

Three semiconductor innovations to watch in 2025

As the semiconductor industry moves to smaller scales, it must overcome several technical challenges. In 2025, we expect three key developments to make headlines: Gate-All-Around transistor designs, Backside Power Delivery, and an increased focus on semiconductor assembly and packaging



What will make headlines in 2025

To achieve smaller semiconductor structures, improved transistor designs are essential. Leading-edge fabs have been working on new transistor designs, known as Gate-All-Around (GAA), for some time. We expect these designs to enter production in 2025 at TSMC and possibly Intel. TSMC's GAA pilot lines are already operational, while Samsung has been producing GAA transistors since the previous generation.

Another interesting development is backside power delivery, which revolutionises semiconductor design through a new power delivery network. By decoupling the power delivery network from the signal network, semiconductors can benefit from improvements, such as reduced heat. Intel is incorporating this technology into its latest manufacturing process, though it's uncertain if it will enter production this year.

We also expect to see a growing importance of the semiconductor supply chain back-end (assembly and testing). TSMC is advancing its assembly and packaging solutions, transitioning

from CoWoS-S to CoWoS-L technology. This technology allows semiconductor manufacturers to create larger semiconductors by connecting multiple discrete elements within a chip.

What about Intel?

Intel is currently working on its 18A node semiconductor manufacturing process, which incorporates backside power delivery and the new GAA transistor design. The company needs to develop this technology to remain in the race with TSMC as the leading semiconductor manufacturer.

Intel recently announced that its 18A process is ready for customer projects and expects to start production in 2H25. Nevertheless, the big uncertainty remains the ability to achieve good production yields. Intel's showcase product, the Clearwater Forest data centre CPU, which is based on the 18A process, is now expected in 1H26, pointing at a delayed introduction of the 18A manufacturing process.

What is happening at TSMC?

TSMC offers leading manufacturing capabilities to its customers. Customers such as Nvidia and Apple are willing to pay a premium for these leading semiconductors as they need these to sell superior, high-margin products to their consumers. TSMC benefits from its scale to optimise its production process but can also gain process technology before the competition does, thereby increasing its yields.

If TSMC solidifies its position as a technological leader, it can invest its profits into new technologies, advancing its leadership position further, while others may struggle in segments that are less profitable. If Intel does not close the gap now, it risks remaining behind for a considerable time.

Key 2025 semiconductor developments to watch out for

- Gate All Around transistor design
- Backside power delivery
- Growing importance of Assembly and Packaging solutions

The importance of the Windows/Intel combination may slowly fade

For decades, the combination of Microsoft Windows and the x86 processor architecture dominated computing in the PC era. However, the rise of smartphones has shifted this landscape. Modern smartphones typically use CPUs based on ARM designs and run on Android or iOS operating systems. Microsoft's efforts to support ARM-based hardware could be a game-changer for traditional x86 microprocessor developers, especially as Apple has found success with its ARM-based laptops.

NVIDIA is also developing a home server based on ARM-based processor architectures. Intel and

AMD aim to fend off this threat with a new x86 alliance and new, more efficient processor designs. However, as ARM is developing its capabilities to design data centre servers, the traditional x86 server stronghold also comes under pressure.

Besides the dominance of the ARM and x86 architectures, the arrival of Nvidia compute engines also comes with a new software standard, the Cuda programming language for computing applications. Developed by Nvidia, this toolkit facilitates the programming of AI models. We anticipate that Cuda will continue to be widely used in 2025, while the prominence of the x86 architecture will further decline.

Key developments taking place in the Benelux in 2025

We also expect some exciting developments in the Benelux. First, we anticipate more news about the volume production of ASML's High NA EUV machines. Recently, Intel announced that it has already produced 30k wafers using High NA EUV, which is a positive step towards potential volume production in 2026. This will also be done with the help of research Institute IMEC in Belgium, which contributes to the development of key building blocks for this technology, such as mask technology, UV resist and metrology. We also expect to hear more about IMEC's investments into start-ups and scale-ups using funds from imec.istart and imec.xpand.

From Nearfield Instruments, we think we'll hear more about its expansion plans following a strong 2025 order book. The company may report additional orders for its advanced metrology system.

We are also keen to hear what progress Besi makes with orders for its advanced hybrid bonding technology, given the AI-driven investments in advanced semiconductors.

ASM should benefit from a higher demand for its atomic layer deposition techniques as the industry moves to 3D memory and smaller node sizes. With a recently obtained €1bn loan from the EIB, NXP will fund research into next-generation semiconductors for the automotive sector and other applications. In Belgium, Melexis is working on innovative sensors for robotics applications. Finally, we expect that SMART Photonics and EFFECT Photonics will announce further steps in 2025 towards volume manufacturing.

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