

Advances in Frontside Process Technology: Trench/Via Filling & Planarization

Trends in frontside contact formation in new power device technologies on Si or SiC are calling for ever more demanding thin film processes – trenches get deeper, aspect ratios get higher and expectations for the quality of the final planarized surface grow. Evatec's Product Marketing Manager *Fabian Kramer* and Manager of Technology Development *Mohamed Elghazzali* give us a taste of the Evatec solutions supporting customers in 2025 and beyond.

The process requirements are clear

Trench/Via filling and planarization processes call for deposition of two layers.

1. A "seed" layer with good step coverage – typically comprising a thin titanium layer in the range 20-50 nm followed by a TiN layer in the range 150-250nm. The Ti layer acts as adhesion layer and TiN as barrier layer.
2. A thick metal contact layer, typically Al, AlCu or AlSiCu according to the device design in the thickness range between 3000-5000nm. The process conditions need to ensure good flow of the material within the trench without voids and provide good final planarization.

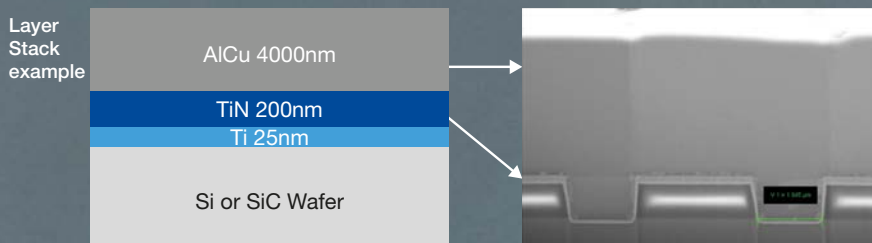
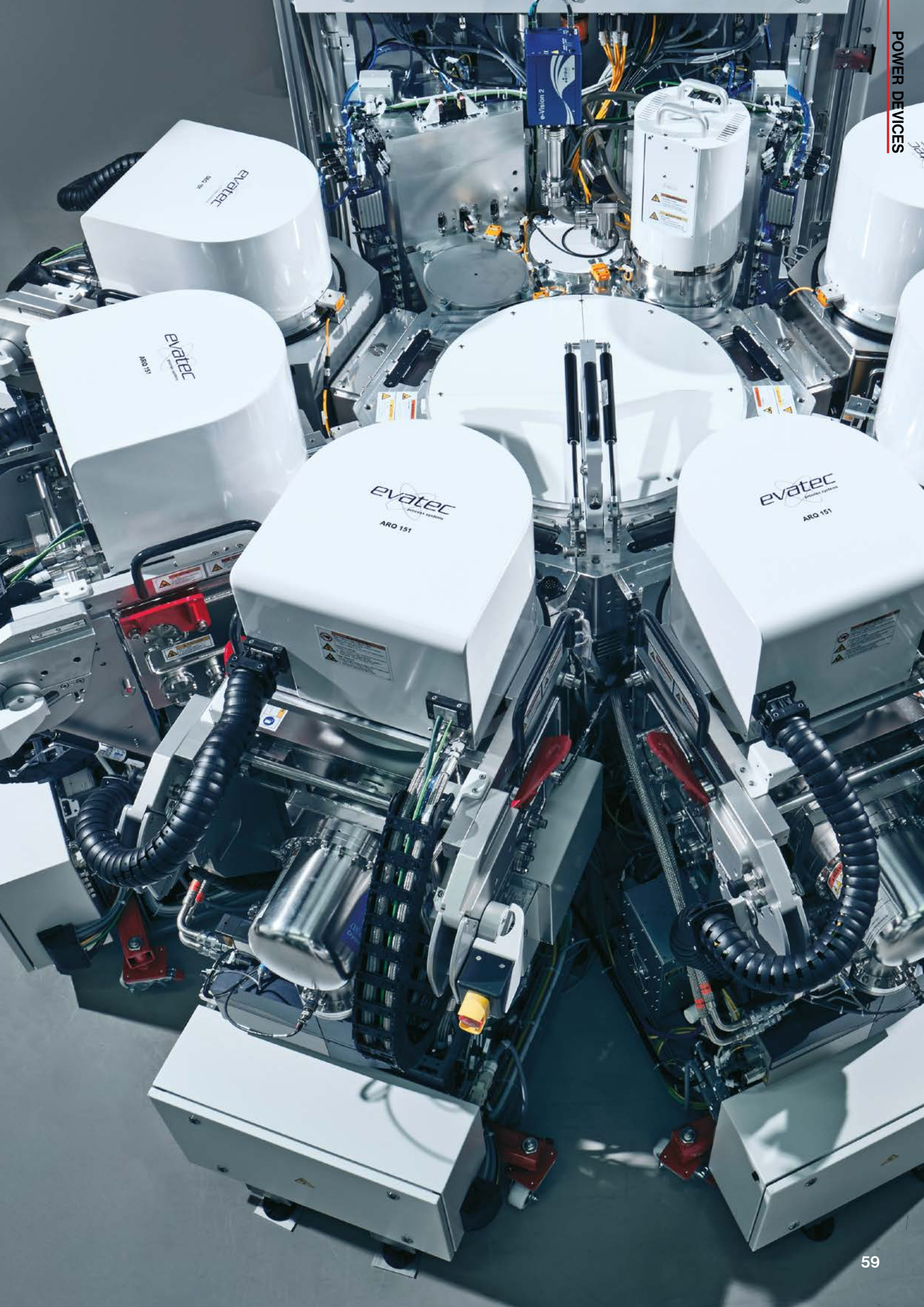


Figure 1: CLUSTERLINE® 200 results for trench filling and planarization

“Supporting Perfect Al Flow in higher aspect ratio trenches”



CLUSTERLINE® solutions are already well established

Evatec's CLUSTERLINE® 200 and 300 platforms are already well established in power device applications.

Figure 1 illustrates a micrograph of typical results achieved on CLUSTERLINE® 200 for frontside contact formation with trenches of aspect ratio approximately 1:1. Seed layers provide the step coverage required for good aluminium adhesion, while good material flow at process temperatures around 400°C provides the required void-free films with smooth surfaces. Details of a typical single process module are shown in Figure 2.

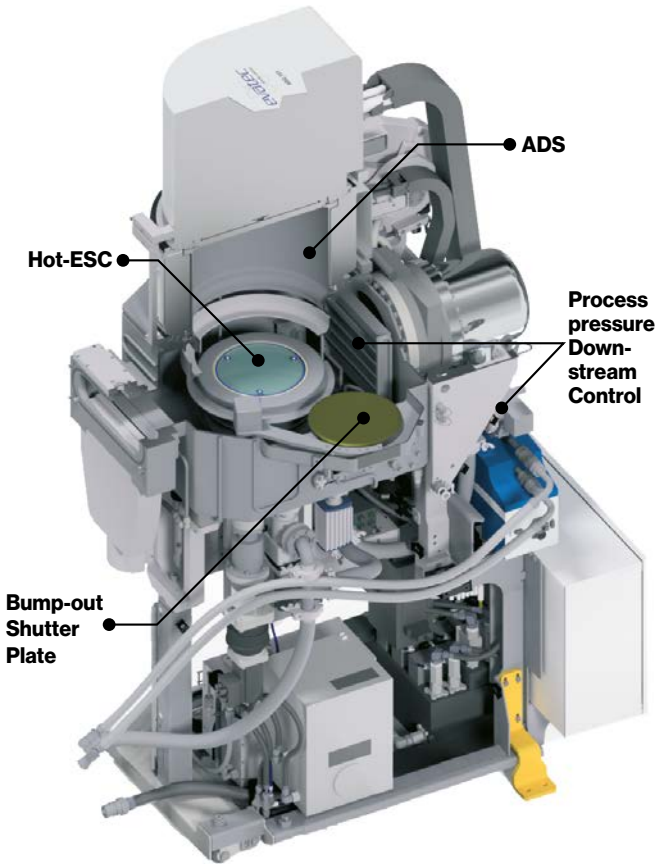


Figure 2: Single process module

More challenging process demands are coming in 2025

Emerging trends in device architecture calling for higher aspect ratios are setting more demanding challenges for substrate handling and thin film processes.

Seed layer deposition needs to achieve sufficient side wall and bottom coverage without significant increase in overall film thickness. For the thick metal layer deposition, substrate handling within the process chamber needs to avoid “sticking” and the risks of subsequent damage or particle generation, while Al Flow still needs to ensure void free films for the more demanding device architectures.

New solution to achieve a higher aspect ratio of 3:1

New dedicated hardware and process control features being introduced to the market at the end of 2024 for CLUSTERLINE® 200 will enable our customer to achieve the new levels of process performance for high aspect ratio features.

- ✓ Enhanced new module design for Advanced Directional Sputtering (ADS) will deliver the improved step coverage essential for higher aspect ratio trenches without increasing required TiN film thickness and deposition times.
- ✓ Process module control technology leveraging downstream pressure control will deliver enhanced process control and process repeatability for the reactive processes required in TiN deposition for the most consistent seed layer deposition in higher aspect ratio applications
- ✓ New process kits including integrated substrate shutters and modified shielding will bring further benefits:
 - Elimination of any wafer pasting steps required simplifying processes and increasing wafer throughput
 - Improved particle management
- ✓ New full face Electrostatic Chuck (ESC) for efficient thermal coupling will enable process temperatures up to 500°C, which will offer customers wider process windows for any new processes and reduce risk of wafer sticking and edge damage.

CLUSTERLINE® 200 is the solution

CLUSTERLINE® 200 enables integration of up to 6 process modules. A possible system layout for front side contact metallization integrating these new capabilities is shown in Figure 3.

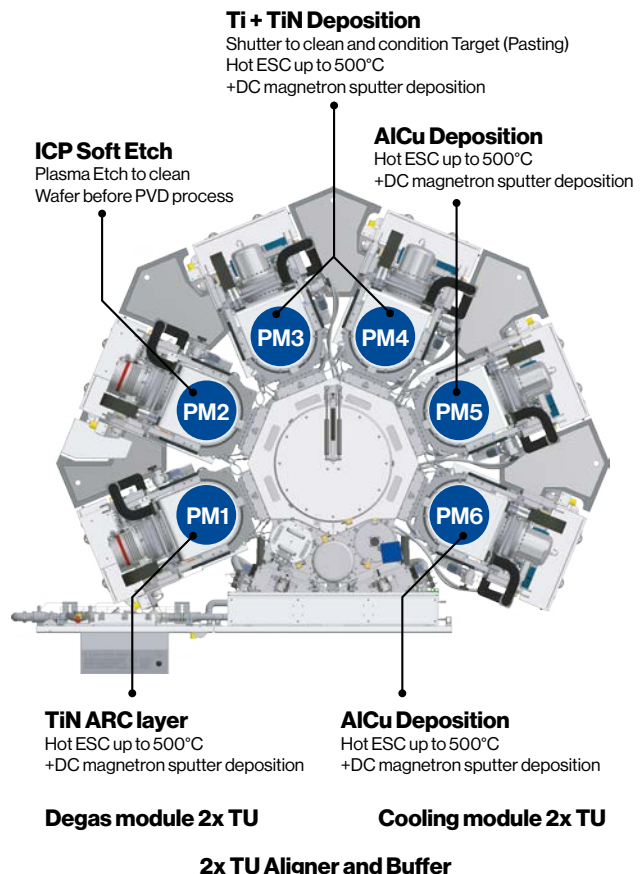


Figure 3: Typical CLUSTERLINE® 200 configuration for gap filling and planarization

SPOTLIGHT ..CLUSTERLINE® 200

A choice of architectures

The CLUSTERLINE® 200 can be configured as a tool for single substrate or batch processing using Single Process Modules (SPM) or a Batch Process Module (BPM) respectively. However, when you configure the tool, you can rely on fully automated cassette-to-cassette processing using Evatec's proven safe handling. For custom applications please also enquire about configurations combining both single and batch process modules.

SPM configuration highlights

Platform variant with strong pedigree in Power Devices, Advanced Packaging, MEMS and Wireless markets allowing easy tool configuration and future expansion for PVD, highly ionized PVD, Soft Etch, PECVD and PEALD for wafer sizes up to 200mm.

- Modular chuck design for rapid exchange between 100, 150 or 200mm formats for production flexibility and maximum tool utilization
- Up to 6 single process modules and up to 6 auxiliary modules for pre- and post treatment steps
- Auxiliary module functions including wafer alignment, buffer, degas, cooling, and ID reader
- Direct thin wafer handling and processing capability for substrate thicknesses down to 70 microns

BPM configuration highlights

Platform variant combining the benefits of sputter batch processing with completely automated handling for selected applications in MEMS and Wireless. A true work horse in the LED / Micro Display and Photonics industries. Integration of additional plasma sources opens up process possibilities for enhanced deposition processes e.g. coating modification including gap filling and planarization.

- Batch processing of up to 20+1 six inch substrates simultaneously
- Batch processing of up to 15+1 eight inch substrates simultaneously
- Rotating substrate table with option for individual rotating substrate chucks
- Integration of up to 4 PVD sputter sources plus 1 plasma source



Want to know more?

To learn more about upcoming solutions on CLUSTERLINE® 200 for power, front or backside applications contact your local Evatec office.

<https://evatecnet.com/about-us/contact-us/>



Not familiar with the CLUSTERLINE® platform? Then why not watch the short CLUSTERLINE® family video to learn about Evatec's range of solutions for 200, 300 and 600mm.

