



Global expertise in plasma processing

Hardware | Process | Software | Electronics | Service



WELCOME TO CORIAL

IN THE HEART OF THE FRENCH SILICON VALLEY



“

We are CORIAL, the plasma processing equipment manufacturer and plasma process developer for specialty semiconductor markets.

Our goal? Help you innovate by understanding your needs and turning your dreams into reality.

”



Flexibility



Technical
prowess



30 years of
experience





WE ARE BASED IN GRENOBLE

IN THE HEART OF THE FRENCH SILICON VALLEY



LYON St-Exupery Airport

LYS - 1 hour

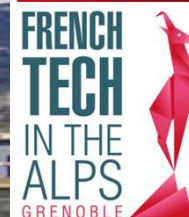
GENEVA Airport

GVA - 1,5 hours



GRENOBLE <-> PARIS

TGV – High Speed Train
3 hours



What makes
La Différence ?

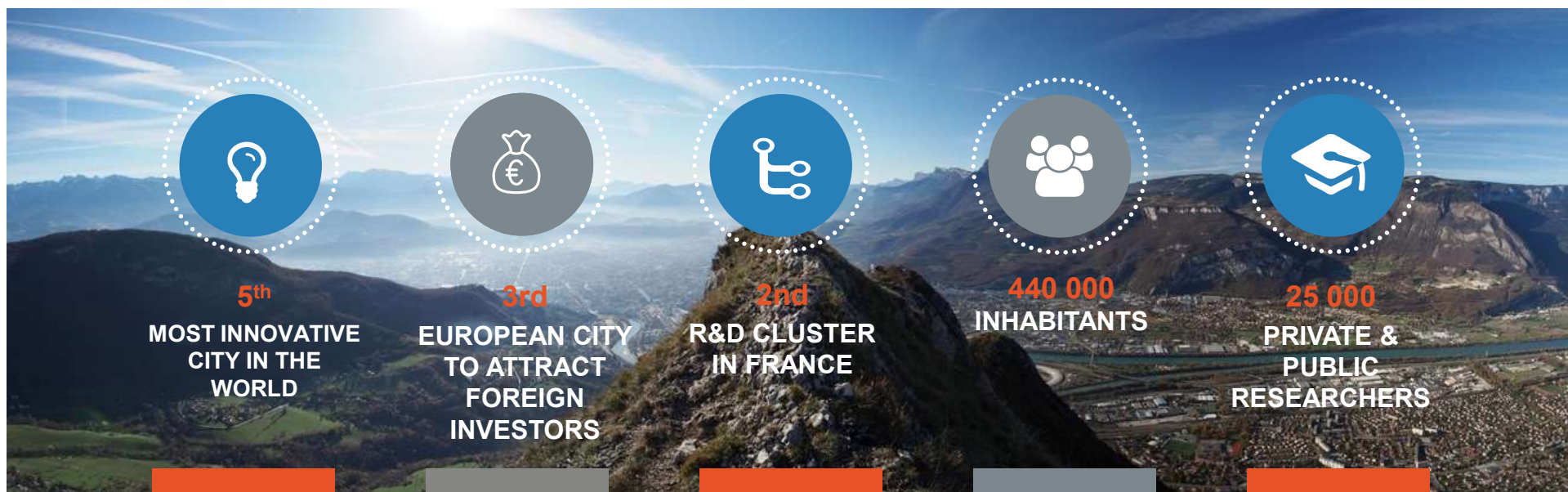
CORIAL is part of the FRENCH
TECH governmental program.





GRENOBLE ECOSYSTEM

IN THE HEART OF THE FRENCH SILICON VALLEY



Grenoble is a focused Ecosystem
In the heart of the French silicon valley



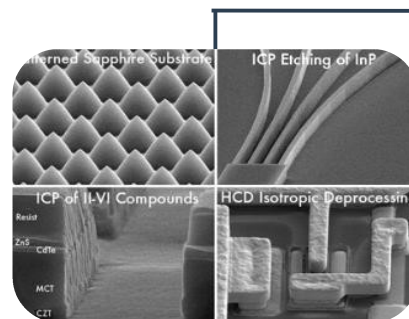


IMAGINE OUR WORLD OF PLASMA

IN THE HEART OF THE FRENCH SILICON VALLEY



Establishment
34 years ago



Large & extensive
process database

*Servicing various
markets:-*

Power Semiconductor
Optoelectronics
Integrated optics
Wireless
MEMS

Worldwide
installed base &
Support



Clean Room for **R&D** and
Equipment **Production**

CORiAL

Markets/Apps/Presence

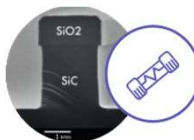


8 KEY MARKETs

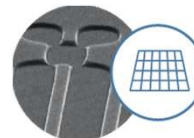
IN THE HEART OF THE FRENCH SILICON VALLEY



Solutions for IC delayering down to the 20 nm technology node



Exceptional process flexibility, from high SiC etch rates to low damage film deposition



Cost-effective mask repair technology, up to 8" x 8"



Solutions to handle the wide range of materials required for MEMS devices fabrication



Silicon and glass DRIE capability on conventional ICP-RIE equipment



Processes for silicon oxide, III-V and lithium niobate-based photonic platforms



Expertise for sapphire patterning on 6" wafers and low temperature PECVD



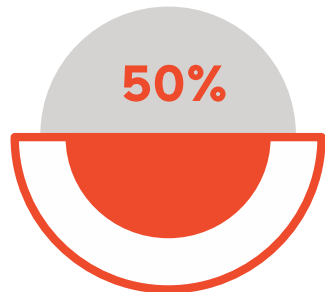
Clean processing with retractable liner that protect reactor, and collects by-products



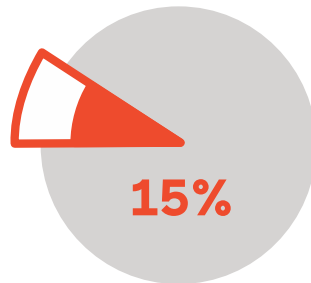


CUSTOMER PROFILE

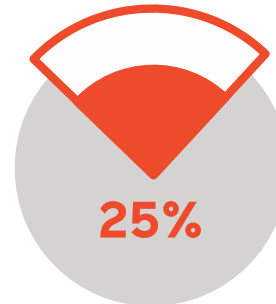
By segments



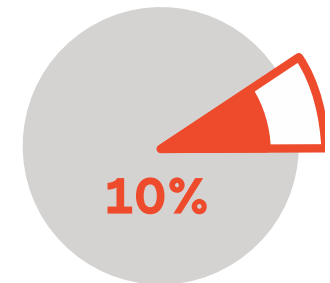
Production Industries



Failure Analysis



Academia & Research



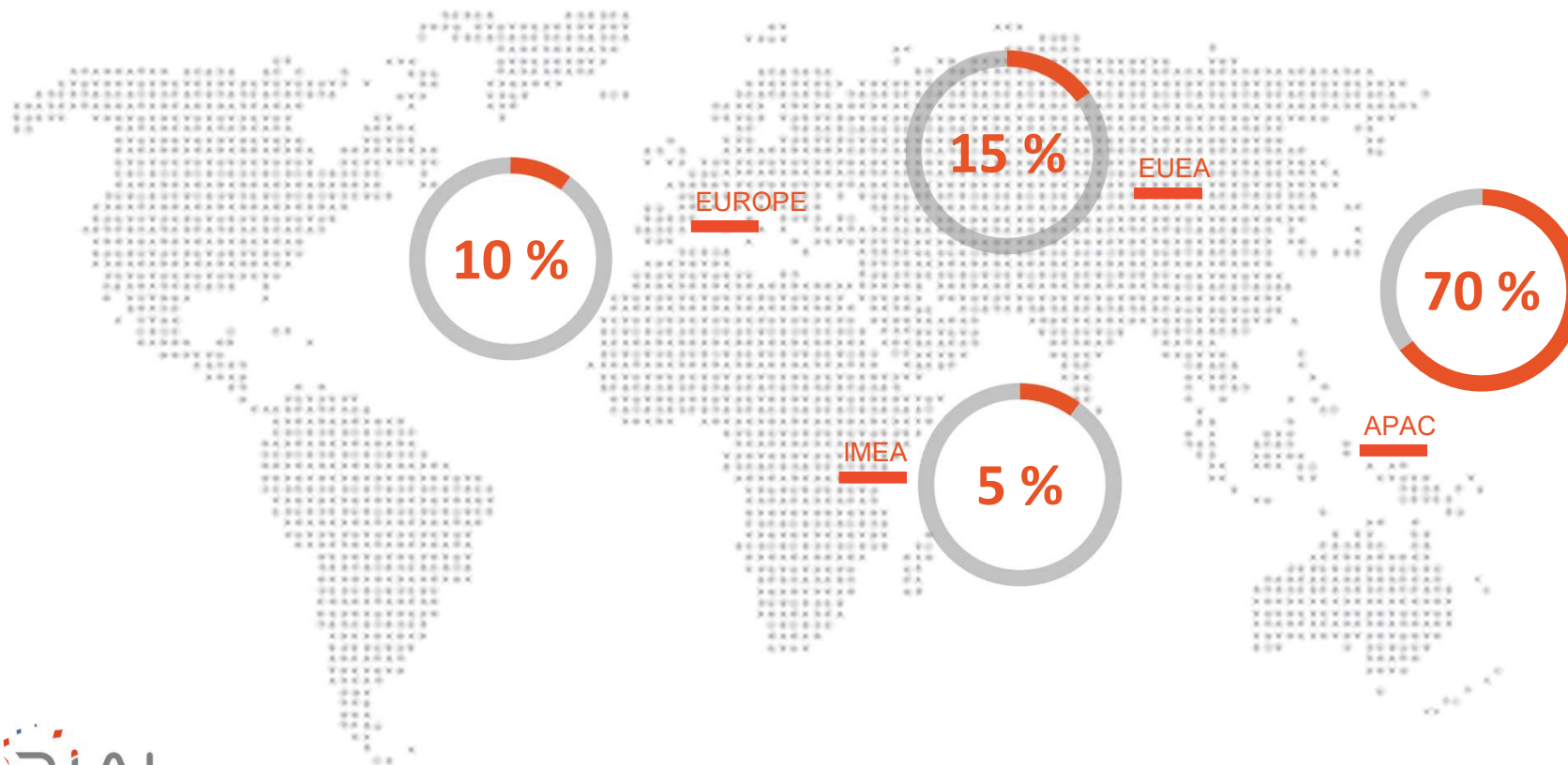
Other





CUSTOMER PROFILE

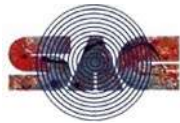
>250 systems installed





SOME REFERENCES

IN THE HEART OF THE FRENCH SILICON VALLEY



DISCOVER OUR
PRODUCTS
&
TECHNOLOGY



DISCOVER OUR TECHNOLOGIES

Deposition Technologies

STANDALONE
PROCESS MODULES

SERIE 200

FOR R&D AND
LOW VOLUME
PRODUCTION



Wafer processing up to 200 mm
with single substrate loading

SERIE 300

FOR 24/7 PRODUCTION
ENVIRONMENT



Batch loading for wafer
processing up to 300 mm

SERIE 500

VERY LARGE
BATCH SYSTEM



Very large area reactor for batch
loading of wafer up to 300 mm





ICP-RIE Etch system CORiAL210IL

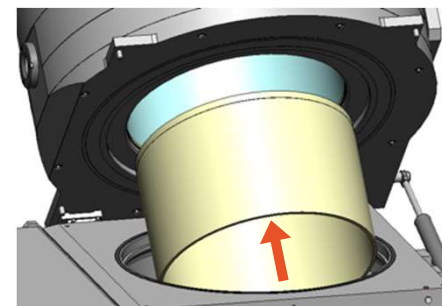
CORIAL's Latest Generation of Reactor

FAST AND UNIFORM ETCHING



THE LINER FOR HARSH ICP-RIE PROCESSES

1. Load lock to run fluorinated and chlorinated chemistries in the same process recipe
2. Load lock for stable and repeatable process conditions
3. RF match box with matching range up to 2000 W
4. Uniform temperature control (from -50°C) for best repeatability
5. Hot walls (>250°C) minimize polymer condensation for selective processes
1. Hot walls and retractable liner reduce clean time
1. Retractable liner and shuttle holding to minimize process cross-contamination





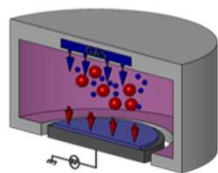
ETCHING PLASMA SOLUTIONS

Etch Technologies

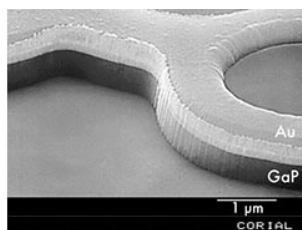


RIE

REACTIVE ION
ETCHING

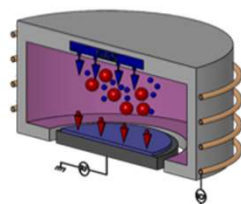


Simple-to-operate equipment for etching a wide range of materials with moderate etch rates

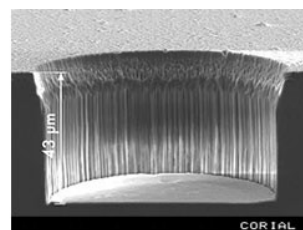


ICP-RIE

INDUCTIVELY
COUPLED PLASMA
REACTIVE ION ETCHING

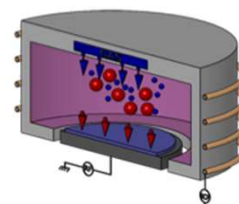


Available processes span from low damage etching to rapid etching of hard materials

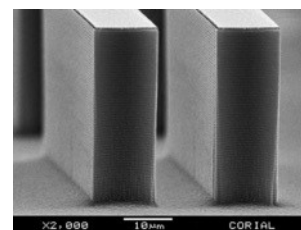


DRIE

DEEP REACTIVE
ION ETCHING

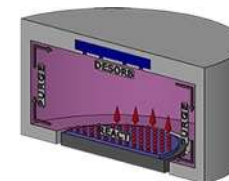


High etch rate, excellent profile control, and high selectivity for etch depth greater than 100 μm

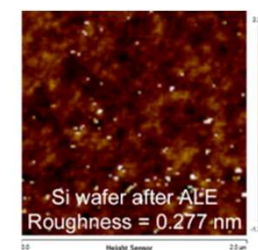


ALE-like

ATOMIC LAYER
ETCHING

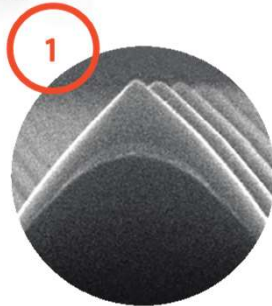


Etch technology enabling the controlled removal of material from a substrate, layer-by-layer

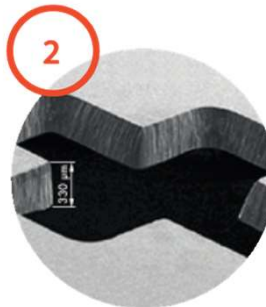


ETCH Solutions

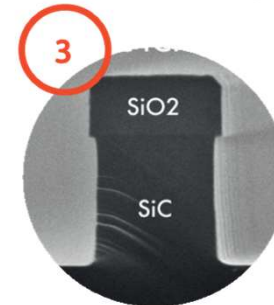
HARD MATERIALS



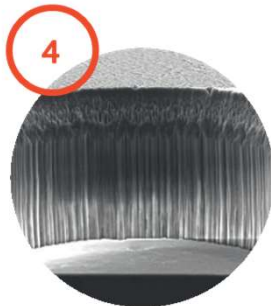
Uniform 6" patterned sapphire substrate fabrication for HB-LEDs



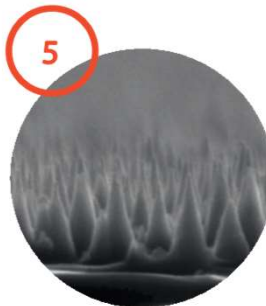
High-rate through sapphire wafer etching for MEMS aerospace applications



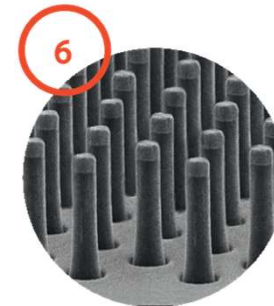
SiC trench etching with smooth sidewalls for power devices



High-rate SiC via-hole etching for RF devices



Roughening of LiNbO3 substrate for SAW filters

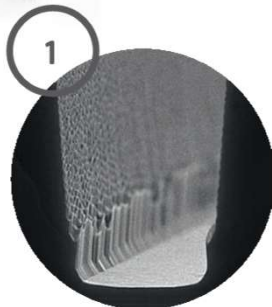


HAR glass pillars micromachining for BioMEMS

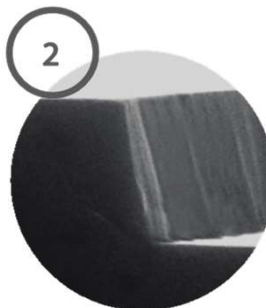


ETCH Solutions

III-V MATERIALS



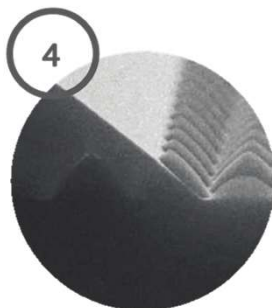
Fast and deep etching of GaAs for MMICs



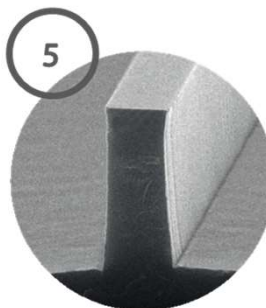
Anisotropic etching of GaAs for mesa structuring



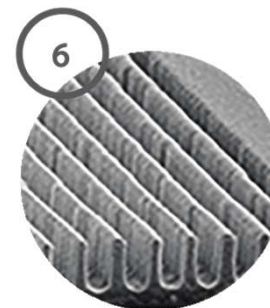
Etching of GaAs-based stacks for VCSEL



Fast etching of GaN for isolation of HB-LEDs on 6" wafer



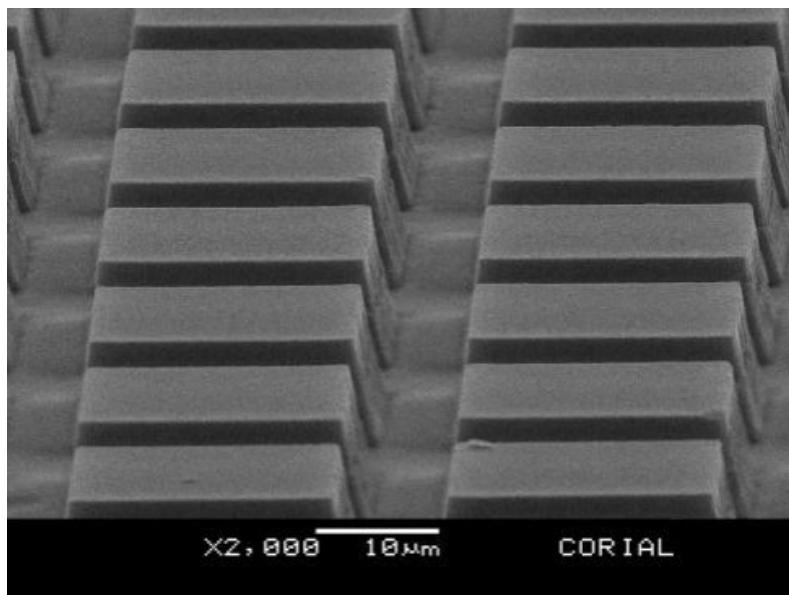
Vertical InP ridge etching for waveguides



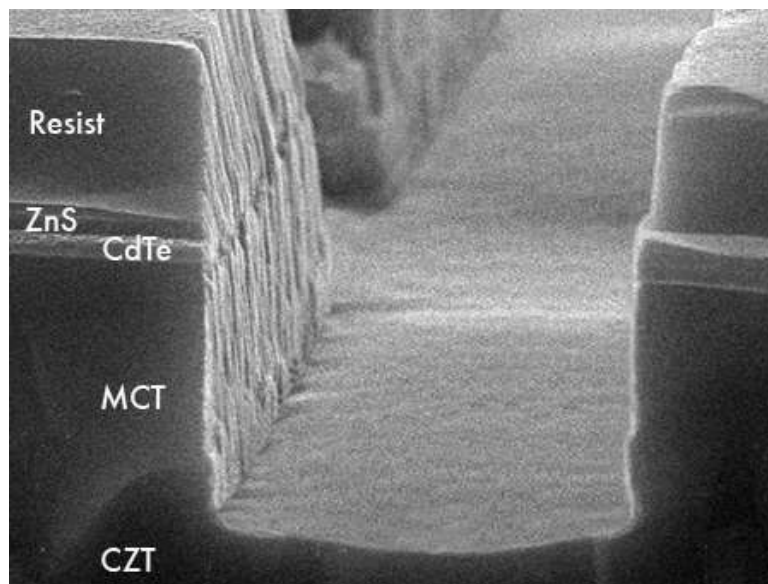
Etching of InP for gratings fabrication



ETCH Solutions
II-VI MATERIALS

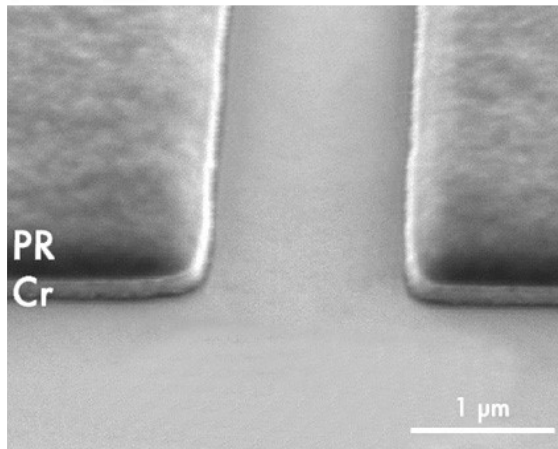


ICP-RIE of
ZnS & CdTe

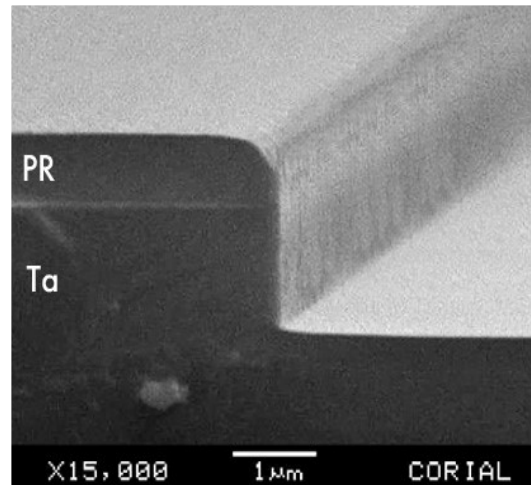


ICP-RIE of
MCT

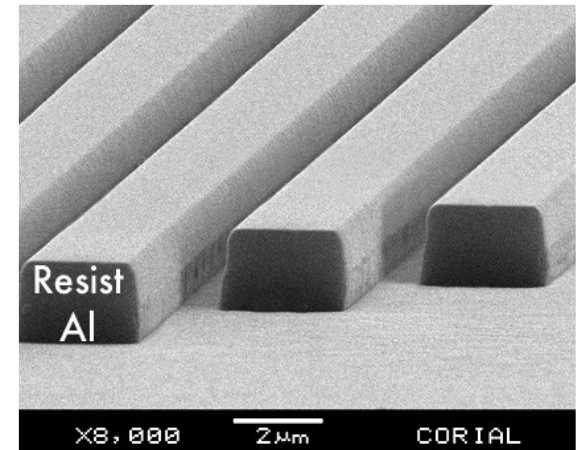




ICP-RIE of Cr



ICP-RIE of Ta

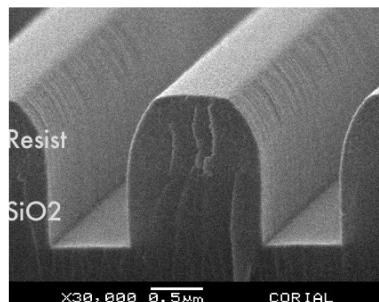


ICP-RIE of Al

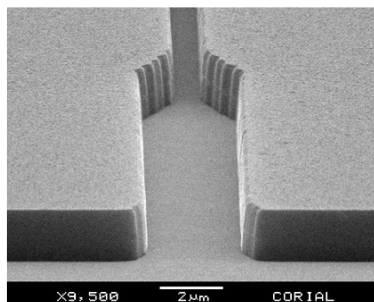


ETCH Solutions

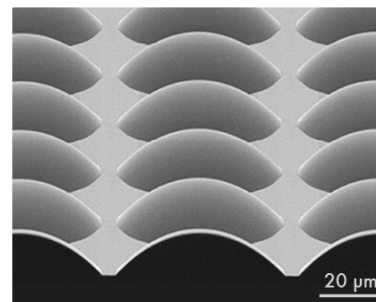
DIELECTRIC & MISC MATERIALS



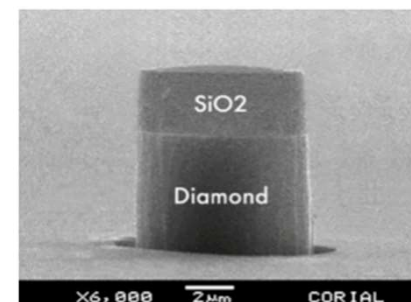
ICP-RIE of SiO₂



ICP-RIE of Si₃N₄



ICP-RIE of SiO₂ microlenses



ICP-RIE of Diamond

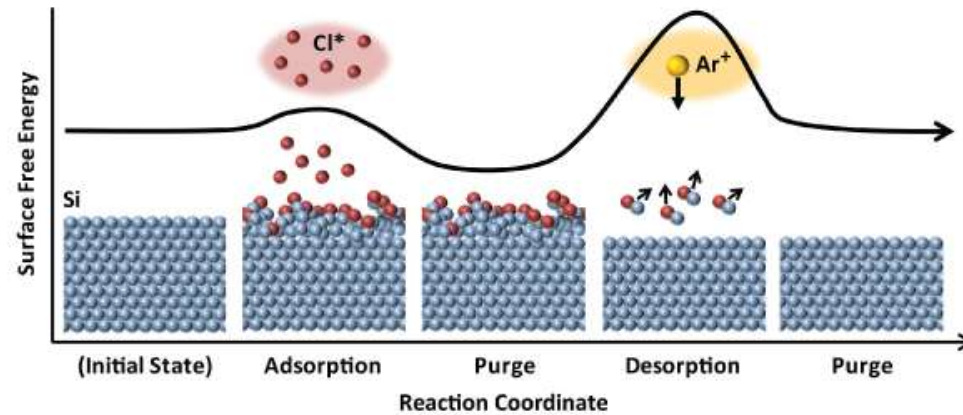
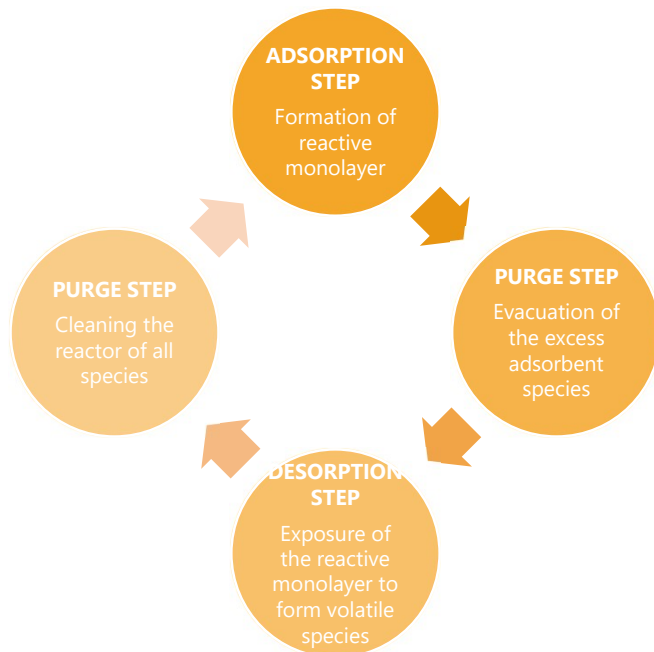
Process	Mask	Etch rate (nm/min)	Selectivity (vs mask)	Uniformity (across wafer)
SiO ₂	PR	400	> 3	±3%
Si ₃ N ₄	PR	350	> 4	±3%
Diamond	SiO ₂	500	> 25	±3%





TIME-MULTIPLEXED for **ALE** etch

Atomic Layer Etching



SELF LIMITED SURFACE REACTION

APPLICATIONS:

- POWER AND RF & MW ELECTRONICS
- R&D, NANOTECHNOLOGY
- NM-SCALE IC TECHNOLOGY
- AND MANY MORE...



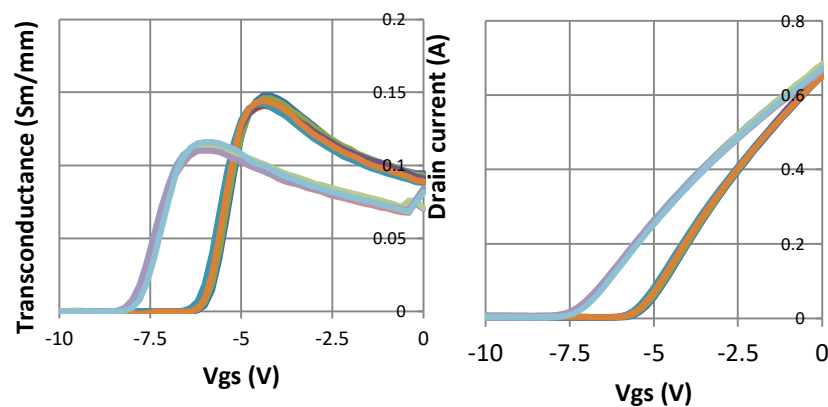


TIME-MULTIPLEXED for ALE GaN etch

Atomic Layer Etching



Atomic scale etching of GaN
HEMT application



HEMT performances
before (left curves) and after recess etching (right curves)

Etching rate 0,4 Å/cycle
Stop etch on AlGaIn



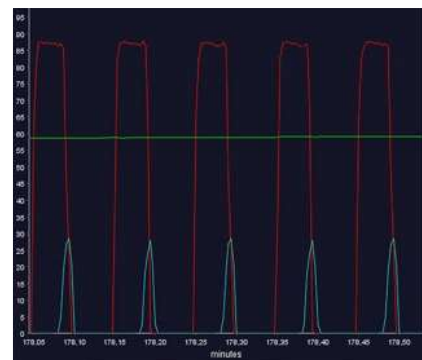
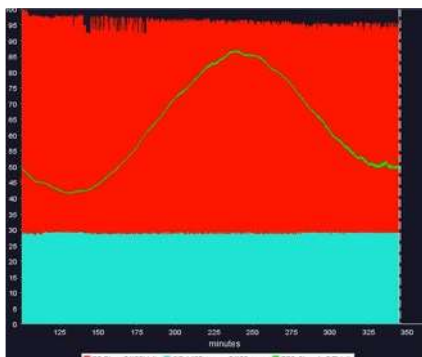


TIME-MULTIPLEXED for ALE Si etch

Atomic Layer Etching



Data logging showing the pulsed process parameters (RF power and Cl₂ flow rate) and laser signal:



Advanced tuning of RF pulsing (red) to control ion energy

Independent and rapid pulsing of chlorine (blue) and argon flows during adsorption and desorption steps

Real-time process adjustment



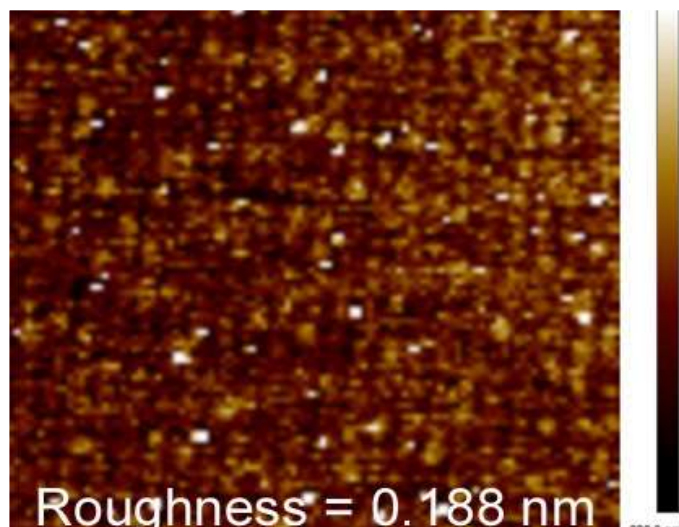


TIME-MULTIPLEXED for ALE Si etch

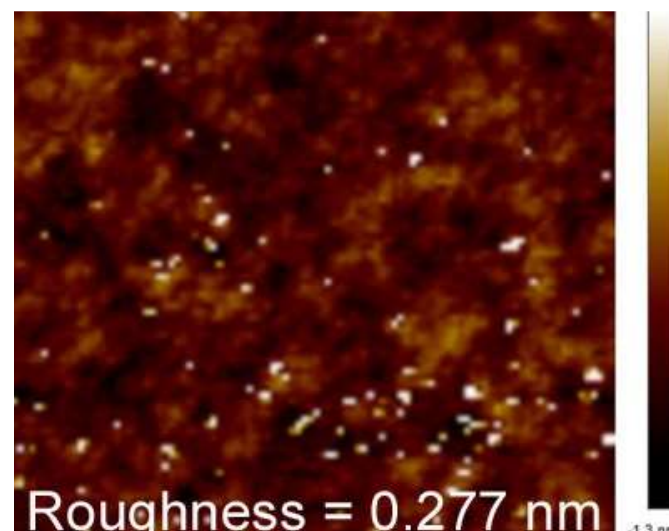
Atomic Layer Etching



Silicon etch rate of 1.67 nm/min with atomically smooth surfaces



Silicon wafer before etching
Roughness = 0.188 nm



Silicon wafer after 0.5 μm deep etching
Roughness = 0.277 nm



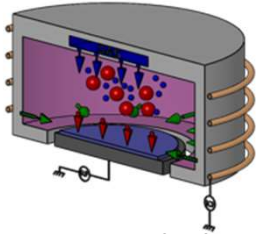


DEPOSITION PLASMA SOLUTIONS

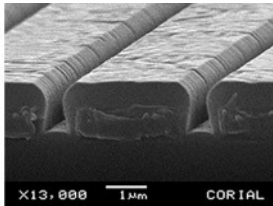
Deposition Technologies

ICP CVD

INDUCTIVELY
COUPLED PLASMA
CHEMICAL VAPOR
DEPOSITION

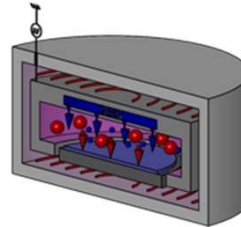


Technology for film deposition on-to temperature and/or damage-sensitive substrates

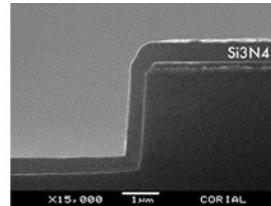


PECVD

PLASMA ENHANCED
CHEMICAL VAPOR
DEPOSITION

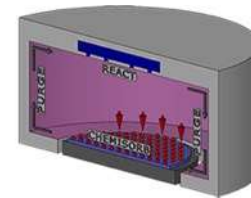


Uniform deposition of thin films (Si, SiO₂, Si₃N₄, etc.), with excellent control of material properties

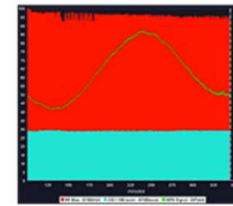


ALD-like

ATOMIC LAYER
DEPOSITION



Highly conformal coatings for MEMS applications, and semiconductor devices



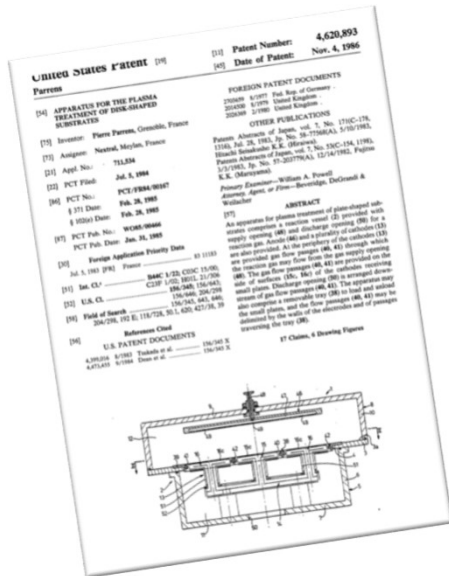


Deposition CORIAL D250L

MAY 3RD 2017

PECVD PLASMABOX
WORLD EXCLUSIVITY

ISOTHERM & PRESSURIZED
REACTOR WITH VACUUM
VESSEL



1. MINIMUM IMPURITY LEVELS IN DEPOSITED FILMS

- Contamination in aSi-H deposited films is reduced by 50 for Oxygen and by 5 for Carbon

2. SUPERIOR PROCESS REPEATABILITY

- Deposition uniformity $< \pm 3\%$ on batch of 25x4" wafers

3. HIGH DEPOSITION RATES

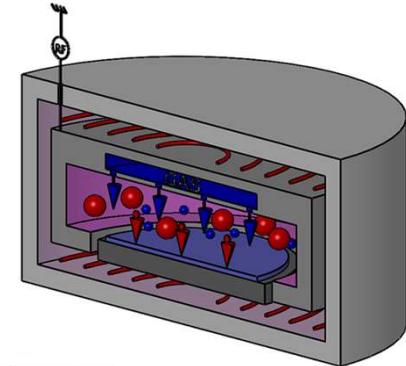
- Deposition rates: 520 nm/min for SiO₂, 250 nm/min for Si₃N₄, 150 nm/min for SiOCH, 100 nm/min for SiC
- Maximum thickness without powders up to 100 μ m

4. INCREASED UPTIME

- No manual cleaning of reactor or vacuum vessel required for many years of operation

5. LOW TEMPERATURE DEPOSITION

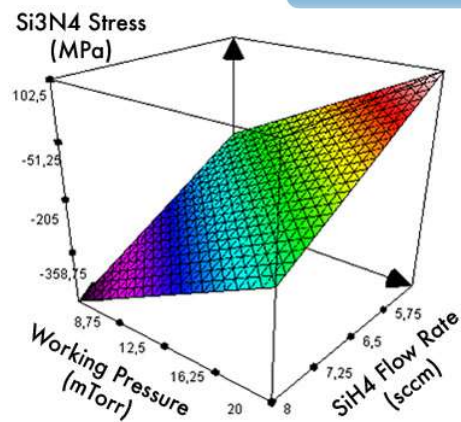
- High-quality, low-damage film deposition at substrate temperatures from 20 to 150°C or 120 to 325°



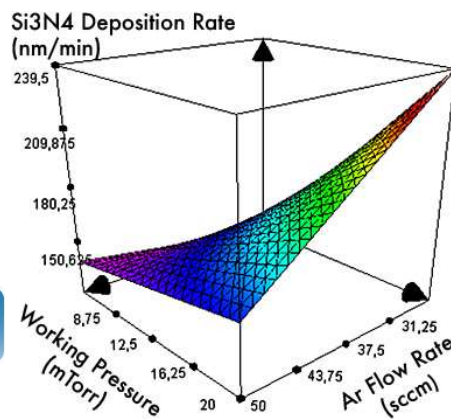


CORIAL 210D ICP-CVD PRPOCESSES

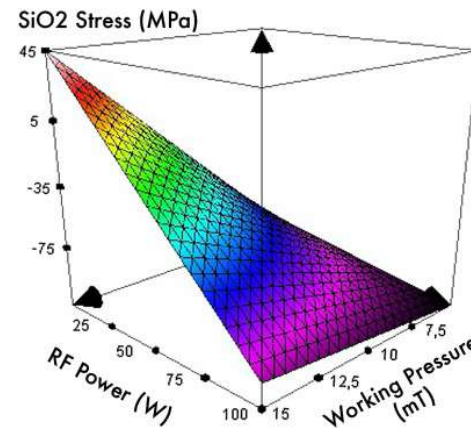
Si_3N_4 with tunable stress



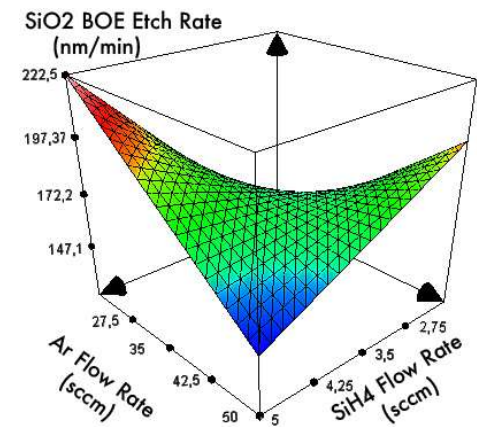
Si_3N_4 with high deposition rate



SiO_2 with tunable stress



SiO_2 with low BOE rate



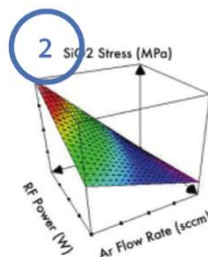


CORIAL D250L PECVD Processes

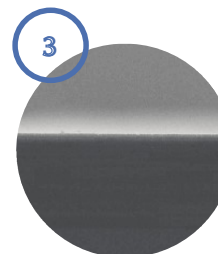
DIELECTRIC & MISC MATERIALS



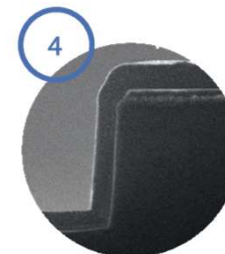
PECVD SiO_2 passivation film deposition



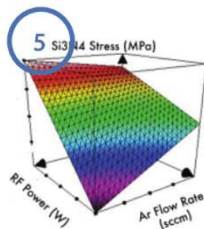
Control of SiO_2 film stress by RF power, Ar flow rate and gas mixture



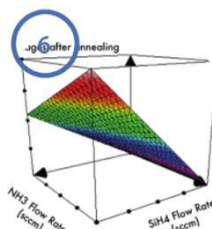
Thick PECVD layer of SiO_2 without pinholes for hard mask



Uniform deposition of Si_3N_4 film for photodiodes



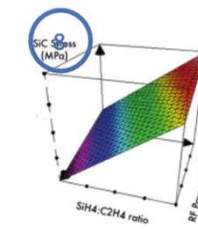
Control of Si_3N_4 film stress by RF power, Ar flow rate and gas mixture



Low damage Si_3N_4 film deposition for photodiodes



Self planarizing PECVD of SiOF for SAW filters



High quality SiC film by PECVD at temperatures $<100^\circ\text{C}$ for OLEDs



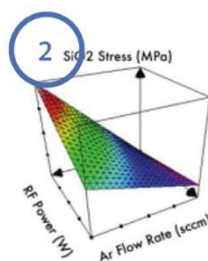


CORIAL D250L PROCESSES

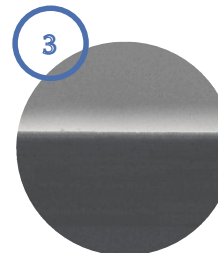
- Dielectric materials



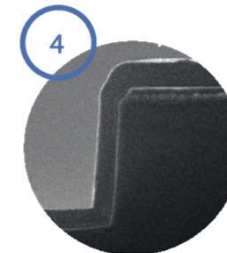
PECVD SiO_2 passivation film deposition



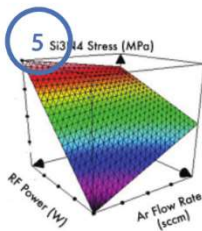
Control of SiO_2 film stress by RF power, Ar flow rate and gas mixture



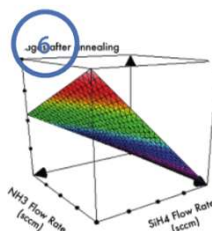
Thick PECVD layer of SiO_2 without pinholes for hard mask



Uniform deposition of Si_3N_4 film for photodiodes



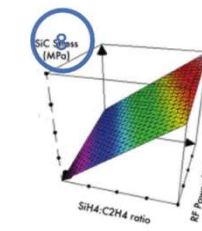
Control of Si_3N_4 film stress by RF power, Ar flow rate and gas mixture



Low damage Si_3N_4 film deposition for photodiodes



Self planarizing PECVD of SiOF for SAW filters



High quality SiC film by PECVD at temperatures $<100^\circ\text{C}$ for OLEDs



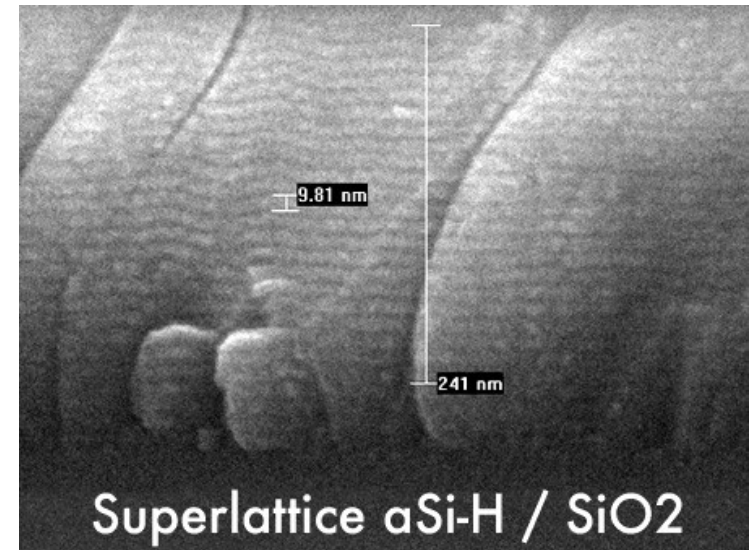
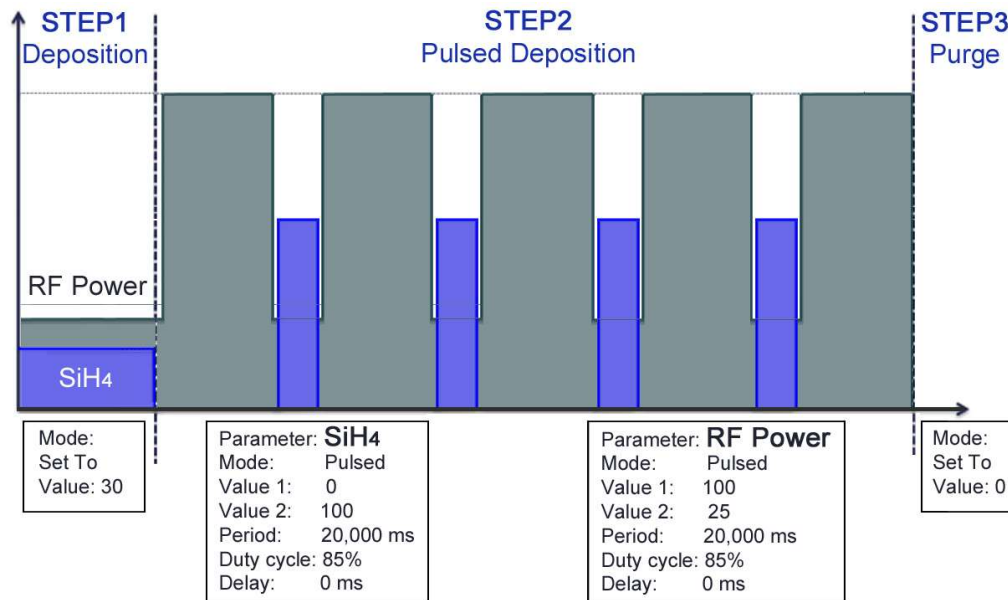


TIME-MULTIPLEXED for ALD-like film

Atomic Layer Deposition



Enlarged process window to achieve better control of film properties, and supports Atomic Layer Deposition



Deposition of 30 periods:
6 nm SiO₂ + 4 nm aSi-H`
by COSMA Pulse software

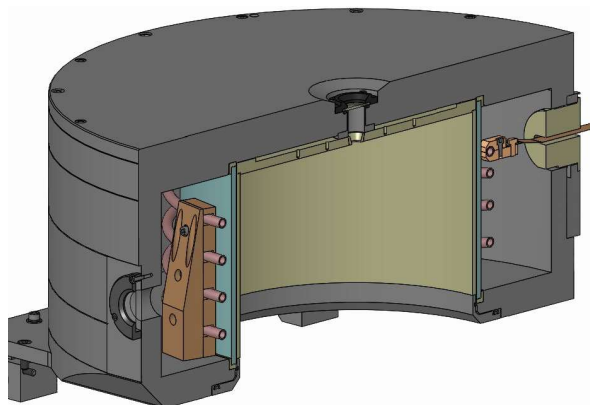


OPERATIONAL BENEFITS



LINER in CORIAL 210IL

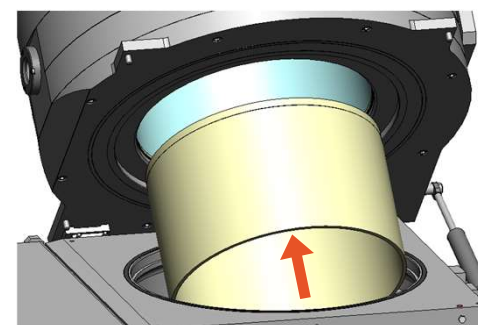
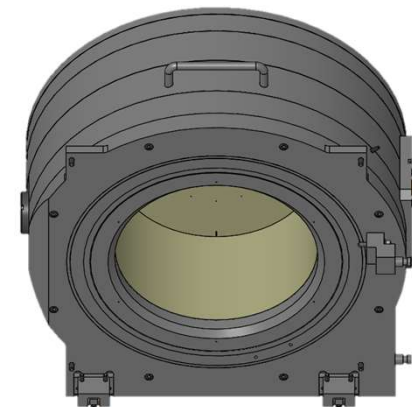
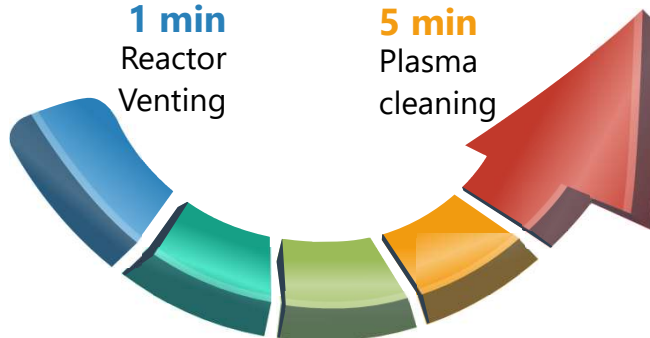
Operational Benefits



200iL LINER FOR HARSH ICP-RIE PROCESSES

5 min
Liner
replacement
1 min
Reactor
Venting

4 min
Pumping down
to 10^{-4} Tor
5 min
Plasma
cleaning



**ZERO
CROSS
CONTAMINATION**

CORIAL
A Plasma-Therm Company



PROCESS CONTROL SOFTWARE

Operational Benefits



Cortex®

The simplest, most efficient software to develop processes, operate, and maintain CORIAL systems



DESKTOP APPLICATION

Process Editing | Process Adjustment | Process Operation
Process Tracability | System Maintenance



REMOTE CONTROL



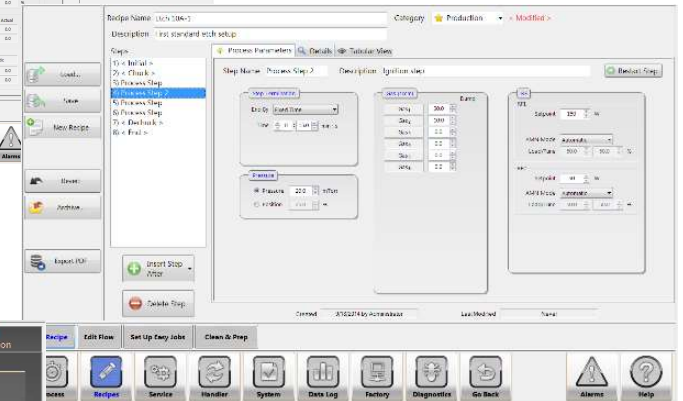
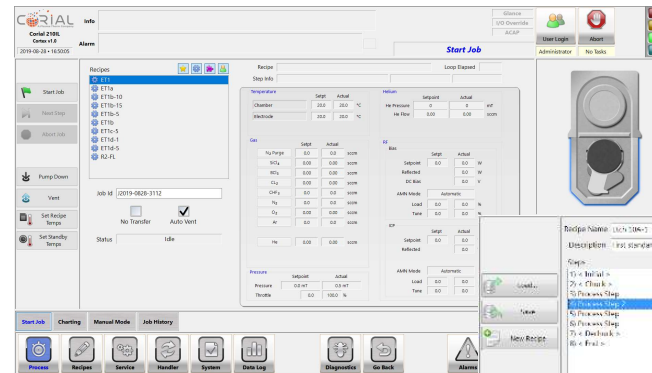


CORTEX SOFTWARE

Operational Benefits

Plasma-Therm proven controls

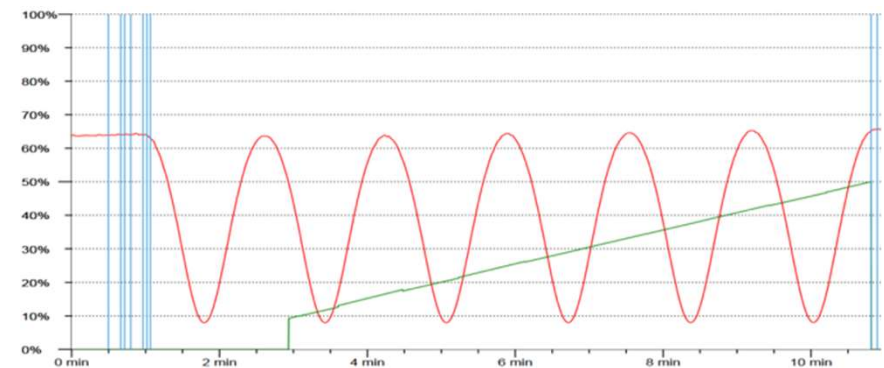
- Graphical User Interface
- Recipe Automation (incl'd proprietary endpoint controls)
- Material handling
- Data Display, Charting, Logging
- Maintenance & Service





END POINT DETECTION

OES & LASER END POINT



A CCD camera and laser diode, in the same measuring head, enables simultaneous visualization of the wafer surface and the laser beam impact on it. A 20 μm diameter laser spot facilitates the record of interference signals.

Real-Time etch rate measurement
Real-Time etched depth
measurement





NEVER VERY FAR AWAY AT **YOUR SERVICE**

MAY 3RD 2017

- CUSTOMER SATISFACTION IS OUR CORE
VALUE



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