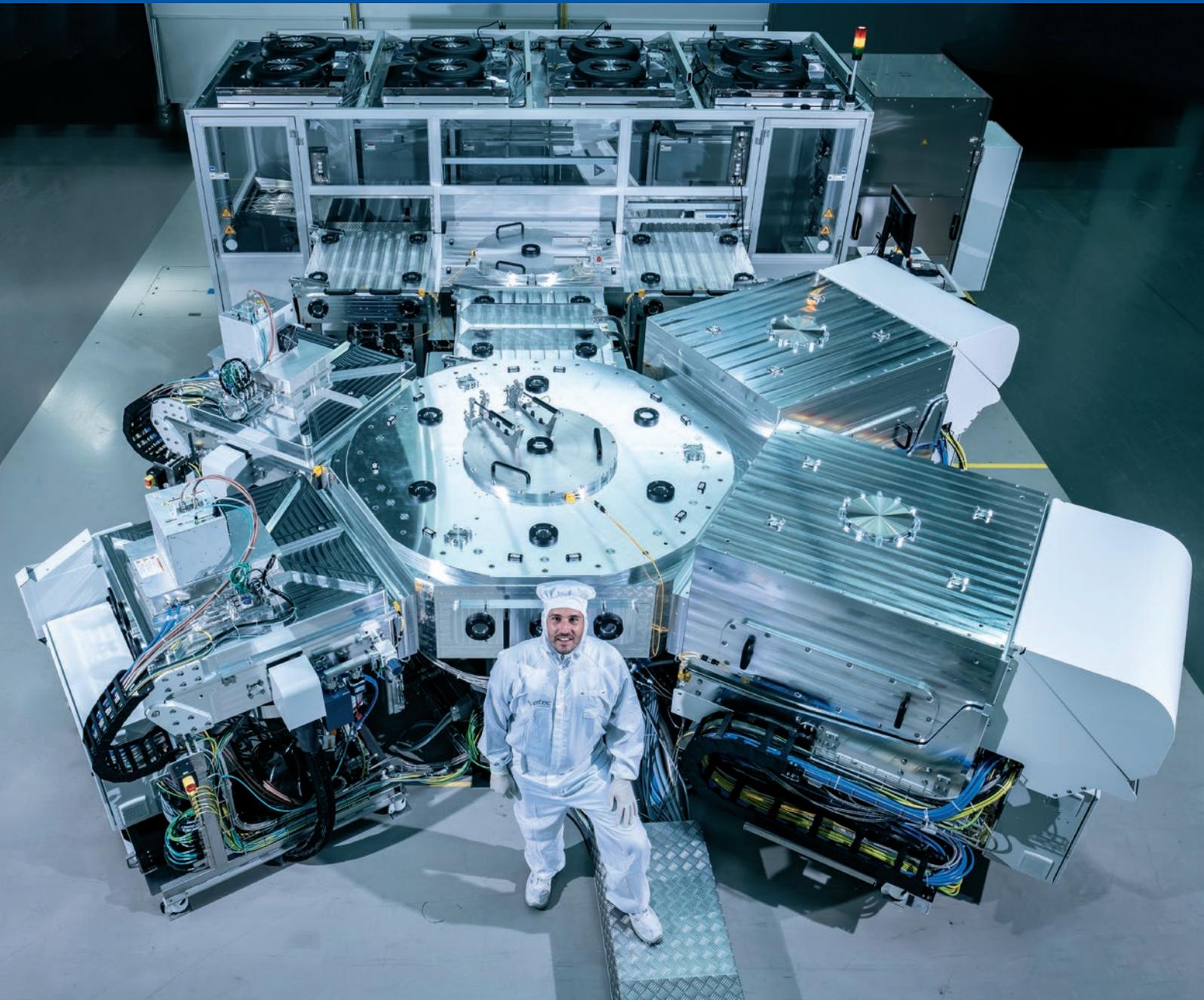


PLATFORMS



# CLUSTERLINE<sup>®</sup> 600

Large area cluster tool for single panel processing



# CLUSTERLINE® 600

EVATEC'S ALL IN ONE SEED  
LAYER SOLUTION FOR PANEL  
LEVEL PACKAGING



Miniaturization and lower cost are driving the demand for Panel Level Packaging. Evatec's process know-how in Advanced Packaging enables customers around the globe to cope with these challenging developments and demands. Low contact resistance ( $R_c$ ) and excellent adhesion of the deposited seed layers combined with low particle generation are some of the major achievements of the CLUSTERLINE® 600 that set the benchmark in the market segments for IC-Substrates and FOPLP.



	<b>Next generation IC-Substrates</b>	<b>FOPLP</b>
<b>Product</b>	<ul style="list-style-type: none"> <li>▪ IC-Substrate</li> <li>▪ Embedded dies</li> <li>▪ Substrate-like PCB</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low Density Fan Out</li> <li>▪ High Density Fan Out</li> </ul>
<b>Market Trends</b>	<ul style="list-style-type: none"> <li>▪ Fine line interconnects with roadmap down to 2µm L/S</li> <li>▪ Embedded die technologies</li> <li>▪ FO on substrate</li> <li>▪ PVD becomes crucial to support roadmap as chemical Cu alternative</li> </ul>	<ul style="list-style-type: none"> <li>▪ Wide adoption for PMIC and RF</li> <li>▪ New potential for High Density Fan Out for APs and heterogenous integration (CPU, memory)</li> <li>▪ Push to FOPLP as supporter of cost reduction roadmap and heterogenous integration</li> </ul>
<b>Device Technology</b>	<ul style="list-style-type: none"> <li>▪ Seed Layer deposition</li> <li>▪ TGV seeding</li> <li>▪ Reactive Ion Etching (RIE)</li> <li>▪ Nano-Descum</li> <li>▪ Deep Etching</li> </ul>	<ul style="list-style-type: none"> <li>▪ Seed Layer deposition</li> <li>▪ Reactive Ion Etching (RIE)</li> <li>▪ Nano-Descum</li> </ul>
<b>Process / Application</b>	<ul style="list-style-type: none"> <li>▪ Degassing organic substrates</li> <li>▪ Physical Argon etching</li> <li>▪ Reactive Ion Etching</li> <li>▪ Harsh chemical etching</li> <li>▪ Sputtering seed layer metals (e.g. Ti and Cu)</li> <li>▪ DC or DC pulsed</li> <li>▪ Reactive sputtering</li> </ul>	

# THE WORKHORSE FOR PANEL LEVEL PACKAGING

CLUSTERLINE® 600 is qualified at the major OSATs and IDMs for Panel Level Packaging. It enables the latest technologies on panel sizes up to 650 x 650mm.

## IN ATMOSPHERE

### HANDLING

Tailormade handling packed with quality control features for safe manipulation of substrates from cassette or buffer, through the process and back again.

### BATCH DEGASSER

Atmospheric batch degassing is ideal for repeatable accurate outgassing of organic substrates.

## TRANSITION

### COOLING

After degassing, the substrates are transferred to vacuum. Cooling during the transition ensures enough thermal budget for the subsequent process steps.

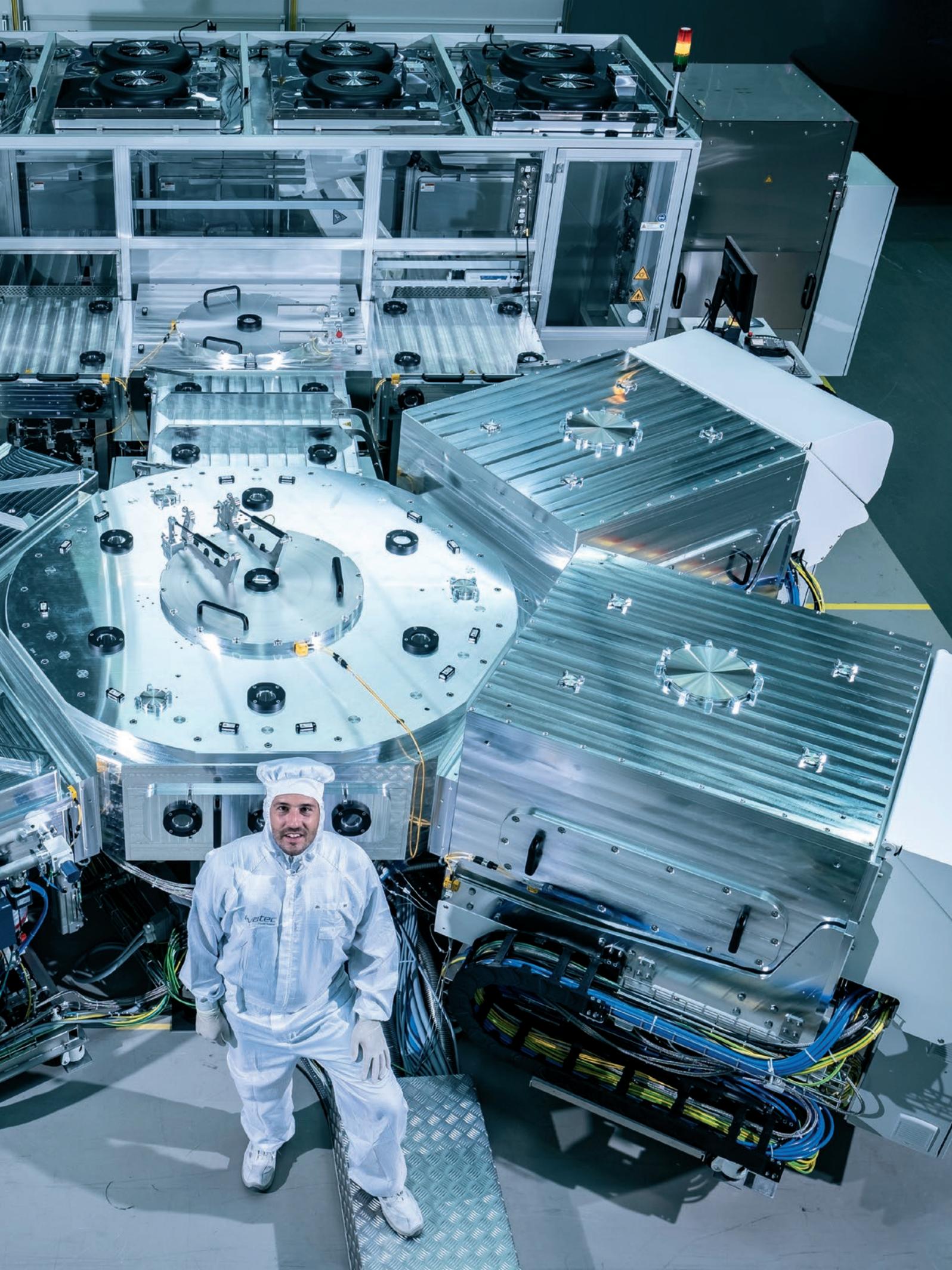
## IN VACUUM

### CCP ETCH

Evatec etch technology ensures ideal interface preparation for subsequent PVD processes  
→ **Maximize adhesion**  
→ **Minimize R<sub>f</sub>**

### PVD SPUTTER

Evatec cathode technology combines high uniformity with excellent target utilisation and thermal management within strict substrate temperature limits.



# DEGASSING

## Repeatable and reliable outgassing of organic substrates

The atmospheric batch degasser (ABD), where a batch of substrates are simultaneously degassed in multiple heated slots with nitrogen laminar flow, is the preferred solution for organic substrates (e.g. AMC, ABF, PID, PI, etc.).

The advantages of the atmospheric batch degasser are:

- Panel slots with individual N<sub>2</sub> laminar flow for:
  - fast and precise temperature control of substrates (conductive heating)
  - emissivity independent temperature control (no overheating and no local hot spots)
  - transporting volatile compounds away from the substrates (no re-contamination)
- Smart design for easy access and maintenance

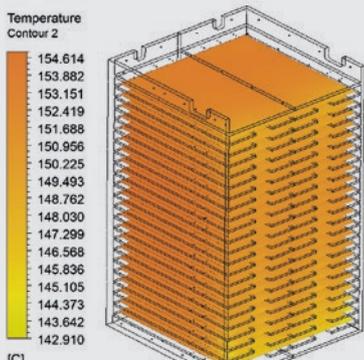




“EVATEC PATENTED ABD TECHNOLOGY ELIMINATES THE RISK OF LOCAL OVER HEATING”

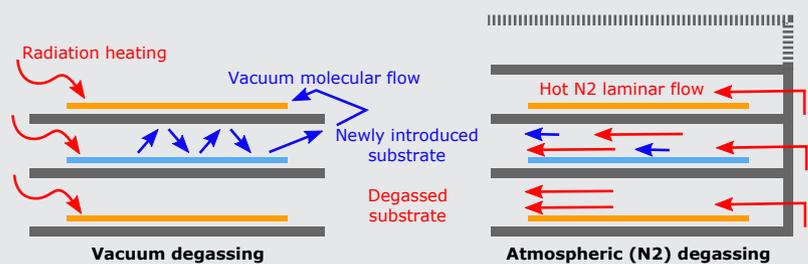
## ATMOSPHERIC BATCH DEGASSING OFFERS:

- Fast and precise temperature control
- Outstanding temperature uniformity
- Nitrogen laminar flow for transporting volatile compounds
- Sufficient time for diffusion of volatile compounds and moisture



## THE BENEFITS OF ATMOSPHERIC DEGASSING

Diffusion of volatile components from the bulk material to the surface is driven by temperature and time. Desorption is driven by the concentration gradient which is the same whether desorption takes place in vacuum or in atmosphere. However, the advantage in atmosphere is that the concentration gradient can always be kept high if a laminar flow of inert gas is applied, while in vacuum the degassing of the volatile components has to take place by less efficient molecular diffusion.



Basic comparison of batch degassing in vacuum and atmosphere. Desorbed molecules are symbolized as blue vectors. Orange substrates are hot and degassed, blue ones are cold and not degassed.

# ETCHING

## Perfect for large area panel processing

Removing native oxides and preparing the substrates' interface are the major reasons for etching in Advanced Packaging. Low Rc and superior adhesion of the sputtered seed layer are the results.

Leveraging our patented plasma source design, Evatec's process know-how on CLUSTERLINE® 600 uses dual frequency CCP with a high and a very high frequency controlling plasma density and ion bombardment. Etch rates, uniformity and thermal budget can all be kept

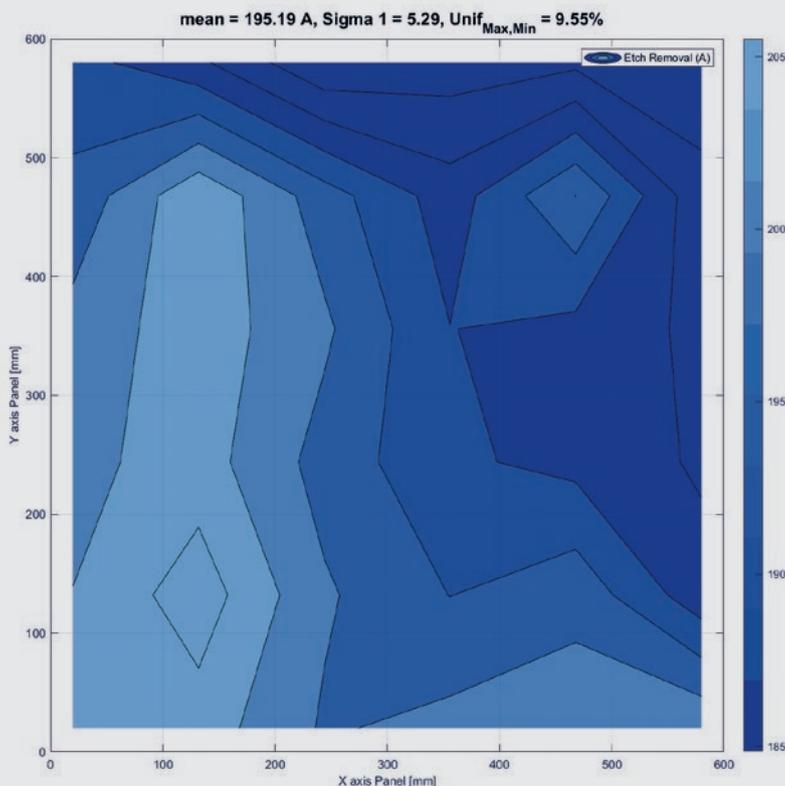
successfully in balance.

Just as important, non-moving parts and a static substrate during processing avoid unwanted particle generation and yield losses.

The CLUSTERLINE® 600's CCP Etch Modules are capable of providing physical (Ar-sputter Etch) or chemical etch processes ( $\text{CHF}_3$ ,  $\text{C}_3\text{F}_8$ ,  $\text{CF}_4$ ,  $\text{O}_2$ ,  $\text{N}_2+\text{H}_2$ ,  $\text{Ar}+\text{H}_2$ , etc.) or a combination of these in one module using our long history of process know-how.

## TAKE A LOOK AT THE RESULTS

Panel size: 600 x 600, 36  $\text{SiO}_2$  chips, measurement EE = 20mm



“DUAL  
FREQUENCY  
CCP ETCH AND  
NO MOVING  
PARTS DURING  
PROCESSING  
GUARANTEE  
BEST IN CLASS  
ETCH RESULTS”



## Features and benefits

### Dual frequency benefits

- DC bias (ion bombardment) adjustable with frequency combination
- Directional etching is possible (anisotropic etching)
- Very good for directionality and small features
- Uniformity control easier (one plasma source)

### Reactive ion etching benefits

- Same tool can perform chemical and physical etch by different gas and frequency combinations
- Comprehensive library of process data for RIE
- Development of DRIE for deep etch applications (same module, additional gases)

### Low pressure regime benefits

- Long free path
- High directionality of ions (anisotropic etching)
- Uniform etch rate
- Ideal for small and narrow structures

# SPUTTERING

## Superior seed layer adhesion and uniformity

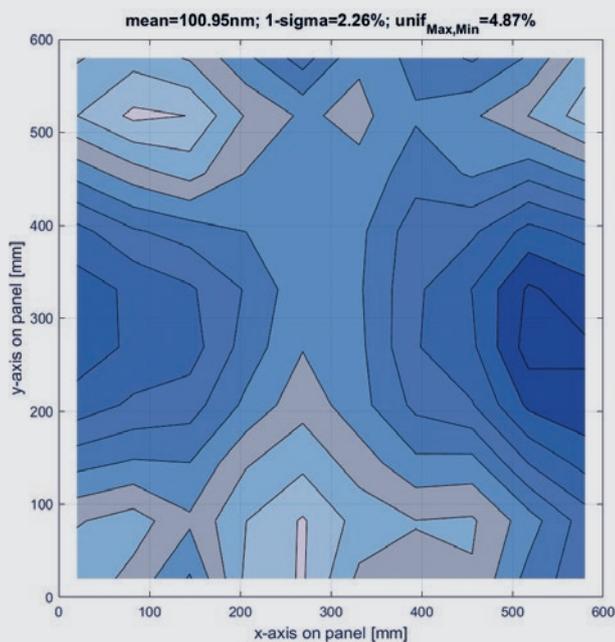
Benefit from Evatec's long history in delivering tailor-made PVD based metallization processes to the semiconductor industry. Rotating cathode sputter technology delivers excellent film uniformity over large areas, and just like for etch processing, static panels during deposition avoids particle generation.

### The benefits of rotating target technology

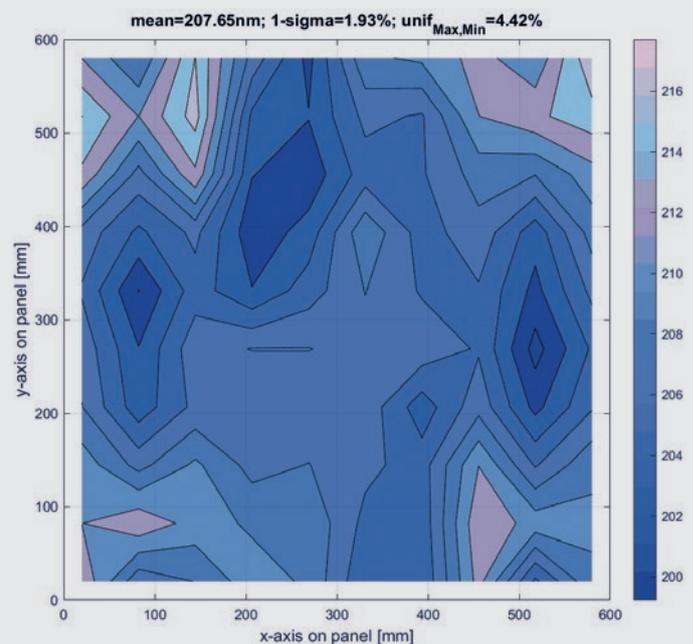
- Best panel cooling due to combination of steady substrate during process and superior target cooling
- Excellent deposition uniformities by innovative moveable magnet bar technique
- Production proven technology
- No redeposition areas above panel
- Design for rapid cathode maintenance using motorized drawer concept

## TAKE A LOOK AT THE RESULTS

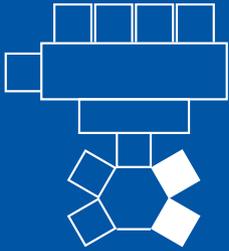
10 x 10 points were measured by 4-point probe



Ti deposition



Cu deposition



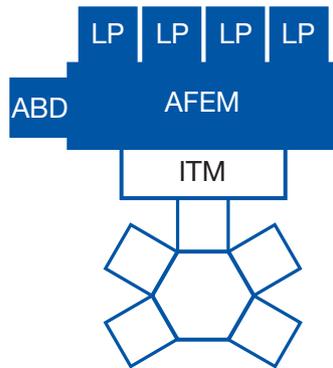
“ROTATING TARGET TECHNOLOGY OFFERS LONGEST TARGET LIFE FOR LOWEST COST OF OWNERSHIP”

# HANDLING

## Advanced control for safe production

Evatec's long experience in delivering systems of cluster architecture with fully automated robot handling means you can be confident of secure and robust handling all the way from FOUF or cassette through processing and back again. The systems and control features on the CLUSTERLINE® 600 are designed specifically for panel handling in particular, and of course, the system is SECS / GEM compliant for fab integration.

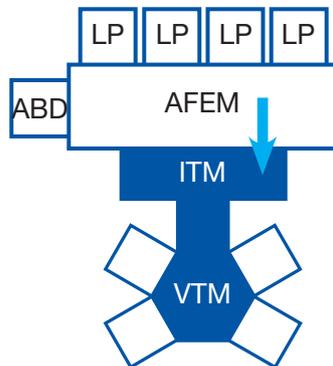




## Atmospheric Front End Module (AFEM)

### Front End Robot

The robot handles movements in and out of the FOUP, the batch degasser (ensuring “first in first out” processing) and to and from the system Interface Transfer Module (ITM) via any intermediate test stations required. Handle glass, EMC, CCL, FR4 and other thin substrates direct or on carriers according to your application.



## TRANSFER

### Cooling and pumping

Evatec's elegant 2 stage architecture brings benefits in both process control and throughput:

- Most efficient pumping and sufficient cooling time increases thermal budget prior to next process steps
- Faster 2 stage pumping to reach base pressure prior to transfer to the central Vacuum Transport Module (VTM)
- Separated air locks for Panel In and Panel Out
- Space for additional panels in vacuum e.g. for pasting

### Vacuum Transfer Module

Our 6 sided transfer module is equipped with dual robot arm allowing integration of up to 5 process modules. Additional flanges for RGA are available on all process modules.

## Features & benefits

- Robust and safe handling for production
  - up to 3.1kg payload
  - up to 12mm handling warpage/sag/bow
  - semi S2 and S8 compliant
- Fully SECS / GEM compliant
- Additional features possible
  - e.g. ionizer, in-situ warpage measurement, RFID reader
- Advanced positioning system (APS)

# PRODUCTION PERFORMANCE

## LET EVATEC BE YOUR GUIDE

### Securing production for today

Combining innovations in panel handling together with careful selection of source designs and our many years process know-how in degas, etch and PVD technology eliminates risk. CLUSTERLINE® 600 is already qualified at several OSAT and IDMs.

CLUSTERLINE® 600 is a tool designed for daily production. You can be sure of excellent adhesion and low  $R_c$ s in processes like FOPLP at the levels seen in wafer based processes. Robust handling and efficient process flow ensure run rates of 24 panels per hours.

#### **RUN RATE** 24 panels per hour

Process: 40' degas at 120C, 20nm etch, 100nm Ti, 200nm Cu

Substrate: 500µm thick EMC or ABF build up; good emissivity towards the chuck; maximum temperature permitted 120°C

#### **ADHESION** > 1000 N/m

Seeding Ti+Cu on different PI films (DuPont, etc.) and ABF materials (GY50, GX-T62, etc.)

Seed layer deposition with CLUSTERLINE® 600 system → electroplating → post-baking (for ABF) → thermal cycle test → machine peel test for adhesive bond evaluation

#### **$R_c$** < 1 mOhm

Single Kelvin structures; via diameter = 30µm; dielectric thickness or via height = 8µm; PBO passivated;

40 minutes Degas, 20nm Etch (SiO<sub>2</sub> equ.), 100nm Ti, 300nm Cu;

#### **ROBUST HANDLING**

Up to 12mm sag/bow on end effector

High payload up to 3.1kg

In-situ warpage measurement

Alignment station in AFEM

Advanced alignment features

### CLUSTERLINE 600® – Giving you the lead in production

- ✓ Avoid particles with static panels during etch and deposition processes
- ✓ Manage thermal budget with innovative system and process design
- ✓ Reduce production cost with high utilization of rotatable tube targets
- ✓ SEMI-like system architecture and features
- ✓ Fully SECS / GEM integrateable

## Working on the capabilities needed tomorrow

Today, the CLUSTERLINE® 600 is the benchmark for all in one Seed Layer sputtering in FOPLP and IC-Substrate manufacturing.

Evatec is working on the next generation of process capabilities with selected customers and partners.

Thanks to its cluster-type system architecture, new capabilities and features can easily be integrated to the CLUSTERLINE® 600 as they become available.



# CLUSTERLINE® 600

Large area cluster tool for single panel processing

## Technical Information

- Processing area: 600mm x 600mm
- Panel size up to: 650mm x 650mm
- Maximum panel weight: up to 3.1kg
- Up to five process modules
- Up to 24 panels per hour (panel sides)
- Up to two Atmospheric Batch Degasser (ABD)
- Degas temperature: 120°C ± 10°C (BKM)
- Panel temperature in process typically <100°C
- Excellent R<sub>c</sub> results
- Excellent adhesion of Seed Layer on substrates
- Excellent uniformity results
- Reactive Ion Etch (RIE) option



### ABOUT EVATEC

Evatec offers complete solutions for thin film deposition and etch in the Advanced Packaging, Power Devices, MEMS, Wireless Communication, Optoelectronics and Photonics markets.

Our technology portfolio includes a range of advanced sputter technologies, plasma deposition & etch as well as standard and enhanced evaporation.

Our team is ready to offer process advice, sampling services and custom engineering to meet our customers individual needs in platforms from R&D to prototyping and true mass production.

We provide sales and service through our global network of local offices. For more information visit us at [www.evatecnet.com](http://www.evatecnet.com) or contact our head office.



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