the current time.

This document does not guarantee the future performance of our company.

'TORAY'

Innovation by Chemistry