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Advanced Packaging: Integration into SMT production

SMDs and dies on a single production line

In the age of advanced packaging and highly integrated SiP modules, the traditional dividing lines between semiconductor back-end manufacturing and SMT processes are increasingly blurring. ASMPT has platforms in its portfolio that take the production spectrum to this new level. In addition to the DEK Galaxy solder paste printer, these include the highly innovative SIPLACE TX micron placement platform and, above all, the groundbreaking SIPLACE CA2 hybrid placement platform, which sets completely new standards in the industry.

Before advanced packaging came along, the division of roles in electronics production was clear: SMT manufacturing was designed for high cycle rates and maximum speed, while precision was the top priority in semiconductor production. After all, the contact points on a die are many times smaller than classic SMD solder joints, and the distances between components were more generous. Only through back-end processes was it possible to establish a reliable connection between the fine structures of the die and the contact surfaces scaled to SMD sizes — an essential prerequisite for integrating the processing of dies into high-speed SMT production.

In the traditionally compartmentalized world of electronics, a new function often meant a new chip — an extremely expensive and lengthy development process. Today, things are more efficient: instead of developing everything from scratch, proven chips get combined to form a powerful module. Supplemented by standard SMDs, this results in system-in-package modules (SiP) in which dies and SMDs work together in a single housing. This is a clear example of how the boundaries between semiconductor and SMT manufacturing are increasingly disappearing.

However, SiP modules must not only function but also be able to be manufactured economically in large quantities. So what could be more obvious than integrating die processing directly into the SMT line? For a long time, this approach failed due to technical realities: conventional placement machines and solder paste printers were simply too imprecise, and classic die bonders were too slow for the cycle rates of modern SMT lines.

ASMPT recognized early on that new solutions were needed. As a technology pioneer and market leader with a strong presence in both worlds — semiconductors and SMT — the company succeeded in overcoming these process limitations. The result: platforms that seamlessly combine both technologies for the first time.

DEK Galaxy: Advanced packaging meets high-precision solder paste printing

One example of the successful integration of advanced packaging into existing SMT processes is the DEK Galaxy solder paste printer. The platform combines high performance with remarkable flexibility and allows fast product changes while maintaining stable processes. With a wet-printing accuracy of > 2.0 cpk at ±17.5 µm (±6 sigma), the DEK Galaxy is suitable for wafer e-bumping using solder paste printing as well as for the pre-assembly of highly complex SMT assemblies. The system also reliably masters direct ball attachment on wafers and substrates with ball diameters down to 0.2 mm, making it the ideal central component for integrated hybrid production lines.

The DEK Galaxy offers a wide range of options that make it particularly suitable for advanced packaging. By using singulated tooling systems such as DEK Virtual Panel Tooling or MASS, multiple individual substrates can be processed in a single print cycle. For substrate and wafer processing, the platform supports JEDEC-compliant wafer chucks and carrier standards. Grid-Lok® and customizable tools enable optimal PCB support, even with high component density. The machine is also ideally suited for special applications such as 3D stencil printing with AgS paste in power electronics packaging.

Despite its high precision and flexibility, the DEK Galaxy remains fast: Linear motors and the newly developed DEK Typhoon high-speed stencil cleaning system ensure a core cycle time of just seven seconds for unrestricted cycle time capability even in modern high-speed lines.

SIPLACE TX micron: Maximum precision for SiP and high-density applications

With the SIPLACE TX micron, ASMPT presents a placement platform that has been specially developed for demanding advanced packaging and high-density applications. The machine overcomes previous limitations on placement accuracy and speed with its

combination of temperature-stable glass-ceramic scales, precise registration mark detection, high-resolution image processing systems, and vacuum tooling. The result: placement accuracy of up to ±10 µm combined with a maximum throughput of up to 93,000 components per hour.

The SIPLACE TX micron is optimized for processing even the most sensitive components. The fully programmable placement process includes features such as touchless pickup, zero-force placement, and complete traceability — from tape to end product. A high-resolution vision system detects the smallest cracks or damage at full speed and sorts out defective components at an early stage. For use under controlled conditions, the platform is certified according to cleanroom class 7 (DIN EN ISO 14644-1) and SEMI S2/S8.

The SIPLACE TX micron also demonstrates its strengths in everyday production: A high-resolution PCB camera, the multi-purpose dual conveyor with flexible transport options and the non-stop feeding of components from JEDEC trays via the SIPLACE Tray Unit ensure maximum yield. The platform is complemented by powerful software that ensures precise process control and consistently high placement quality — even with high throughputs and varying product requirements.

SIPLACE CA2: Hybrid high-speed platform for dies and SMDs

The SIPLACE CA2 marks a real quantum leap in the field of advanced packaging. With this revolutionary hybrid platform, ASMPT once again proves its market and technology leadership. The SIPLACE CA2 perfectly complements the SIPLACE TX micron and, as a combination of SMT placement machine and die bonder, brings maximum flexibility to the line. In a single operation, it processes SMDs fed via changeover tables and feeders or conveyors and dies directly from the sawed wafer. This allows the entire die bonding process to be integrated directly into the SMT line. Time-consuming external process steps such as die taping are no longer necessary, nor is the use of specialized individual machines. This not only saves space and costs but also significantly reduces setup effort, refill times, and tape waste. In addition, direct processing from the wafer is much gentler on sensitive dies and minimizes the risk of component damage — a clear advantage over classic tape feeding.

A changeover system allows up to 50 different wafers to be handled for flip chip and die attach assemblies, with a wafer swap taking just 13 seconds. At the same time, a wafer chuck, a flux dipping unit (LDU), and ten 8-mm tape and reel feeder tracks can be operated in parallel — for maximum flexibility with high cycle rates. A novelty in semiconductor processing: trace data for each individual die enables complete traceability from the wafer to the placement position on the printed circuit board — a significant contribution to quality assurance and process control.

The integration of die processing into the SIPLACE CA2 required a completely new development, as conventional semiconductor manufacturing processes would have significantly slowed down the throughput of an SMD line. The background: Dies are delivered presawed on carrier films (wafer film frames), but still need to be separated. To do this, the die is slightly lifted using a cutting needle that pierces the carrier film from below while the film is simultaneously moved in the opposite direction using negative pressure. Due to the high fragility of the dies, depending on their geometry and material properties, this separation process can only be accelerated to a limited extent for technical reasons and is therefore the time-determining process in volume processing. The solution: an intelligent buffer system that works on the principle of a collect-and-place placement head. While the dies are gently separated and temporarily stored, the placement process continues uninterrupted. By parallelizing die removal and placement, the SIPLACE CA2 achieves a throughput of up to 54,000 dies and 76,000 SMDs per hour — with a placement accuracy of up to ±10 µm @ 3 σ. This makes the hybrid platform ideally suited for modern high-speed lines.

System-in-package: Key technology for new markets

Whether smart devices, 5G communication, autonomous driving, or artificial intelligence — all these technologies require highly integrated and powerful yet compact electronic systems. This is only possible through consistent miniaturization coupled with increased functional density at the component level.

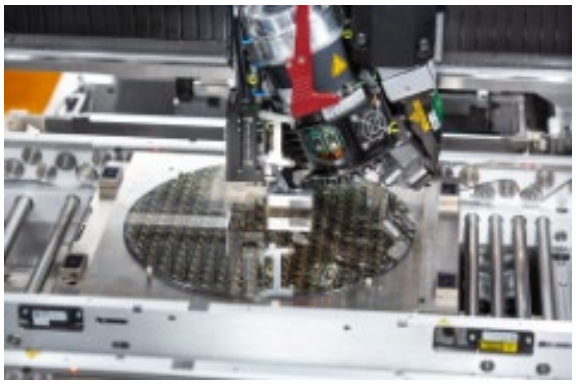
System-in-package (SiP) technology plays a key role in this. It allows different chips — such as logic, memory, RF, sensors, or power electronics — to be integrated together with passive SMD components in a single device package. This results in highly functional modules with short signal paths, reduced space requirements, and improved electrical performance.

For manufacturing operations, this means a paradigm shift because SiP modules require the seamless integration of semiconductor processes such as die bonding and wafer processing with typical SMT processes such as solder paste printing and SMD assembly. As a result, the range of SMD manufacturing applications is significantly expanded into areas that were previously reserved for semiconductor-only lines.

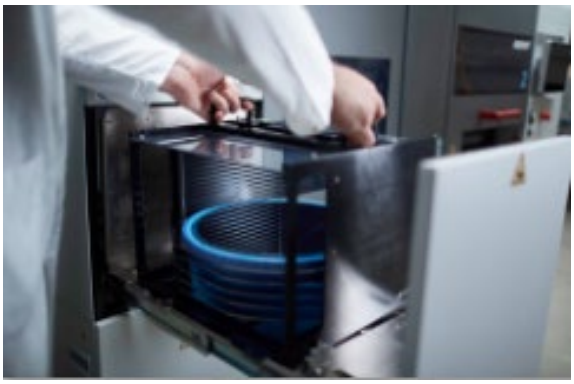
In order for SiPs to be produced economically, these high-precision processes must not only be precisely coordinated but also upgraded into high-volume production operations with high cycle rates and maximum automation.

With the DEK Galaxy solder paste printer and the SIPLACE TX micron and SIPLACE CA2 placement platforms, electronics manufacturers have powerful solutions at their disposal to fully exploit this market potential with a seamlessly integrated process. Precision, speed, and innovative strength have been combined across systems with innovations that only a technology leader with in-depth expertise in both worlds — semiconductor and electronics manufacturing — can achieve.

SIPLACE TX micron placement machine: A leap forward in innovation for advanced-packaging and high-density applications.
(Image credit: ASMPT)

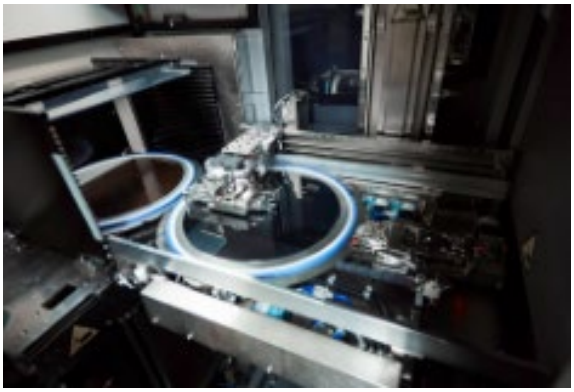


Wafer handling for a wafer-level SiP. Assembly for WLFO wafer-level fan-out is also possible.
(Image credit: ASMPT)

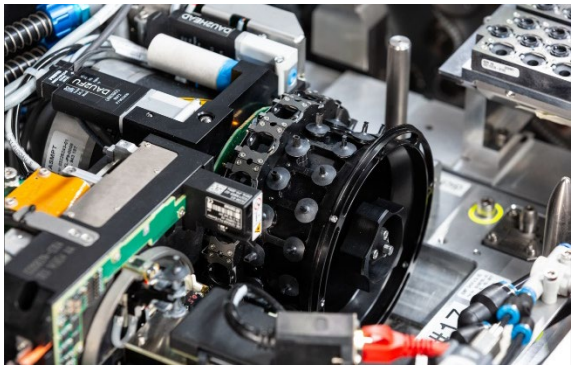


Automatic changeover system: The SIPLACE CA2 placement platform can handle up to 50 different wafers.
(Image credit: ASMPT)

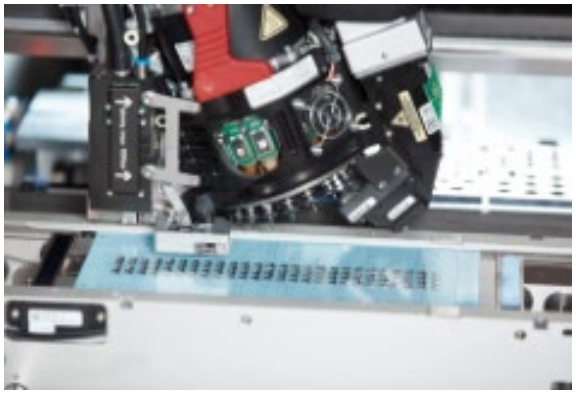
DEK Galaxy solder paste printer: Performance and precision for SMD processing and advanced packaging.
(Image credit: ASMPT)



Wafer transfer to the pick-up zone: Wafer swaps takes only 13 seconds with the SIPLACE CA2.
(Image credit: ASMPT)



The quadruple flip unit (left) removes components from the wafer with intermediate storage for dies (right): Similar in design to a collect-and-place placement head, the buffer decouples the complex removal process from the placement process and also enables die attach placements.
(Image credit: ASMPT)



Thanks to intelligent buffering, the SIPLACE CA2 achieves a placement rate of up to 54,000 dies per hour with direct removal from the wafer.
(Image credit: ASMPT)

SIPLACE CA2 placement machine: Hybrid high-speed processing of SMDs and dies, directly from the wafer.
(Image credit: ASMPT)