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Q&A at the Explanation Meeting on the Copper Foil and Engineered Powders

Reference: Material for the Explanation Meeting on the Engineered Materials Business
Note:
PKG = Package substrate
HDI = High density interconnect—a printed circuit board with a high wiring density that serves as a motherboard.

■ Q&A Session

Q. This time, significant changes were seen in the forecasts for the entire engineered materials business. Are there any changes to the target sales of 180 billion yen or the target operating profit of 40 billion yen for 2030 set in the 2022 Medium Term Business Plan?

A. With respect to the vision for 2030 for the Engineered Materials Sector, we are currently preparing the 2025 Medium Term Business Plan. Please wait for us to externally announce specific figures in May. According to the plan we are now working on, we think that we may be able to present slightly higher figures than what you mentioned. We are reviewing the figures not only for the copper foil business but for all business units in the Engineered Materials Sector.

Q. This time, you showed market trends and other figures reviewed based on the results of surveys. How are consumers surveyed, how is information collected, and what is the accuracy of the results of such surveys?

A. We ask the same research agency to conduct surveys every year. We do not use the survey results as they are; instead, we revise them based on information we collect from customers and OEMs. We use data from the research agency merely as reference information. Since it is difficult to conduct an extensive survey, we have accumulated the results of partial surveys, reviewed past survey results, and repeatedly checked the accuracy and points of change. However, there is a significant change this year compared to last year, so we would like to conduct interviews with customers rather than rely only on survey results from a single company, so we will carefully review these figures going forward.

Q. I have a question about your plans to increase production capacities that you announced in the news releases dated January 7. The investment amounts involved in increasing the production capacities for VSP and MicroThin™ were not disclosed. What are the rough investment amounts?

A. We have not made a large investment. Generally, we invest in piping, pumps, and some other equipment. Since both MCF and TCF already have facilities to manufacture these products, our plans do not require a large investment, and the total investment amount is less than one billion yen.

Major Applications and Market Trends of MicroThin™ for Packages (Smartphones)

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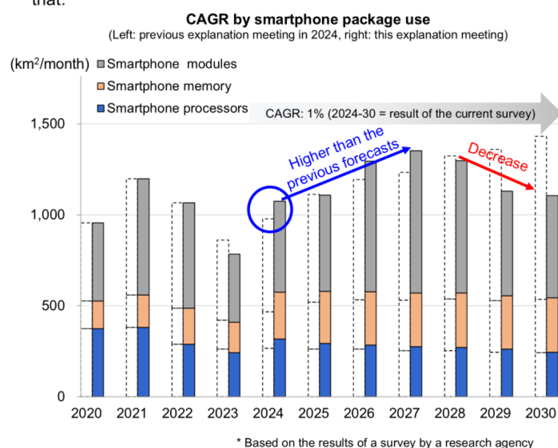
The sales of smartphones have already seen slow growth because the market has matured and for other reasons, and we recently made downward revisions to the forecasts for 2028 and beyond.
Especially, usage in 5G mmWave modules will increase with the spread of multiband models until around 2028, but is expected to decrease after that.



Usage in modules (CAGR: 2%)	• Usage in modules accounts for more than half of the total demand for MicroThin™ for packages for smartphones • The growth of usage in RF modules will be limited due to low unit sales growth though usage per unit will increase. • Usage in 5G mmWave modules will increase with more multiband models until 2027 to 2028, but will decrease after that.
Usage in memory (CAGR: 3%)	• Though only one unit is installed in a single smartphone, usage in memory is expected to grow due to the following possibilities: - Adopting use of MSAP for the center layers of three-layer LPDDR[*1] substrates - Increase in the number of layers in eMCP[*2] substrates (from two layers to three layers)
Usage in processors (CAGR: -4%)	• No change from the previous forecast • Due to the sluggish growth of unit sales of smartphones, usage of MicroThin™ in processers is expected to show a slight decline in the future.

*1 Low-Power Double Data Rate: Memory designed specifically to consume less power based on standards derived from SDRAM.
*2 Embedded Multi Chip Package: Memory package designed to reduce mounting area and power consumption

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Q. Please tell us more about the reason behind your forecast that smartphone PKG usage will decrease in 2028 and beyond. I think you previously explained that the unit consumption per smartphone would continue to increase. I would like to know whether we should care about the risk that it may decrease.

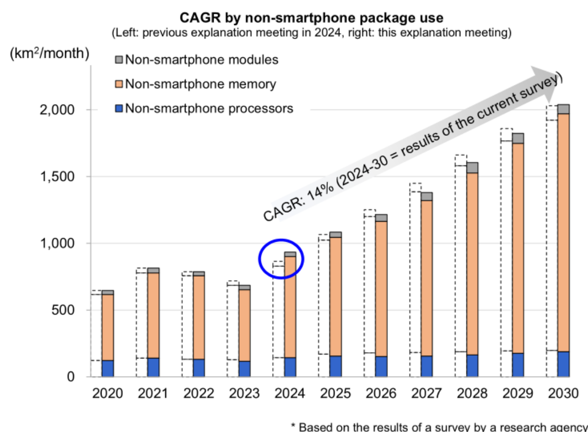
A. The research agency presented its opinion that there is a possibility that a shift to substrates that do not use MicroThin™ may occur in 2028 and beyond. We presented these forecasts based on that opinion, but whether such a forecast becomes reality is to be seen, and we would like you to understand that we must verify this in the future.

Major Applications and Market Trends of MicroThin™ for Packages (Non-smartphones)

We promote the well-being of the world through a spirit of exploration and diverse technologies.

Demand for MicroThin™ in non-smartphones, especially in data centers and other communication infrastructure, is expected to continue to increase in the long-term.
Future growth will be driven mostly by usage in memory, but usage in on-vehicle modules and processors for wearable devices are also expected to increase.

CAGR by non-smartphone package use
(Left: previous explanation meeting in 2024, right: this explanation meeting)



* Based on the results of a survey by a research agency

Usage in modules (CAGR: 13%)	• Introduction of MicroThin™ in image sensors and millimeter-wave radars for ADAS and automatic driving is expected. • Owing to the growth of IoT, usage of MicroThin™ in WiFi and other communication modules for industrial equipment is expected to increase.
Usage in memory (CAGR: 15%)	• There will be a shift toward DDR5 with a high use rate of MSAP, and use in LPDDR is expected to increase. • In data centers, where the largest demand is expected, demand for MicroThin™ in general-purpose servers as well as in high-speed processing for generative AI can be expected to expand. • Though usage in on-vehicle applications account for about 10%, usage in ADAS and automatic driving will also increase.
Usage in processors (CAGR: 4%)	• Usage of MicroThin™ in processers is mainly in FC-BGA. • It is expected that usage in smartwatches, VR headsets, etc., will increase though the scale is not so large.

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Q. I think that the forecast that non-smartphone PKG usage will increase remains unchanged. Please explain the reason behind this forecast again.

A. It is usage in memory that has high growth potential, and usage in memory for servers and data centers will increase. We think that this is largely due to a shift toward higher transfer rate memory, such as DDR3, DDR4, and DDR5. We forecast that changes in usage in modules and usage in processors will be smaller than in memory. As for usage in notebook PCs, use in LPDDR will increase. This memory consists of three layers, and we forecast that use of MSAP in the center layer will gradually increase. In addition, we think that the fields shown in blue on slide 9 will attract extensive attention in the future. As for AI servers, an image of a typical high-end server main board is shown on slide 24, and there are similar boards for mid-range and low-end AI servers and for switches. These are less expensive than boards for high-end AI servers and are outfitted with a very large number of GDDR memory chips around the GPU. On the other hand, HBM is not mounted on the base material. Recently, these low-end and mid-range AI servers have become available, and we are paying close attention to this field because growth in demand for such servers may bring about significant growth in the usage of MicroThin™ for PKG in the future.

Q. According to your explanation, today's generative AI uses HBM, but it may be that DDR memory and other types of memory will begin to be used in low-end models, and accordingly, MSAP and MicroThin™ will come to be used. Have any such movements actually occurred?

A. We have seen some such movements.

Q. The CAGR for MicroThin™ for non-smartphone PKG is lower than that indicated in the material for the explanation meeting held last year. What is the reason behind this change?

A. The CAGR shown in this explanation meeting was calculated based on data for 2024, and the CAGR shown last year was calculated based on data for 2023. Since the sales volume was in the process of recovery during 2023, the CAGR calculated based on the low sales

volume became high. Please understand that these figures were calculated based on data for different periods, but the real growth rates are the same. There is no major difference in our growth rate and market trend forecasts between last year and this year.

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Sales Performance and Forecast for MicroThin™ for Packages

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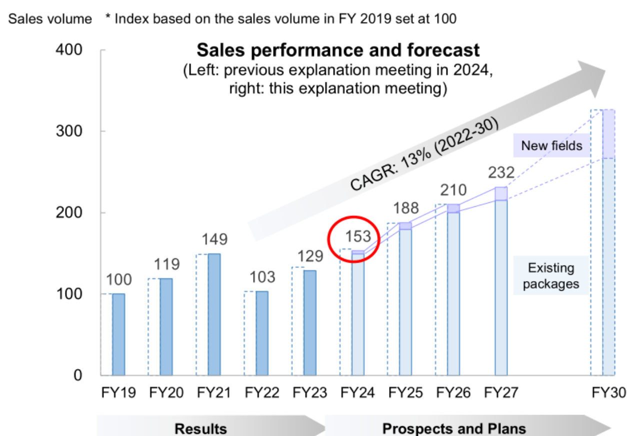
In FY2024, demand recovered to bring us back to a state where we can receive orders on actual demand and has continued to be strong mainly in data centers and other applications. Future growth will be driven mainly by usage in non-smartphones, and we aim to promote usage in a wider range of applications and increase use in new fields.



FY23
- Prolonged inventory adjustment has been gradually coming to an end, and demand has been recovering to a state where we can receive orders based on actual demand.

FY24
- Demand for MicroThin™ especially in memory and modules for non-smartphones expanded and recovered to the level in 2021.

Forecast for FY25 and beyond
- Increase in the number of electronic devices where MicroThin™ is used with the popularization of 5G technologies.
- Expansion in the use of MicroThin™ in servers and installation of other applications

[Applications where the use of MicroThin™ is expected to increase]
- Optical modules
- High-multilayer PCBs for ultra-high-speed infrastructure
- Flexible printed wiring boards for ultra-high-speed communications

Currently, we are working hard on marketing activities and product development in order to create new businesses.

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Q. Could you tell me more specifically about the applications in which use of MicroThin™ for PKG is expected to increase? Also, please explain what optical modules are and what ultra-high-speed infrastructure is.

A. When optical fibers are connected to a server, an optical transceiver is used to convert optical signals into electrical signals. This optical transceiver is an example of an optical module. Such modules are required to support high-speed transmission, and MicroThin™ has been used in multilayer PCBs for 400-Gbps and 800-Gbps high-speed transmission since last year. We have been placing the greatest focus on this field. We expect that use in this field will greatly increase in the future. As for multilayer PCBs for ultra-high-speed infrastructure, we have high expectations that MicroThin™ will come to be used in the internal layers of servers and routers. Some customers have already started evaluating these applications of MicroThin™, and we think that use in this field will also increase in the future. Flexible printed wiring boards for ultra-high-speed communications refer to FPCs produced by MSAP, and we think that demand for MicroThin™ in FPCs as fine-line PCBs may increase. Our marketing activities in this field are not sufficient, and we would like to work harder on market research going forward.

Q. With respect to your strategy of breaking into the field of SAP for PKG, what are the technical issues, costs, and other details of the area that you are not ready to attack and of the area you will attempt to break into going forward? What do you think of the risk that there may be a shift to SAP in cutting-edge fields?

A. We have been making efforts to break into the field for FC-BGA over many years, and while the hurdle to clear is high, we have no intention of giving up. We believe that there is room in the market for us, and it is paramount to continue these efforts while looking for partners with whom we can collaborate. In addition, SAP is a very difficult process, and we are also developing copper foil for SAP to support various manufacturers working on SAP. Surface treatment shapes are the key in copper foil for SAP, and we are also developing technologies

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related to them. At this point, we think that there are still no obvious signs of significant risks caused by a shift to SAP in cutting-edge fields.

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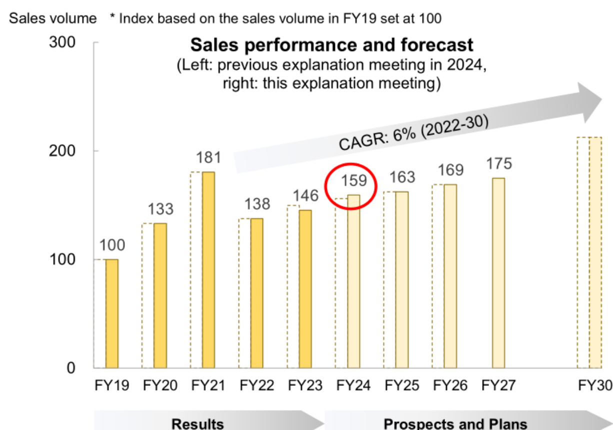
Sales Performance and Forecast for MicroThin™ for HDI[*1]

In FY2024, unit sales of North American brand smartphones remained flat, but demand for MicroThin™ increased slightly. In addition, currently, the use of MSAP in Chinese smartphones, especially in foldable models, has been rapidly increasing.



FY23
- Unit sales of North American brand smartphones remained flat, but demand for MicroThin™ increased slightly.
- Among Chinese smartphones, there's a growing trend of models using MicroThin™, particularly in foldable models.

FY24
- Unit sales of North American brand smartphones remained flat, but demand for MicroThin™ increased slightly.
- MicroThin™ has been introduced in smartphones (foldable models) of an increased total of four Chinese smartphone manufacturers.

Forecast for FY25 and beyond
- Expansion of introduction of MicroThin™ in Chinese high-end models
- Increase in the number of electronic devices where MicroThin™ is used with the popularization of 5G technologies

- Enhance promotion to encourage Chinese smartphone manufacturers (OEMs) to use MSAP.
- Explore the use of MicroThin™ in HDI for non-smartphones (related to AR, VR, etc.)

Foldable smartphones have come to use increasingly thin substrates and require narrower circuits to suppress noise. As a result, opportunities to use MSAP have been rapidly increasing.

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*1: High Density Interconnected PCB

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Q. When MicroThin™ for HDI was launched in 2017, you said that you expected growth, but due to the predominance of the subtractive method, you have found it difficult to reach mid-tier models. What is the reason you cannot forecast expansion, and what is the reason you emphasized the forecast of a rapid increase in use in foldable models in a stronger tone than last year?

A. Use in HDI has definitely been increasing, but line width reduction is the key to further increasing use. Simply considering costs alone, MSAP is more expensive, and it is still common to select the subtractive method whenever it can be used. However, we believe that line widths will be further reduced in the future and MicroThin™ will gradually come to be used in an increasing number of models, though this increase may not be dramatic.

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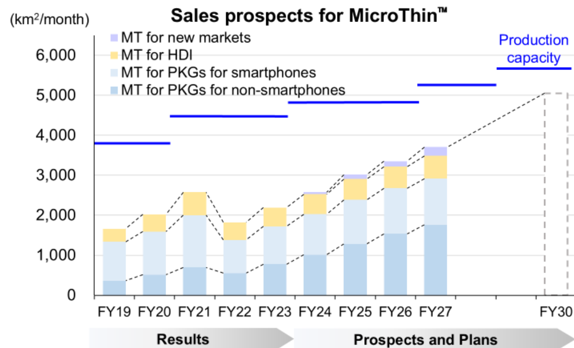
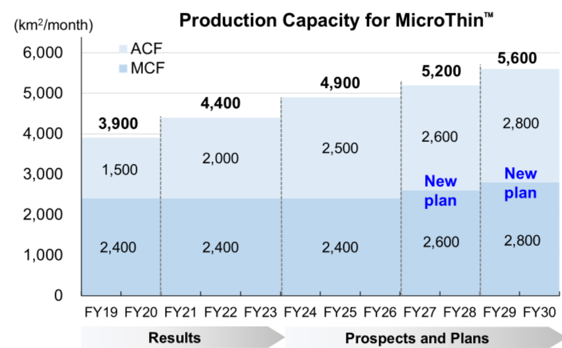
Sales Prospects and Production Capacity for MicroThin™

We promote the well-being of the world through a spirit of exploration and diverse technologies.

The sales of MicroThin™ will continue to increase with the advancement of high-speed communication technology. Our production system has adequate production capacity to accommodate present demand increases, but we have developed long-term production capacity expansion plans based on continuous improvements in productivity toward 2030.



- MicroThin™ for packages
  Demand in non-smartphone fields is expected to expand due to increases in communication capacity and speed, etc.
- MicroThin™ for HDI
  Promotion of use of MSAP to Chinese smartphone manufacturers (It is now used by four Chinese smartphone manufacturers.)
- MicroThin™ for new markets
  We are working to promote the use of MicroThin™ in HSD for high-speed infrastructure, etc.



- For the time being, we will strive to expand the production capacity by improving labor productivity through job satisfaction reforms and improving operation rates, yields and other technology coefficients through DX.
- From FY2027 onward, we will remodel the existing facilities and take other measures to expand the production capacity.

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Q. You explained that you will increase MicroThin™ production capacity over time toward 2030. Please explain the reason behind your decision to invest now even though the current operation rates are not so high.

A. Please allow me to explain our plan to increase the production capacity during this period. Results that exceed forecasts pose concerns for customers, and it is very important for us to be able to meet peak demand for copper foil. Even if the total production seems to be large enough to meet demand for product, being unable to sufficiently supply it to meet increased demand during peak periods would be a major blow to us. We think that it is important to increase production efficiency and have sufficient production capacity in anticipation of demand increases during peak periods.

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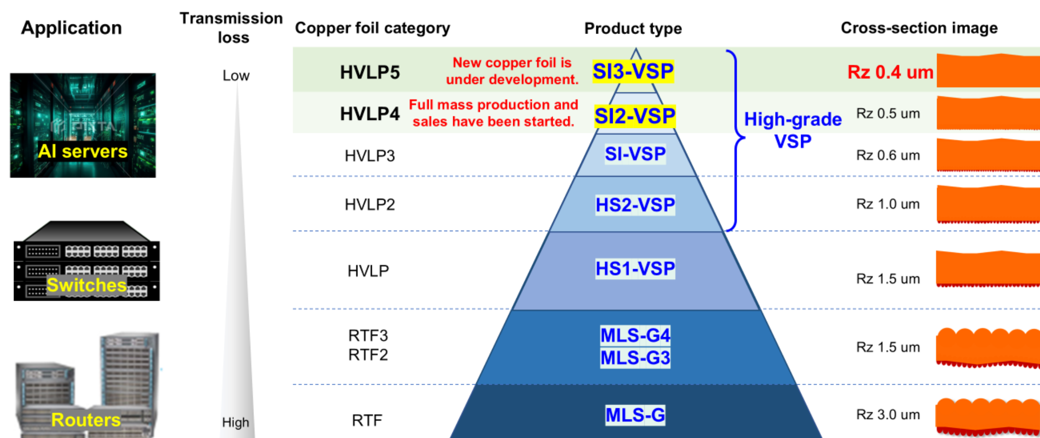
Copper Foil for High-Frequency Communication Infrastructure (VSP™/MLS®-G)

Owing to growing demand for generative AI, etc., there have been increases in data traffic and expanding demand for higher speed communication, and it is our high-grade copper foil that backs up these trends. Recently, we have started the full mass production and sales of copper foil of category HVLP4 (SI2-VSP) and started developing new copper foil of category HVLP5 (SI3-VSP).



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Q. How does VSP contribute to profitability? Improving the product mix by increasing the ratio of VSP means decreasing the ratio of general types of copper foil and does not increase the sales volume of electro-deposited copper foil, but rather results in increased profits due to larger margins. Please explain the risk of increased fixed costs due to increased investment and what increased profit scenarios improving the product mix may result in due to differences in profitability from the perspective of margins.

A. As for replacement by VSP, copper foil positioned higher in the triangle shown on slide 14 has a larger margin and is less volatile. The low volatility is a greater benefit to our business than large margins. General-purpose products compete with many other products and have a higher degree of compatibility. Consequently, our sales often drop, especially when demand decreases. We would like to increase the production of product lines positioned higher in the triangle as much as possible because they have larger margins and help us to operate stably.

Q. The growth of the market indicates that VSP will see great growth. Let me ask you a question about the triangle shown on slide 14. I think that you lead this competitive market from the technological aspect. Please explain the technological competition with other companies.

A. We differentiate ourselves from our competitors with VSP by making the most of our large market share, which is one of our strengths. We do business with a variety of customers, which gives us many opportunities to adapt our products to their resins, which is what at present enables us to differentiate ourselves from our competitors. Consequently, we think that it is very important for us to enhance our capability to develop products and to respond flexibly in this area; to work more closely with customers than before; and to meet their needs. Given the harsh competitive environment, our products would be excluded from the list of candidate materials for customers' next models if there were worries about supply stability when mass production starts. Therefore, we think it is very important for us to

have a solid capability to produce products and adequate production capacity in addition to development capability.

Q. What are the quantities of VSP used in conventional data centers and in AI servers? Is it correct to assume that since higher-end VSP will be used in main boards for high-end servers, the improvements in the product mix will be more significant than the quantities?

A. Allow me to explain about VSP for AI servers. As high-end servers are becoming increasingly fast as new models are released, we have been receiving requests for higher-end VSP. Let me explain this using the triangle shown on slide 14. For next-generation AI servers, there are requests for higher-end copper foil of category HVLP5 rather than the current HVLP3 and HVLP4. In addition, VSP is used more in AI servers than in standard data centers, and it is used more in high-end AI servers than in low-end and mid-range AI servers.

Sales Performance and Forecast for High -Grade VSP™

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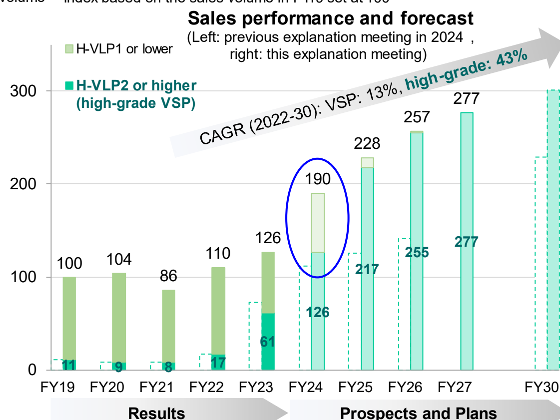
In FY2024, demand for the product in AI servers and other applications in the communication infrastructure market saw great growth, and we could capture demand for high-grade VSP foil (category HVLP2 or higher) for higher speed transmission. From FY2025 onward, further expansion of demand is expected.



Up to FY23
- High-grade products would come to be used in AI servers, high -speed routers, etc., and put into mass production.

FY24
- Demand for high-grade products of HVLP 2 and higher categories mainly in AI servers and high -grade switches rapidly expanded.
- The production capacity for VSP foil in Taiwan was increased (from 420 to 520 tons/month).

Our products' share of the high-grade VSP market is estimated to be 60%.

Forecast for FY25 and beyond
- Plan to expand sales of mainly high -grade products of HVLP 3 and higher categories
- Start production of VSP in Malaysia (60 tons/month)

To steadily address the demand that is growing day by day, we will continue to consider further increasing production in a timely manner.

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Q. I have a question about slide 15 about VSP. In the explanation meeting on the interim results, you said that you would not need to increase your production capacity. I would like to know why this time you have changed your thinking. The graph shows that you forecast sales of high-grade VSP to grow significantly in 2025 and that the growth thereafter will not be so great. What is the reason behind this forecast?

A. The current situation is that new models of AI servers are being released from fiscal year 2024 to fiscal year 2025. Each new AI server model is higher-end, and the quantity of high-end VSP used in such servers has been increasing rapidly. We forecast that growth from fiscal year 2026 to 2027 will be small, but this is very difficult to forecast. Actually, we think that larger growth may occur during this period. It is difficult to forecast conditions two to three years hence, and we have adequate capacity to accommodate demand even if growth greater than the current forecast occurs. We are ready to accommodate whatever demand occurs.

Q. Is my understanding correct that you can accommodate demand for about 277 indicated as an index on slide 15 by increasing the production capacity for VSP as announced in the news release dated January 7?

A. Yes, that is correct.

[New Product] (2) Use of Silver-Coated Copper Powders in Solar Cells

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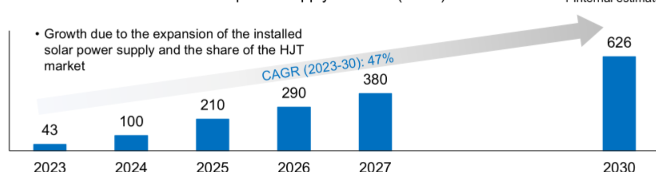
In response to trends toward decarbonization and increases in the price of silver, silver-coated copper powders have been used as a replacement for silver powders for heterojunction (HJT) silicon solar cells. We contribute to realizing a decarbonized society by providing metal powders that show electric resistance equivalent to silver at lower prices than silver.

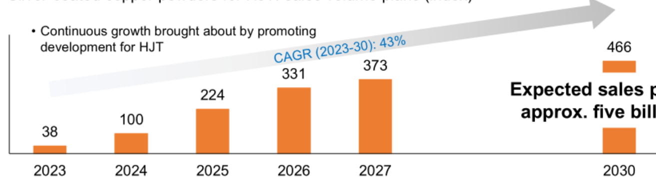
HJT market trends and sales plans for silver-coated copper powders for HJT

■ HJT market forecast: amount of power supply installed (index)*1

*1 Internal estimates

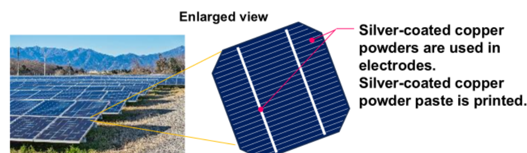


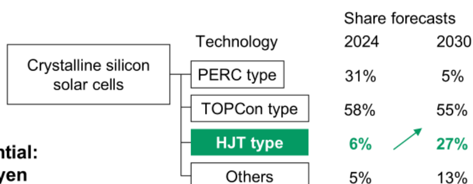
■ Silver-coated copper powders for HJT: sales volume plans (index)



Expected sales potential: approx. five billion yen

HJT





	Technology	Share forecasts 2024	2030
Crystalline silicon solar cells	PERC type	31%	5%
	TOPCon type	58%	55%
	HJT type	6%	27%
	Others	5%	13%

• PERC type: PERC cells were previously mainstream solar cells, but they are not efficient and their share has been sharply decreasing.

• TOPCon type: highly efficient type
Since TOPCon cells can be produced by using the manufacturing process for PERC cells, they will continue to remain as mainstream solar cells.

• HJT type: highly efficient type
HJT cells are solar cells with higher performance than TOPCon cells and are **expected to expand their share as secondary mainstream solar cells.**

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Q. Don't your silver powders and silver-coated copper powders cannibalize each other? There is no problem if you can take market share from competitors. How do you differentiate these products?

A. These products are differentiated from each other and we do not think our products cannibalize each other. Our silver powder business is based on a product mix of small amounts of a variety of products and does not handle silver powders for solar cells. On the other hand, with silver-coated copper powders, we aim to promote their use in heterojunction (HJT) silicon solar cells as a replacement for silver powders. Therefore, we think that our silver powders and silver-coated copper powders do not cannibalize each other at all.

Results and Prospects for Protective Coating Materials for Semiconductor Production Equipment

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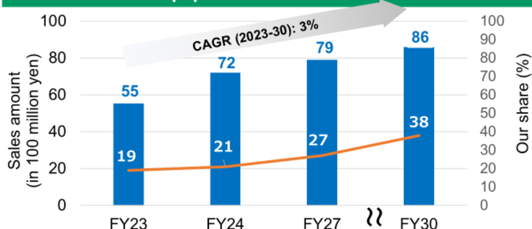
Protective coating materials for semiconductor production equipment market forecasts*1



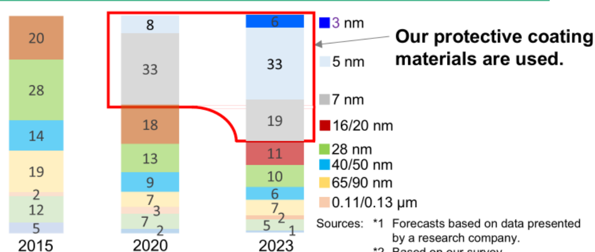
Major applications: advanced logic and dry etching processes

With the miniaturization of semiconductor process nodes, YF_3 and YOF*1, which are highly resistant to plasma, are gaining attention as coating materials for dry etching equipment*2.

With higher integration of semiconductor devices, demand for YF_3 and YOF has been expanding.

*1: Yttrium oxyfluoride
*2: Equipment used in a semiconductor production process to process unnecessary parts in semiconductors by using reactive gas or plasma

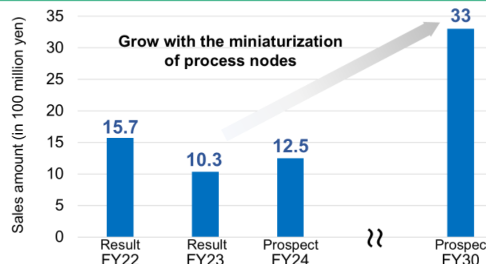
Semiconductor process node trends*2



Our protective coating materials are used.

Sources: *1 Forecasts based on data presented by a research company.
*2 Based on our survey

Sales results and prospects



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Q. Please tell me more about Nippon Yttrium. What is the percentage of sales of protective coating materials for semiconductor production equipment out of total sales? Also, please explain the competitive climate you face as well as their strengths.

A. Sales of protective coating materials for semiconductor production equipment account for nearly half of total sales at present. We aim to increase sales of these materials to a level much higher than half of total sales toward 2030. In the fields in which our materials are used, we have the largest market share. Our strengths are technologies, our track record, and the intellectual property that we have accumulated over the years through coordination with semiconductor production equipment manufacturers and coating manufacturers.