



# TOP 3 HARDWARE TRENDS TO WATCH IN SEMICONDUCTOR MANUFACTURING EQUIPMENT

Recent semiconductor chip shortages show how important manufacturing infrastructure is to the semiconductor industry and to the world. These are the next manufacturing hardware trends to prepare for.

By Daniel Walldorf, strategy and business development manager

Much of the promise of Industry 4.0 focuses on the production efficiency and optimization that can be gained from unlocking insights hidden in manufacturing data. It is a story driven by IT and computing and the cloud, and one that rarely mentions the hardware advancements that make these technology breakthroughs possible. But there are some important hardware trends worth paying attention to, especially for semiconductor manufacturing equipment original equipment manufacturers (OEMs).

Chief among them? The global push to increase semiconductor manufacturing equipment production and semiconductor capacity and maximize hardware capabilities to optimize machine equipment and performance. After all, an OEM's semiconductor manufacturing capabilities are only as strong as the equipment making the chips. And it begins with smarter equipment design.

# 84%

of equipment spending driven by forecasted capacity increases at 167 fabs and production lines

## CHANGE IN FABRICATION EQUIPMENT SPENDING

**+141%** EUROPE/ MIDDLE EAST

**+47%** TAIWAN

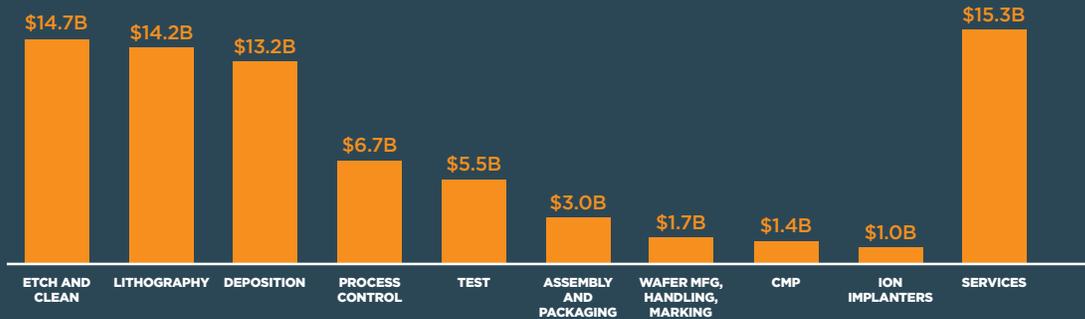
**-5.5%** KOREA

**-11.7%** CHINA

Source: World Fab Forecast Report, SEMI, Sept. 2022

## MARKET FOR SEMICONDUCTOR MANUFACTURING EQUIPMENT BY MACHINE TYPE

2019 — Market size (USD billions)

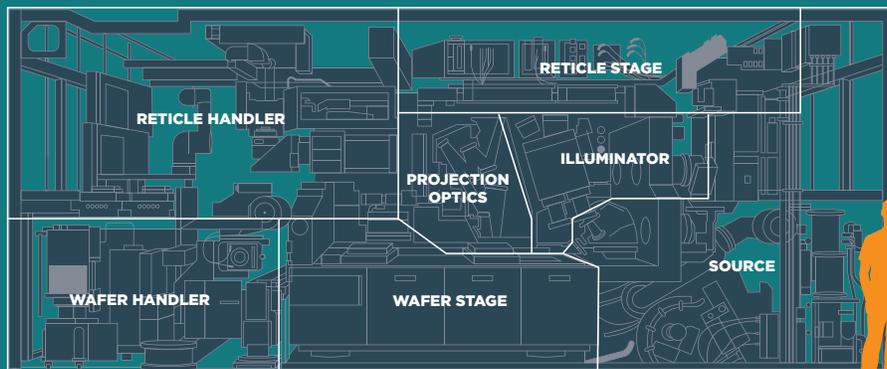


Source: *The Semiconductor Supply Chain: Assessing National Competitiveness*, Center for Security and Emerging Technology, Jan. 2021

## TREND 1

### Connectivity Innovation Reduces Assembly Time and Errors for Semiconductor Manufacturing Equipment

While other industrial manufacturing sectors are in the midst of pivoting from static assembly lines to modular, task-based stations, the semiconductor equipment industry has long taken a modular approach to manufacturing. It is just more practical. Simply put: The machines that make semiconductors are enormous — the newest extreme ultraviolet (EUV) lithography machines, for example, are the size of a bus. Shipping these highly sensitive, complex pieces of equipment in one enormous package is a recipe for disaster. The best way to guarantee the product quality and precision that semiconductor customers require is to ship the machine in modules that are assembled in the fab. OEMs have been relying on this method for years.



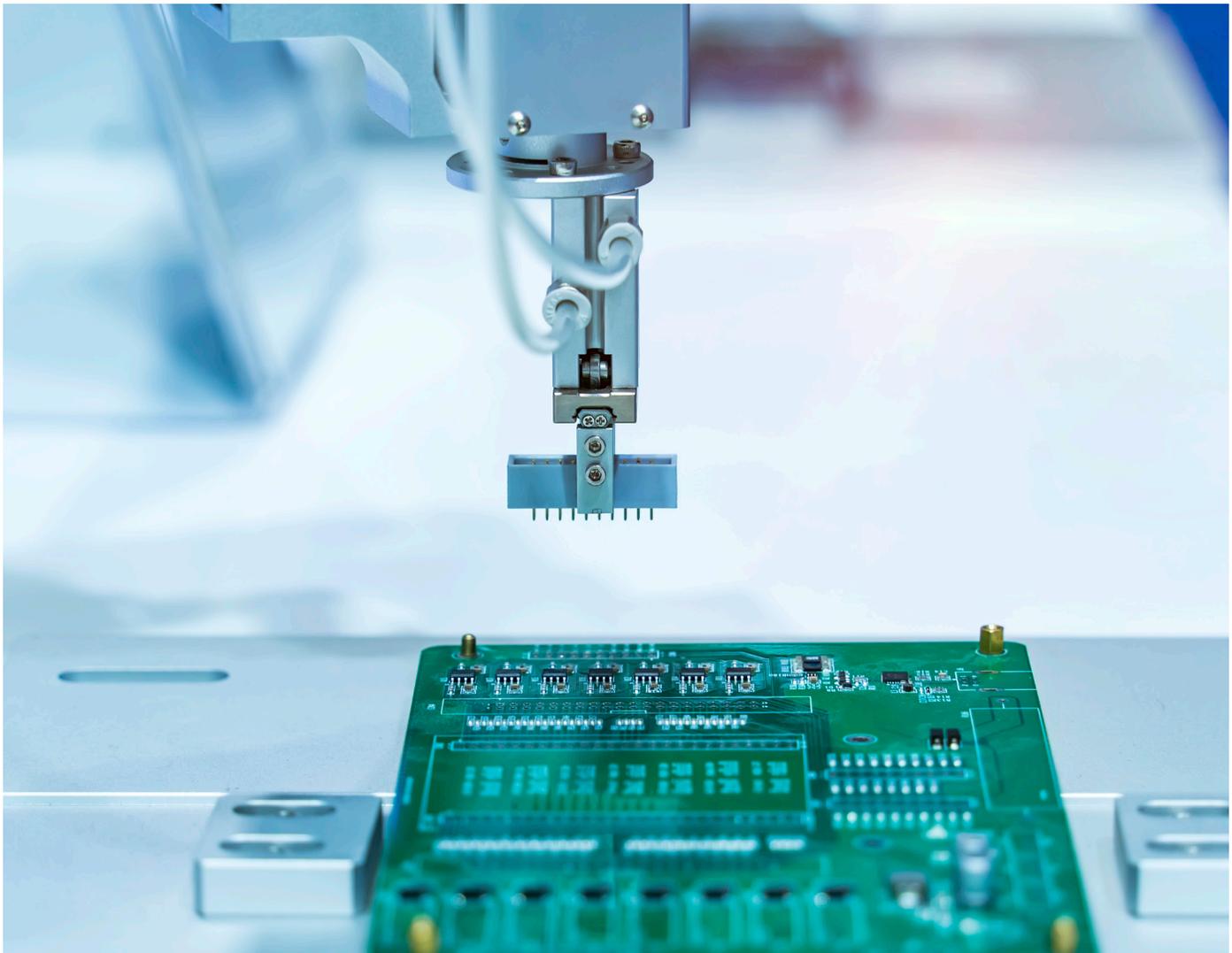
#### SPECIAL DELIVERY

The newest EUV lithography machine prints semiconductor chips with atomic-level precision, but the machine itself is the size of a city bus. The seven modules that make up the machine are shipped separately and assembled on-site in the fab.

What is the trend then? Ease.

Manufacturers no longer need to connect hundreds of wires to the different modules that join a semiconductor machine together, instead OEMs are putting more effort into designing machines in a way that require just a few electrical connections with complete harnesses. This innovation not only saves valuable time during machine assembly; it also reduces errors. And as semiconductor machines continue to grow larger — and the modules that make them up multiply — the reduced error and assembly time will become critical.

Another benefit of this approach? By bringing greater speed to the assembly process, semiconductor OEMs can bring new machines online faster and with fewer errors. More semiconductor machines means more production capacity — a critical culprit behind recent chip shortages.



## TREND 2

### Industry 4.0 Drives Need for Greater Contact Density in Semiconductor Manufacturing Equipment

There are few sectors in the industrial market that have embraced the principles of Industry 4.0 as fully as semiconductor equipment manufacturers. While others struggle to bring basic automation into their production facilities, semiconductor equipment OEMs are already debating the merits of digital twins.

This is an industry that has long relied on incredible levels of rigor in the production process. After all, developing a machine that can conduct metrological evaluation at the atomic level requires impeccable precision. Every part of manufacturing this highly complex, specialized equipment is tested, tweaked, and optimized in real time. To capture those field-level insights, the machine components must be capable of high-speed data transmission. Many OEMs are in the process of transitioning their 100Mbps networks to 1Gbps Ethernet.

But these new high-speed machines are also bigger, as previously noted. For example, the latest equipment from manufacturer ASML has four times the volume of the previous generation. Larger machines require more components and connections, increasing the complexity inside. For device OEMs, that means shrinking the size of components and parts to deliver more contact density.

Case in point: Components such as the classic RJ45 Ethernet connector are being replaced with the Mini I/O industrial IP20 Ethernet connector that delivers high-speed performance in an envelope that is one-fourth the size. And the versatile MicroSpeed connector delivers blazing 25Gbps data rates in a form factor of just 5mm.



## TREND 3

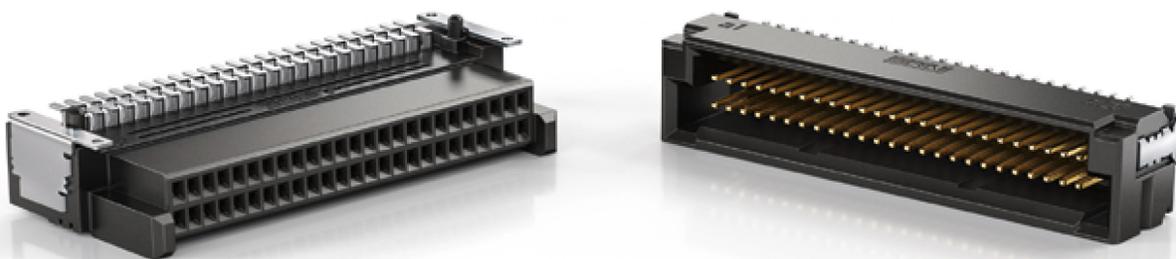
### Influenced by Data Centers, Semiconductor Manufacturing Equipment OEMs Pivot to Small-Pitch Backplane Connectors

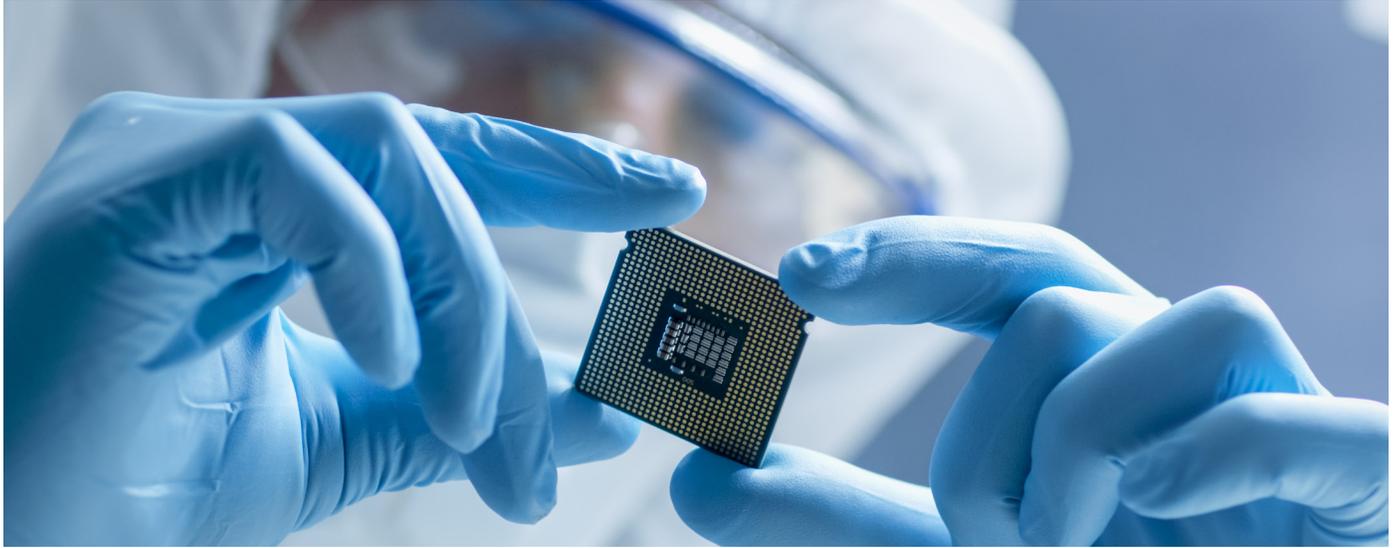
Manufacturing semiconductor equipment is complex, with hundreds of steps across a multi-layered international supply chain that delivers perfect, highly precise parts at just the right time. In this environment, it is no surprise that semiconductor OEMs seek as much stability as possible. Quality and reliability are tantamount.

For that reason, semiconductor equipment manufacturers typically specify machines with mature product families, using components and parts that have proven themselves in the marketplace. Most of these tried and true product families have their origins in computer or data centers. However, that industry is undergoing a revolution of its own, as innovations in edge computing and AI drive demand for new high-speed and often highly integrated connectivity. Those innovations are just starting to show up in the industrial market.

At the same time, new standards for industrial controls have matured in the last decades to meet the high reliability standards of semiconductor manufacturing equipment OEMs. Especially in backplane and board-to-board connectivity, OEMs are moving from 2.54mm pitch backplane connectors to the 1.27mm pitch connectors that are mainstream in industrial applications today.

#### INDUSTRIAL 0.8MM FINE PITCH BOARD CONNECTOR FROM TE





## New Focus on Semiconductor Manufacturing Equipment Is an Opportunity

Although the field of semiconductor manufacturing equipment is often hush-hush, with OEMs guarding their intellectual property closely, the looming challenges and opportunities of semiconductor chip innovation and manufacturing technology challenges are trends that affect all manufacturers. How can OEMs keep their competitive edge while adapting to (1) the evolving technology expectations and needs of the market, and (2) the realities of global supply chain challenges?

### We are here to help.

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