evatec
process systems

CLUSTERLINE® 200

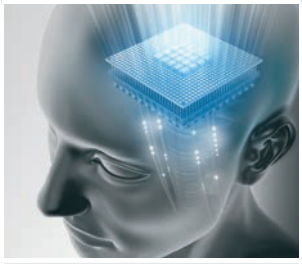
BATCH PROCESS MODULE TECHNOLOGY FOR DYNAMIC SPUTTER

OPTOELECTRONICS, MEMS, PHOTONICS, WIRELESS

CLUSTERLINE®

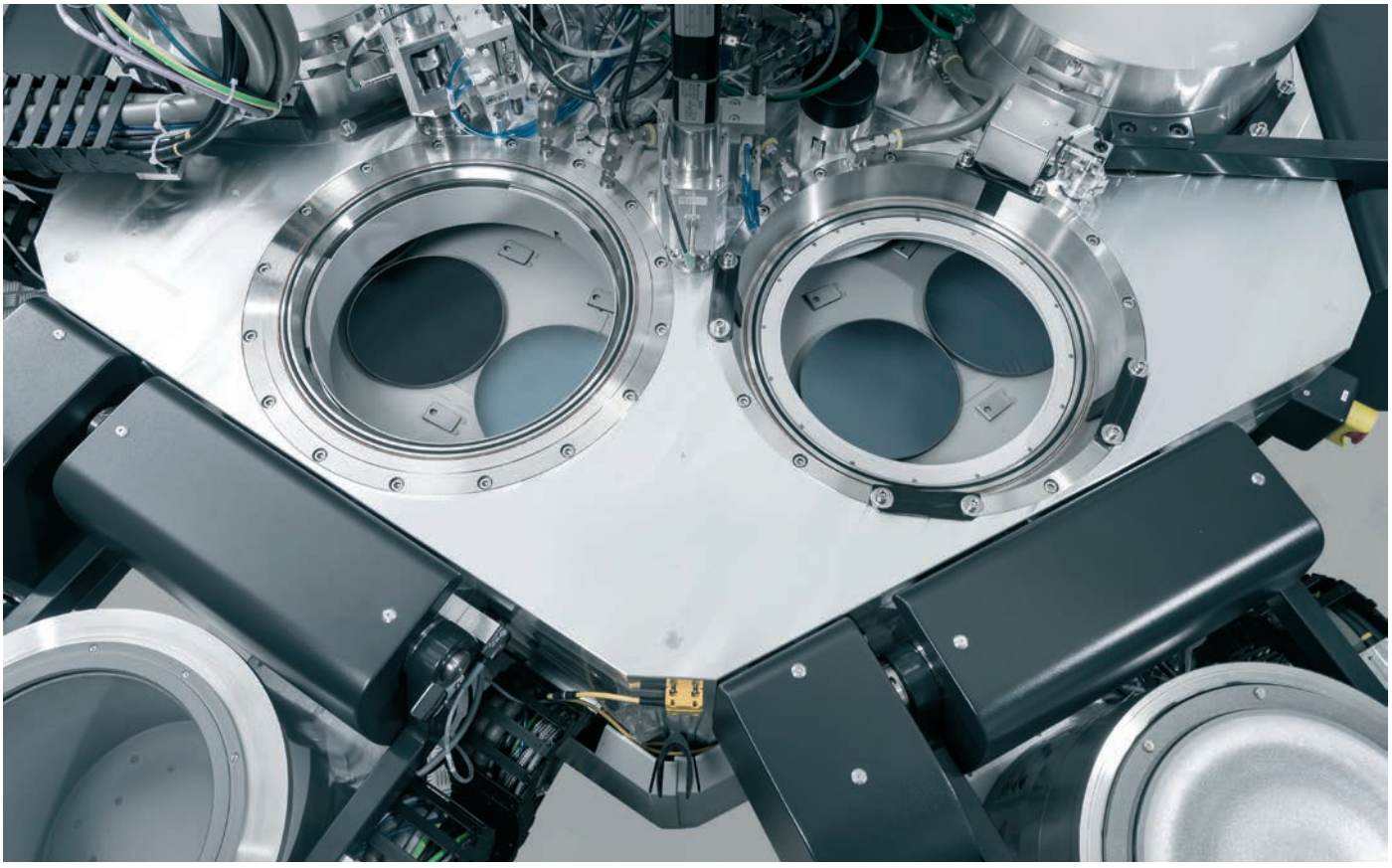
Enabling your roadmap in thin film deposition

The combination of Evatec's process know-how and CLUSTERLINE® 200 equipped with batch process module technology enables your technology roadmap for LEDs with the highest efficiencies, NIR bandpass filters with the best transmissions and TC-SAW devices with unique performance. Enjoy new levels of throughput and yield for the lowest cost of ownership in thin film deposition.

Market / Industry	WIRELESS COMMUNICATION	MEMS	OPTOELECTRONICS	PHOTONICS
				
Product	▪ III-V RF-devices: Power Amp. RF Filters, RF switches, IR; WBG RF devices	▪ Optical MEMS ▪ Sensors ▪ Actuators	▪ Micro LEDs & HB LEDs ▪ IR Devices ▪ Photovoltaic Modules ▪ Laser / VCSEL	▪ Mirrors ▪ NIR bandpass filters for 3D sensing TOF ▪ Integrated Optics ▪ Wafer Level Optics ▪ AR Coatings
Device / Technology	▪ HBT on GaAs ▪ p-HEMT on GaN ▪ IR devices ▪ RF Filters: TC-SAW & BAW ▪ Gap filling and planarisation	▪ Passivation ▪ Discrete Sensors ▪ Integrated MEMS: SoC, SiP	▪ GaN on sapphire ▪ GaN on Si ▪ GaN on GaN ▪ DBRs	▪ Interference Coatings ▪ DBRs
PVD Process / Application	▪ Backside ViaTFR ▪ Metal Electrodes ▪ HD-SiO_2	▪ Metals ▪ Dielectrics ▪ TFR e.g. NiCr(Si),TaN ▪ Thermoelectric Layers	▪ TCOs: Hot ITO, GZO, IZO ▪ Metal Electrodes ▪ Dielectrics	▪ Plasma assist ▪ Low/high index metal oxides ▪ Metals / Dielectrics

VERSATILITY HAS A NAME

CLUSTERLINE® combines the features of batch processing and automated handling to bring advanced capabilities for applications in semiconductors and photonics.



Damage free sputtering of TCO´s and metals

- Unique leading edge dynamic sputtering technology for damage free layers on sensitive materials including GaN and GaAs

Ion Assisted Sputtering for smooth layers with virtually no optical losses

- Ion Assist source (PSC) operated in combination with sputter source to enable surface roughness of ≤ 0.3nm

Low cost of ownership due to high throughput and automation

- High throughput due to optimised sputter rates and co-sputter possibility
- Simultaneous handling of different form factor substrates for maximum tool utilisation
- Increased yield by automation - eliminating operator errors

Dynamic sputtering for outstanding uniformities and lower sputter temperatures

- Supreme layer uniformity of ≤ ±0.25% without shapers

Low particle counts

- Uniformity shapers eliminated with Evatec's unique SSC 300 rotating target RF/DC sputter source
- SEMI compliant fully automated substrate handling enables low particle counts / cassette to cassette operation

In-situ process control

- Broad Band Monitoring (GSM) with In-situ measurement during process
- Plasma Emission Monitoring (PEM) for fully oxidized films at high deposition rates

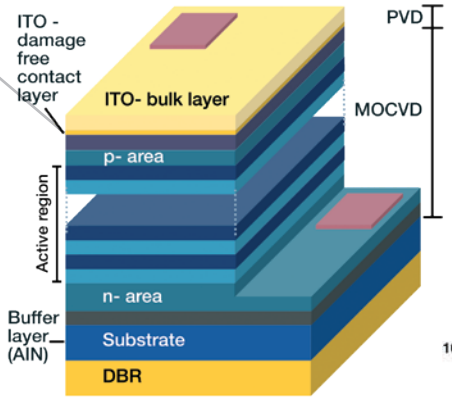
OPTOELECTRONICS

Whether its in established LED production, or for the new Micro LED technology, CLUSTERLINE®'s batch processing architecture enables you to push LED performance to the limit. We can provide unique process solutions bringing together our expertise in achieving the repeatability and accuracy required in optical processes with our capability in automated substrate handling for semiconductor and LED applications.

KNOW-HOW IN TCOs

Damage free TCO's

Evatec's CLUSTERLINE® 200 equipped with batch process module technology is the reference tool for damage free ITO layers for LED and Mirco LED applications. The unique dynamic batch processing enables lowest LED Vf values in combination with highest transmissions and LOP values perfectly matching our customers specific LED design.

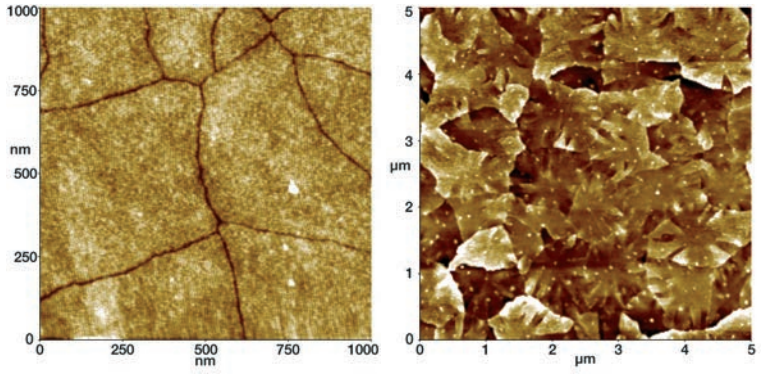


TCO's at a glance

- Damage free TCO contact layers for lowest Vf values
- Low resistivity
- High transmission up to 99.8%
- Unique grain size control
- Thin damage free TCO layer technology down to 150Å
- Material know how in ITO, IZO, GZO and hot ITO
- Low particle counts for Mirco LED by unique shaperless sputter source and automation
- Low CoO due to high throughput and automation
- High system flexibility for 2", 3", 4", 6" and 8" substrates
- Evatec process performance and process support for various LED devices e.g. blue, red

Maximum LED performance through Evatec's process know how

Making a single TCO layer without taking the complete LED device into account is not enough. With Evatec's long term process experience in TCO layers we are the partner to optimise the TCO and annealing process for your specific LED characteristic to push LED performance to the limit.

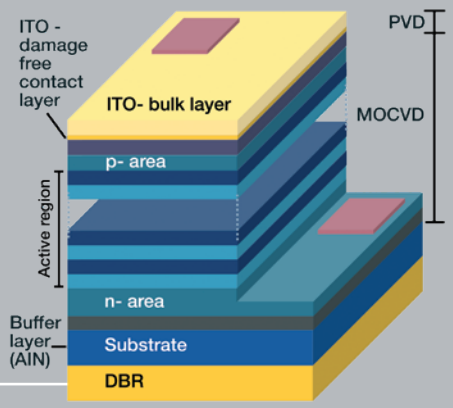


Example of Evatec's ITO grain size control abilities

KNOW-HOW IN DBRs (Distributed Bragg Reflectors)

Low loss DBR Mirror coatings by Ion Assisted Sputtering

A game changer for low loss sputtering is the use of EVATECs plasma source (PSC) in combination with PVD sputtering. The additional process energy provided by the plasma source leads to layers with reduced roughness and thus reduced optical losses. The typical effect is ilustrated below for SiO_2 layers.



DBRs at a glance

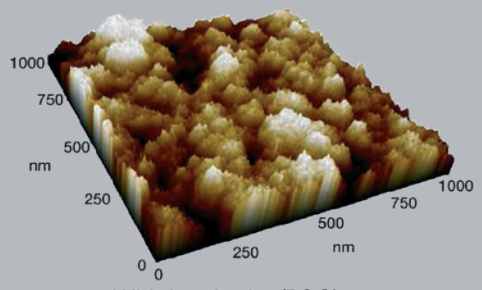
- DBR reflectivity of >99.5% for a specified wavelength range
- Very low optical losses combining PVD sputtering and ion assist
- Excellent thickness uniformities ≤± 0.25%
- Very good run to run repeatability due to in-situ broadband optical monitoring (GSM) ≤± 0.1%
- Low CoO due to high deposition rates by Plasma Emission Monitoring (PEM)
- Full SEMI automation leads to stable film performance and eliminates operator errors

Close partnership

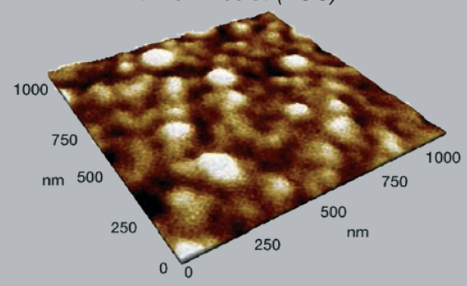
Different LED designs require different DBR solutions and close partnership means we can identify the most suitable mirror design and process technology for you.

"CLUSTERLNE®: One platform for TCO, DBR and metals processes minimizes spare part management and training"

Without Ion Assist (PSC)



With Ion Assist (PSC)



SiO_2 roughness by PVD sputtering in combination with with Ion Assist (PSC) for improvement by a factor of ten

PHOTONICS

CLUSTERLINE® 200 with batch process module technology is perfectly equipped to address wafer level optics applications, integrating the cathode technology for high rate deposition of stable multilayer dielectrics and the particle free automated handling technology essential for the safe processing of high value wafers. Secure thin glass and silicon wafer handling, combined with PEM and Broadband Optical Monitoring (GSM) deliver run to run repeatabilities of ±0.1%.

FACIAL RECOGNITION AND PROXIMTY SENSING

Game changing hardware that delivers new levels of process performance

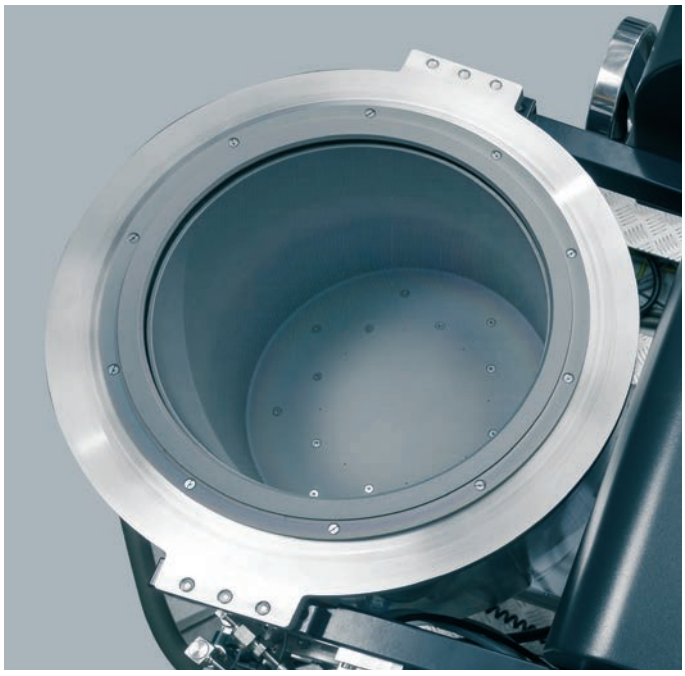
Plasma Source (PSC)

- Surface roughness reduction of SiO_2 by a factor of 10
- Less scattering
- Less optical losses
- Class leading filter transmission values
- Class leading reflectivities for mirrors

Substrate handling and tracking

- Cassette to cassette operation eliminates manual handling
- Integrated vacuum flip for double sided processes
- Batch or individual wafer tracking
- Automatic handling of monitor substrates

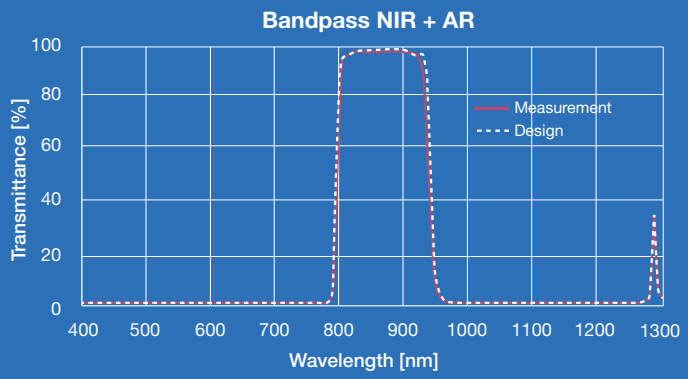
Plasma Source



In-situ substrate flipping for double sided filters and stress control

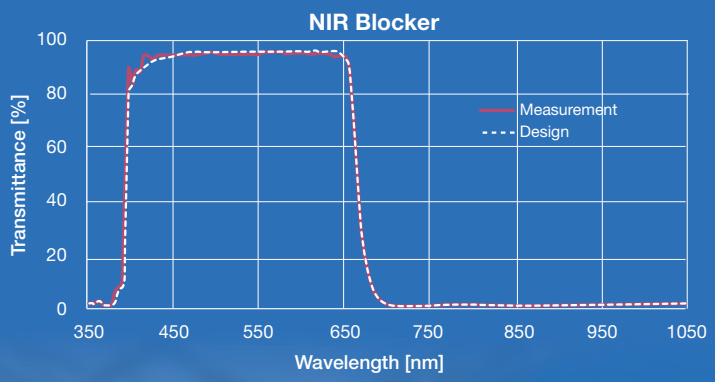
NIR bandpass / VIS blocker

- aSi:H optimised for low stress and low absorption
- aSi:H/SiO_2 reaches T=98% (with AR)
- Broadband monitoring allows control of partially absorbing materials such as aSi
- Excellent thickness uniformity ± 0.25% over 8”



UV-NIR Blocker to improve color rendering of image sensors

- Multilayer SiO_2/Nb_2O_5
- Design manufactured without the need for any test batches



“PERFECT MATCH BETWEEN MEASURED AND DESIGNED CURVES”

WIRELESS / MEMS

CLUSTERLINE® 200 is the perfect choice for processes like gap filling or where uniformity of ≤± 0.5% on 8” is required e.g. TC-SAW electrodes or BAW mirror layers. Evatec’s flexible substrate tooling system enables rapid switch between different substrate sizes and even simulatenous handling of multiple sizes to bring the highest tool utilisation to your production.

PRECISION IN TC SAW / BAW PROCESSES

8” READY FILTER PRODUCTION - Perfect uniformity by combining Plasma Source (PSC) and table with rotary chucks

- Excellent layer uniformity < ± 0.5% on 8”
- Low temperature processing
- High density SiO_2 > 2.32
- FTIR w3, w4 peak control for best TC-SAW device performance
- No voids
- Low particles by eliminating shaper at sputter source
- Very good gap filling combining PVD sputtering and PSC in the unique batch chamber
- High throughput by batch processing
- High system flexibility for 4”, 6” and 8” substrates

GAP FILLING & PLANARISATION - Perfect results using table with RF Bias

- Table with RF Chucks gives perfect gap filling for highest aspect ratios
- High system flexibility for 4” and 6” substrates
- Highest planarisation possible
- High density SiO_2 > 2.32
- Uniformities < ± 1.5% on 6”
- No voids
- Low particles by eliminating shaper at sputter source
- FTIR w3, w4 peak control for best TC-SAW device performance

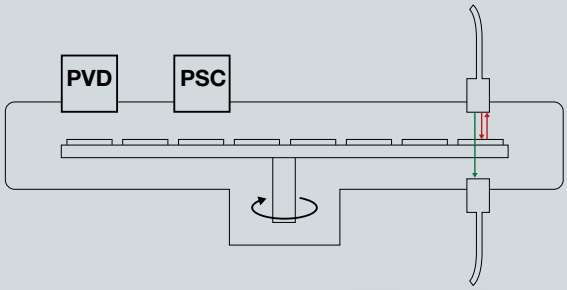
“CLUSTERLINE® DELIVERS CLASS LEADING UNIFORMITIES ON 6 & 8 INCH”

ADVANCED PROCESS CONTROL

In-situ Advanced Process Control (APC) “raises the bar” in delivery of high performance thin film processes. The APC is the enabler for “wafer level optics” or high precision NIR band pass filters for smart phones. In-situ closed loop control is used to monitor the layer thickness, film stoichiometry, refractive index and surface quality. High-end optical processes benefit from the APC capabilities just as much as coatings for the next generation solid state lighting or RF devices.

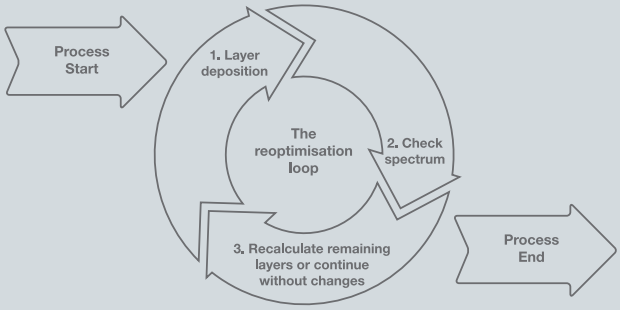
GSM Broadband Optical Monitoring

- In-situ broadband or dedicated wavelength monitoring for layer termination with increased yield
- In-situ measurement during process directly on the production wafer or optionally on a monitor substrate
- Reflection or transmission set-up
- Proprietary strategy generator for easy process setup of new filter designs



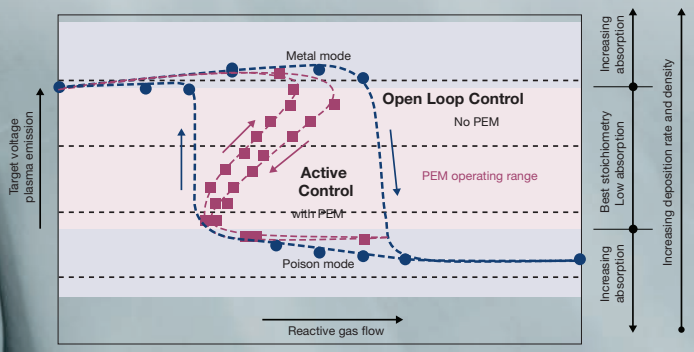
Reoptimisation

- Increased yields for complex stack designs
- Fully automated process, no increase in process times
- Recovers production batches after unexpected process interruptions (e.g. power outage)

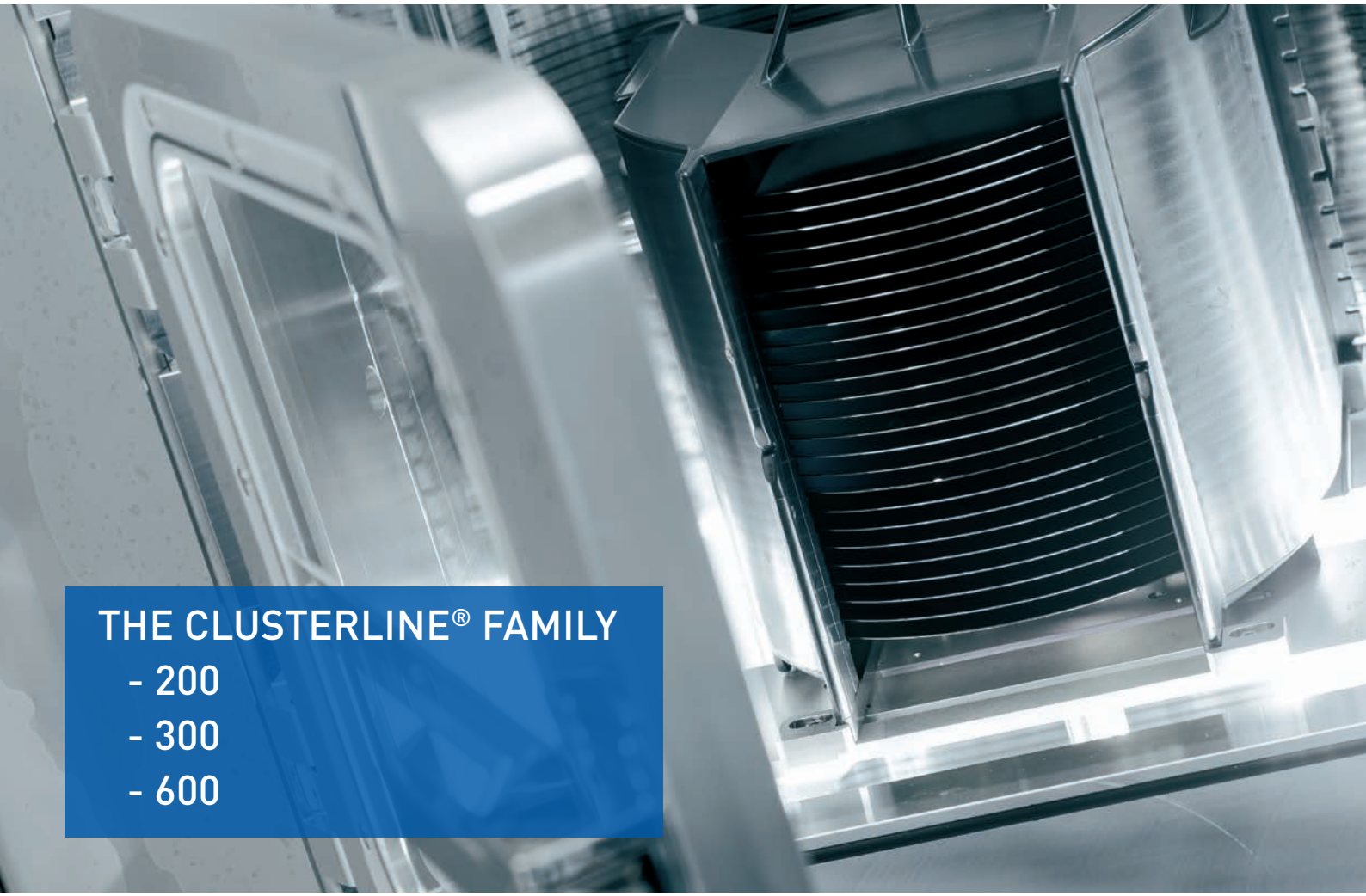


PEM Plasma Emission Monitoring

- Closed loop in-situ process control for precise film stoichiometry
- Fully oxidized films at high deposition rates
- Low oxygen coverage of target for stable process conditions and arc free deposition



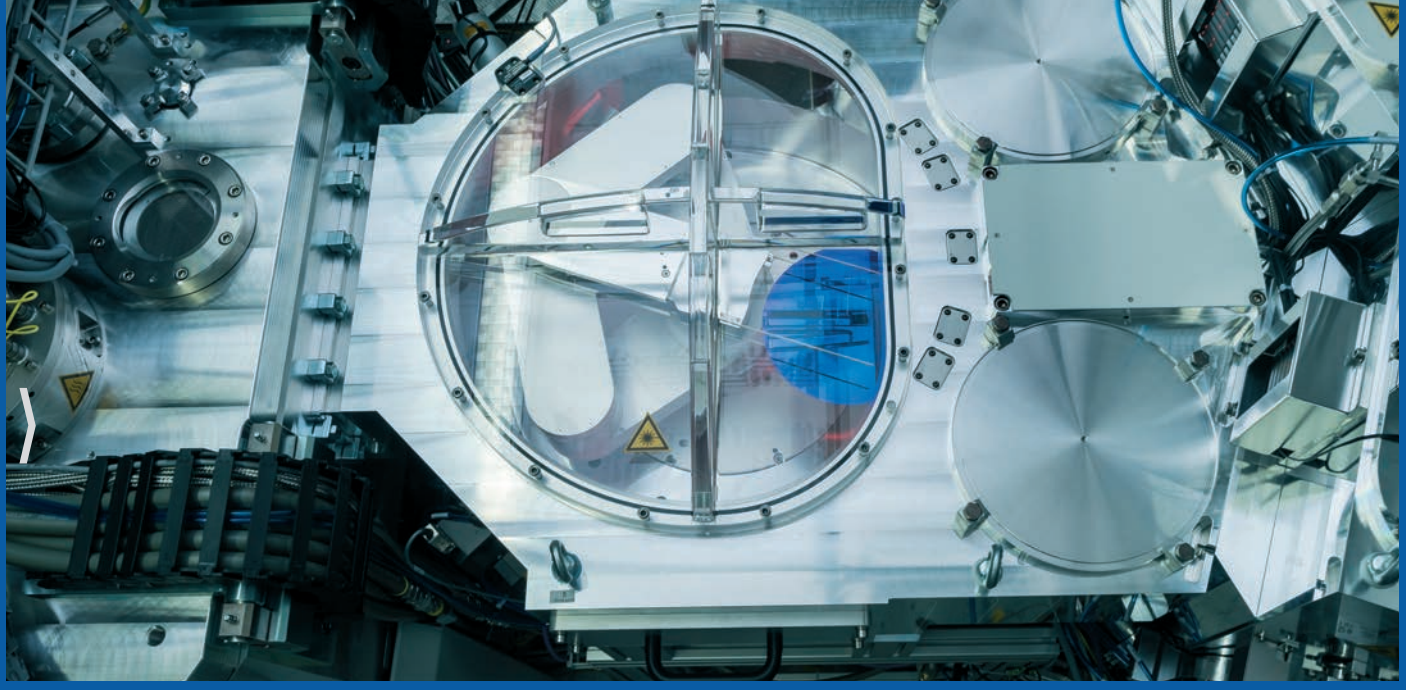
LET THE **CLUSTERLINE®** FAMILY DO THE JOB FOR YOU



THE CLUSTERLINE® FAMILY
- 200
- 300
- 600

CLUSTERLINE® are a family of high volume proven thin film production platforms enabling integration of single process modules such as PVD, highly ionized PVD, soft etch, PECVD as well as PVD batch process modules (bpm).

You can count on Evatec's processes know-how, proven hardware and the advanced substrate handling capabilities to deliver what you need today and tomorrow.



CLUSTERLINE® FAMILY FEATURES

Load Locks

- For best process performance
- Same process conditions from first layer onwards

Thin substrates

- Reliable handling of thin substrates of ≤ 0.1mm thickness
- Various types of substrates including highly transparent glass

Cassette to Cassette

- Minimum particle count – no manual substrate manipulation
- Increased yield – less operator failures
- Continuous production – lower Cost of Ownership

Vacuum substrate flipper

- Vacuum substrate flipper for double sided substrate coatings and for stress compensation
- Supports fully automated monitor substrate handling through CLUSTERLINE® system control software

CLUSTERLINE® 200
LAYOUT WHEN EQUIPPED WITH BPM LAYOUT

Footprint:

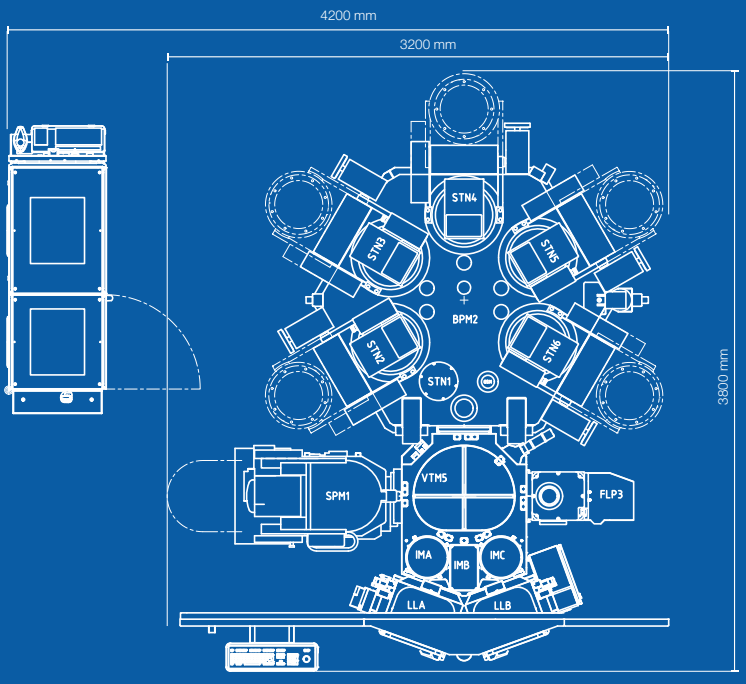
- System size: 3.2m x 3.8m
- Total area with control tower 4.2m x 3.8m

Max number of sources:

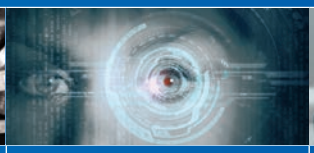
- 5 pcs (4pcs PVD & 1 pc PSC)

Certificates

- TUV CE, TUV NFPA79, SEMI S2



CLUSTERLINE® 200 WITH BPM

SPECIFICATIONS			
BPM (Batch Process Module)	LED, Micro LED	Bandpass filters, DBR, LED, Mirco LED, IR-Filter,	TC-SAW, BAW, Backside Via TFR
Materials	ITO, IZO, GZO, Ag, Au, Ti, TiW, Ni, Cr, Al, Cu	SiO_2, aSi, Si_3N_4, Nb_2O_5, AlO_3, HfO_2, Cr, Al, CrOx, CrOxNy, Ta_2O_5	SiO_2, Al, Cu, AlCu, Cr, Ti, TiW, C
Base Pressure	< 5.0 e^{-7} mbar	< 5.0 e^{-7} mbar	Table rotating chucks: < 5.0 e^{-7} mbar Table RF bias: < 9.0 e^{-7} mbar
Leak Rate	< 7.0 e^{-5} mbar l / sec	< 7.0 e^{-5} mbar l / sec	Table rotating chucks: < 7.0 e^{-5} mbar l /sec Table RF bias: < 2.0 e^{-4} mbar l /sec
Substrate dimensions	2”, 3” ,4”, 6”, 8”, carrier, custom	4”, 6”, 8”, custom	4”, 6” ,8”, custom
Max number of sources	5 pcs (4pcs PVD & 1 pc PSC)		
Capacity per batch examples	Damage free process: ▪ 4”: 42 pcs substrates (14 pcs carrier per batch) ▪ 6”: 17 pcs substrates (direct load)	Monitor substrate (GSM) ▪ 6”: 19 pcs substrates + 1 pcs 6” monitor substrate (direct load) ▪ 8”: 14 pcs substrates + 1 pcs 8” monitor substrate (direct load)	Best uniformity & medium planarisation / rotating chuck table: ▪ 6”: 20 pcs substrates (direct load) ▪ 8”: 15 pcs substrates (direct load)
	Non damage free process: - ▪ 4”: 48 pcs substrates (16 pcs carrier per batch) ▪ 6”: 20 pcs substrates (direct load)	Non monitor substrate ▪ 6”: 20 pcs substrates (direct load) ▪ 8”: 15 pcs substrates (direct load)	High planarisation / RF Bias table: ▪ 6”: 20 pcs substrates (direct load)
Typical source configuration	2x PVD SSC 300 RF/DC	2x PVD SSC 320 DC / 1x PSC	2x PVD SSC 300 RF / DC (1x PSC)
Typical table configuration	2”, 3”, 4” table for carrier 6” table for direct load substrates	6”, 8” table with rotating chucks	Best uniformity & medium planarisation: 6”, 8” table with rotating chucks & PSC High planarisation: 4”, 6” table with RF Bias static chucks
Target Shutter	Yes		
Chamber pressure control	Upstream: Yes Downstream: None (3-pos valve)	Upstream: Yes Downstream: Yes (control valve)	Upstream: Yes Downstream: None (3-pos valve)
Target substrate distance	40 – 130mm - adjustable		
Table rotation speed	0 – 60 rpm		
Chuck rotation speed	N/A	0 - 100 rpm	Table rotating chucks: 0 - 100 rpm Table RF Bias: N/A
Chamber conditioning heating	Optional ≥ 80°C		
Certificates	TUV CE, TUV NFPA79, SEMI S2		

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