

# Semiconductor Metrology And Inspection Equipment - Market Share Analysis, Industry Trends & Statistics, Growth Forecasts (2024 - 2029)

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## Abstracts

The Semiconductor Metrology And Inspection Equipment Market size is estimated at USD 10.47 billion in 2024, and is expected to reach USD 13.49 billion by 2029, growing at a CAGR of 5.20% during the forecast period (2024-2029).

### Key Highlights

Semiconductor metrology and inspection play a crucial role in the management of the semiconductor manufacturing process. The manufacturing process of semiconductor wafers involves approximately 400 to 600 steps, which can be completed within one to two months. Any shortcomings detected early on in the process can result in the wastage of all the efforts put into the subsequent steps. Metrology and inspection procedures are implemented at critical junctures of the semiconductor manufacturing process to guarantee a specific yield.

Hamamatsu emphasizes the importance of achieving high production yields in order to satisfy the current market requirements for semiconductor wafers. Metrology and inspection play a vital role in the extensive semiconductor manufacturing process to guarantee optimal quality and yield. It is crucial to efficiently characterize and measure thin films, line widths, pattern flaws, and other possible defects to promptly address any issues and minimize expensive downtime. In semiconductor inspection, the utilization of higher radiance UV light sources is essential to reduce inspection durations and improve the precision of evaluating patterns and thin films on wafers.

Semiconductor metrology plays a crucial role in the semiconductor manufacturing process by offering detailed information on the physical properties of the wafer and

facilitating adjustments to the production process to meet specific parameters. This ensures the production of reliable semiconductor devices of high quality while minimizing wastage, thus maintaining the economic viability and sustainability of the manufacturing process.

The semiconductor sector is continuously aiming for more compact integrated circuits that provide enhanced performance and speeds, resulting in progress in manufacturing techniques. Maintaining accurate oversight of procedures has emerged as a vital factor in manufacturing. With firms like TSMC, Infineon, Qualcomm, and Intel expanding their chip production investments, the demand for metrology equipment and services is expected to rise in the back-end process.

The demand for cost-effective semiconductor materials is being fueled by smartphones, consumer electronics, and automotive applications. These advancements are inspiring innovations like wireless technologies (5G) and artificial intelligence. Additionally, the semiconductor industry is expected to invest in IoT devices to achieve smart products as the trend of adoption of IoT devices continues to grow. The utilization of smart devices is on the rise and is anticipated to increase further with the global expansion of 5G connections. As per the GSMA, it is estimated that 5G mobile broadband connections will reach 1,100 million (1.1 billion) by the year 2025, while the 5G deployment is expected to encompass 34% of the global population by the same year.

In order to gain a strong foothold in the market, vendors are actively engaging in strategic partnerships to create advanced multifunction inspection platforms. Recently, k-Space Associates introduced its latest thin film metrology tool, the kSA XRF (X-ray fluorescence), in January 2023. This tool is specifically designed to accurately measure the thickness of films that cannot be reliably measured using optical methods. Its effectiveness has been demonstrated in measuring semiconductor and dielectric layers on various substrates such as glass panels, wafers, and susceptors. These applications are particularly relevant in the fields of solar energy, power generation, and other thin-film technologies.

However, the market's growth during the forecast period is expected to be hindered efficiently by factors such as high setup costs and a lack of expertise in handling metrology systems. In order to overcome these challenges, service-oriented players are offering on-demand metrology services, providing a professional extension in the specialized field of precision dimensional metrology.

Furthermore, the growth of the market studied is also challenged by macroeconomic

factors, such as the US-China trade dispute. The United States has imposed several sanctions on China, preventing the country from accessing advanced semiconductor equipment. Since China plays a significant role in the market's supply chain, these trends negatively impact the growth of the market studied.

## Semiconductor Metrology and Inspection Equipment Market Market Trends

### Wafer Inspection to Witness Significant Growth

As the design of semiconductor devices progresses toward smaller nodes, the challenge of increasing manufacturing yields becomes more pronounced. The introduction of smaller nodes and intricate 3D architectures leads to additional steps and heightened complexity in the design phase. With hundreds of steps in the process, any defect or electrical fault at any stage can impede overall production efficiency. Given the significance of time-to-market and time-to-yield in determining the success of a new semiconductor design, the utilization of wafer inspection tools is crucial to ensure optimal performance at each stage.

The growing demand for wafer inspection is expected to be fueled by the increasing need for three-dimensional integrated circuits in the upcoming years. These circuits are widely used in small semiconductor devices such as memory cards, smartphones, smart cards, and various computing devices. Three-dimensional circuits are gaining popularity in numerous space-constrained applications like portable consumer electronics, sensors, MEMS, and industrial products, as they enhance overall product performance in terms of speed, durability, low power consumption, and lightweight memory.

The increasing availability of cost-effective cloud computing solutions has led to a rise in demand for logic devices such as microprocessors and digital signal processors. This is primarily driven by the growing use of server and data center systems in various industries. Furthermore, the proliferation of IoT-enabled devices has resulted in a higher usage of microprocessors. Thin wafers are increasingly utilized in these devices to enhance temperature control and optimize performance. These factors collectively contribute to the expansion of the wafer inspection market.

The widespread adoption of 300 mm wafers in LED applications is also a key driver for the global growth of the thin wafer inspection market. These wafers offer higher yields, enabling LED manufacturers to achieve economies of scale and enhance profitability. As the number of operational 300 mm wafer production facilities continues to increase,

the demand for 300 mm wafers is expected to witness a significant surge.

According to the year-end analysis conducted by the SEMI Silicon Manufacturers Group (SMG), global silicon wafer shipments experienced a decline of 14.3% in 2023, reaching 12,602 million square inches. Additionally, wafer revenue contracted by 10.9% to USD 12.3 billion during the same period. However, there is optimism for the future as the momentum from the 2024 rebound is expected to continue until 2026. This positive trend is anticipated to result in new record-high wafer shipments, driven by the increasing demand for silicon in various sectors such as artificial intelligence (AI), high-performance computing (HPC), 5G, automotive, and industrial applications.

The introduction of 5G and increasing investments in the 5G adoption activities are further expected to drive the demand for wafers and wafer inspection tools in the chip industry. According to the Ericsson Mobility Report 2022, North America is projected to be the global leader in 5G subscription penetration over the next five years. It is anticipated that 90% of subscriptions in the region will be 5G by 2027. Additionally, the report predicts that by 2027, 82% of subscriptions in Western Europe, 80% in the Gulf Cooperation Council, and 74% in North-East Asia will be 5G. In India, where 5G deployments have already begun, it is expected that 5G will account for approximately 40% of all subscriptions by 2027. Globally, 5G is expected to represent nearly half of all subscriptions by 2027, reaching a total of 4.4 billion subscriptions.

The IT, IoT, renewable, EVs, telecom, and other sectors are poised for substantial growth in the upcoming years. Additionally, these sectors heavily rely on wireless technology. The utilization of ICs and semiconductors enables the application of wireless technology. As a result, the wafer inspection market is presented with a multitude of opportunities. Prominent companies in the semiconductor industry, such as Infineon, TSMC, ST, Micron, Intel, Samsung, and others, are making significant investments in chip production activities, which can greatly contribute to the market's increased demand.

### Asia-Pacific to Dominate the Market

Asia-Pacific is one of the prominent regions in the semiconductor industry in terms of manufacturing and consumption. According to SIA, Asia-Pacific is the largest regional semiconductor market, and China accounts for the most significant share in the region. The significant advancements in the electronics sector, combined with the growing

reliance on electronic gadgets like televisions and smartphones, are anticipated to boost the requirement for wafer inspection in the region. Furthermore, companies situated in this area are prepared to allocate funds toward the utilization of wafer inspections.

Many regional companies are entering collaborations and partnerships in the semiconductor metrology/inspection equipment market. For instance, Shenzhen JT Automation Equipment, a chip production tool manufacturer in China, announced a legally binding five-year (2021-2025) memorandum of understanding with Huawei's HiSilicon Technologies, China's largest chip developer. Both firms aim to extend their partnership for the development of semiconductor packaging tools, creating a self-sufficient and regulated industry.

The regional government's initiatives to develop the local semiconductor industry also create a favorable outlook for the growth of the market studied. For instance, China's State Council's "National Integrated Circuit Industry Development Guidelines" aim to make the country a global leader in all segments of the semiconductor industry by 2030. Additionally, the Made in China 2025 initiative maintains achieving knowledge concerning advanced semiconductor manufacturing as a vital component of China's future economy. It is highly focused on building a strategy for strong manufacturing nationwide.

For instance, in July 2023, Hua Hong Semiconductor, the second-largest chip foundry in China, revealed its plan to raise CNY 21.2 billion (USD 2.95 billion). This strategic move is in line with China's determined efforts to attain self-sufficiency in semiconductor supply and overcome the technology blockade imposed by the United States. In contrast to the initial phase that primarily concentrated on chip production, the China IC Fund II has made significant investments in domestic semiconductor manufacturing, equipment, and associated materials to overcome the existing obstacles.

South Korea plans to enact its own version of the "Chips Act" in order to bolster its semiconductor industry amid the ongoing tensions between the United States and China. These tensions have created a demand for services such as assembly and packaging, making it crucial for South Korea to support its semiconductor industry. In March 2023, the country's parliament passed legislation to strengthen its dominant semiconductor industry by providing tax benefits to businesses and encouraging investments. Such government initiatives are expected to boost the opportunities for the backend equipment markers, such as metrology and inspection, to enhance their presence in the region.

In March 2023, Samsung, the Korean electronics giant, announced its intention to invest KRW 300 trillion (equivalent to USD 230.8 billion) over the next two decades in support of the South Korean government's initiative to establish a massive semiconductor hub spanning 7.1 million square meters in Namsayup, Yongin, by 2042. This strategic move is designed to bolster Korea's position in the increasingly competitive global semiconductor market, consequently driving up the demand for backend equipment such as wafer testing, ATP, and other equipment.

Additionally, numerous enterprises are focusing on expanding their activities to boost profits in different sectors. The New Taipei City government announced that ASML Holding NV, a Dutch company that specializes in semiconductor equipment, will commence the construction of its new facility in the Linkou District of New Taipei City in the fiscal year 2024. Moreover, Tokyo Electron Ltd, a Japanese electronics and semiconductor corporation, is making progress in establishing its operations hub in the Southern Taiwan Science Park in Tainan, with plans to complete it by the end of 2024. These investments have the potential to create opportunities in the metrology and inspection market.

## Semiconductor Metrology and Inspection Equipment Industry Overview

The semiconductor metrology and inspection equipment market comprises prominent players such as Applied Materials Inc., Nikon Metrology NV, and KLA Corporation. These firms have continuously expanded their operation scales by focusing on market expansions and acquisitions. Acquisition activities effectively set the ball rolling regarding the overall growth of the market studied. Large companies have also been expending significant resources on R&D operations to protect their market position and drive innovation in the market studied. Overall, the degree of competition remains high, primarily driven by the strong presence of prominent players involved in the market studied.

In December 2023, Hitachi High-Tech Corporation unveiled the DI4600, the latest innovation in its Dark Field Wafer Defect Inspection System. This state-of-the-art tool is specifically designed to inspect particles and defects on patterned wafers in semiconductor production lines. With its dedicated server, the DI4600 offers enhanced data processing power, enabling improved detection capabilities for particles and defects. By incorporating this advanced system into their production lines, semiconductor manufacturers can ensure highly accurate defect monitoring, resulting in

increased yields and cost efficiency as production volumes continue to rise.

In July 2023, Applied Materials Inc. and the Fraunhofer Institute for Photonic Microsystems IPMS announced a pioneering collaboration to create the premier technology center for semiconductor metrology and process analysis in Europe. This innovative hub is designed to provide state-of-the-art metrology systems to accelerate semiconductor research and enhance development efforts with chipmakers and ecosystem partners across Europe, with a specific focus on ICAPS (Internet of Things, communications, automotive, power, and sensors) market segments.

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