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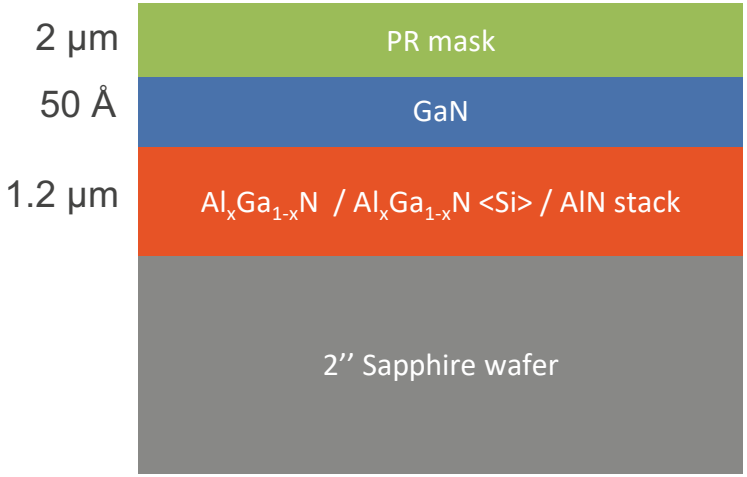
Recess etch for HEMT application

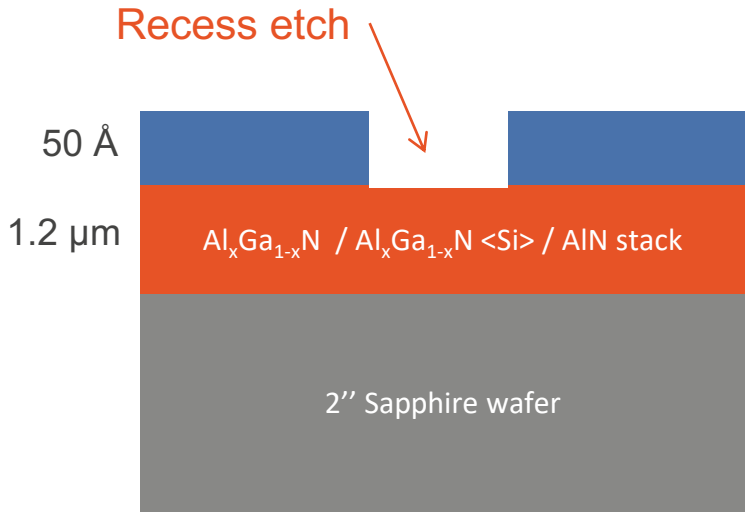
In Corial 210IL

DEVICE STRUCTURE

GaN/AlGaN HEMT Structure

HEMT structure grown on Sapphire substrate





PROCESS SOLUTION
GAN RECESS ETCH

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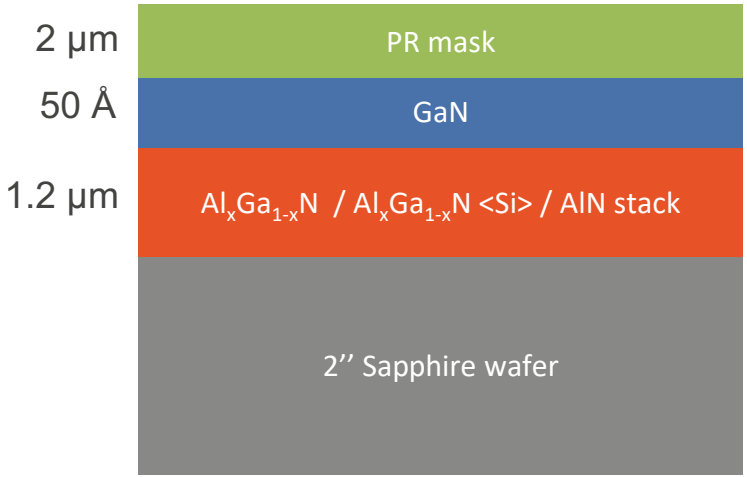
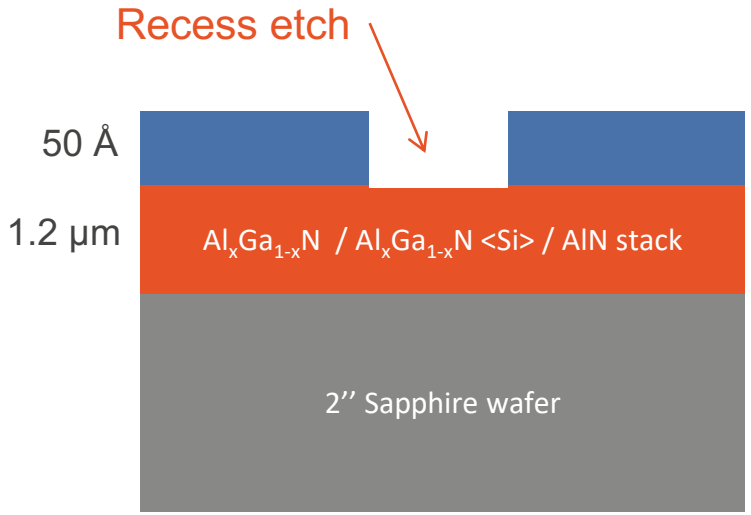
DEVICE STRUCTURE

GaN/AlGaN HEMT Structure

HEMT structure grown on Sapphire substrate





PROCESS REQUIREMENTS

GaN Recess Etch

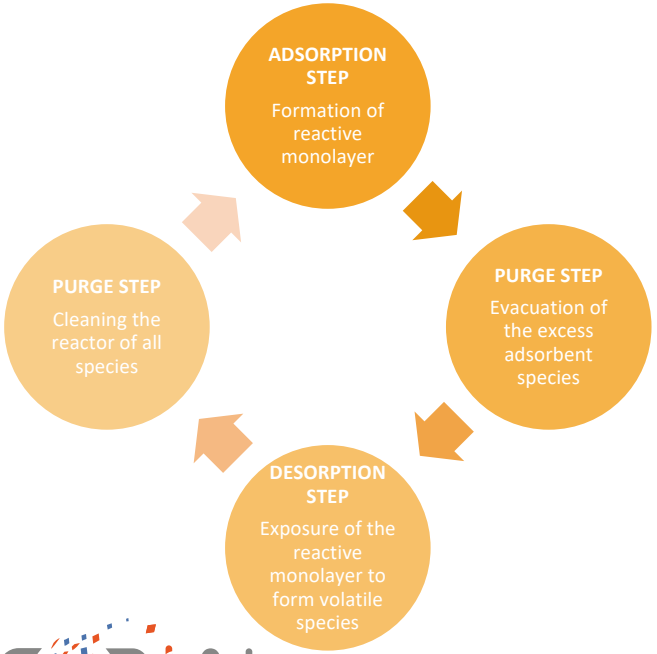
1. Selective to AlxGa1-xN stack
    1. Careful control of etch selectivity
    2. Etch-through GaN and stop-etch on AlxGa1-xN stack

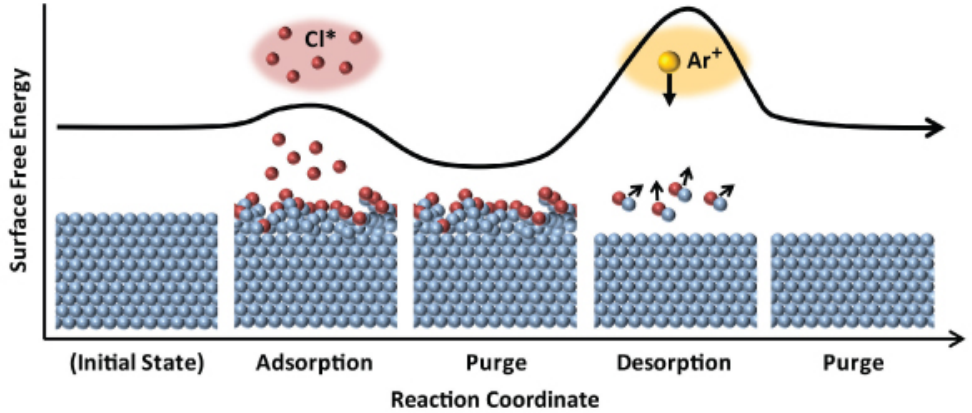
2. Low damage
    1. Low bias power operation required
    2. RF plasma in soft conditions does not entrain damage in HEMTs

3. Low etching rate aprox. 1 atomic layer per cycle

CORIAL PROCESS SOLUTION

Philosophy of a classical Atomic Scale Etching process recipe for recess etching of GaN/AlGaN HEMT structures





KEREN J. KANARIK et. al., Moving atomic layer etch from lab to fab, Solid State Technology 2014

CORIAL PROCESS SOLUTION

Atomic Scale Etch of GaN

CORIAL process steps

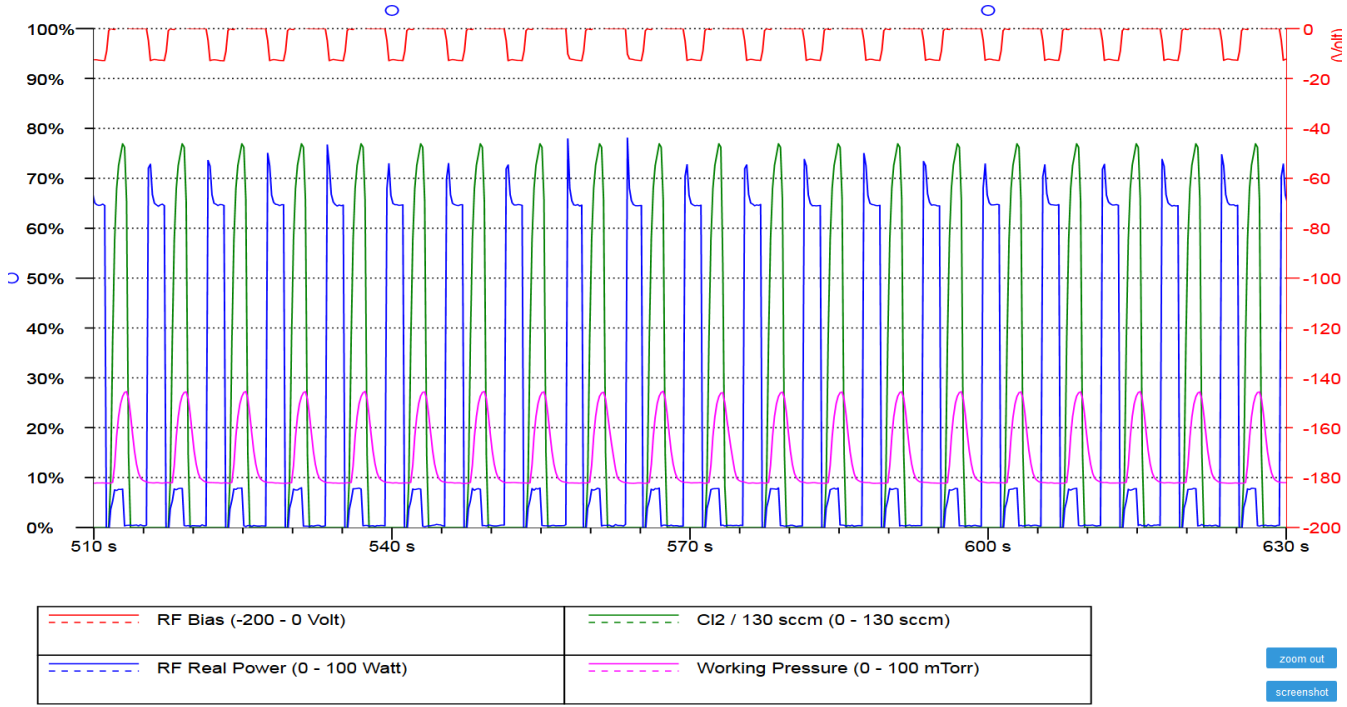
Process steps	RF Power (W)	Pressure (mT)	Chemistry	Pulsed parameters
Adsorption	10	25	Cl2 Ar	Chlorine
Purge	0	10	Ar	
Desorption	100	10	Ar	RF power

- Weak RF plasma activation of Cl2 is used to enhance chlorination of GaN surface
- Desorption of by-products is achieved in RIE mode by Ar+

CORIAL PROCESS SOLUTION

Atomic Scale Etch of GaN

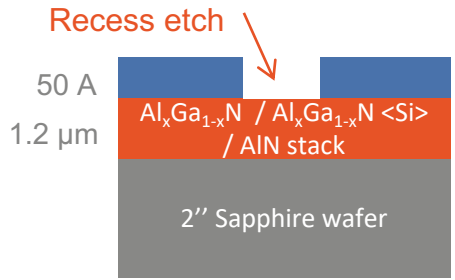
CORIAL process steps



CORIAL PROCESS SOLUTION

Atomic Scale Etch of GaN

CORIAL process performances



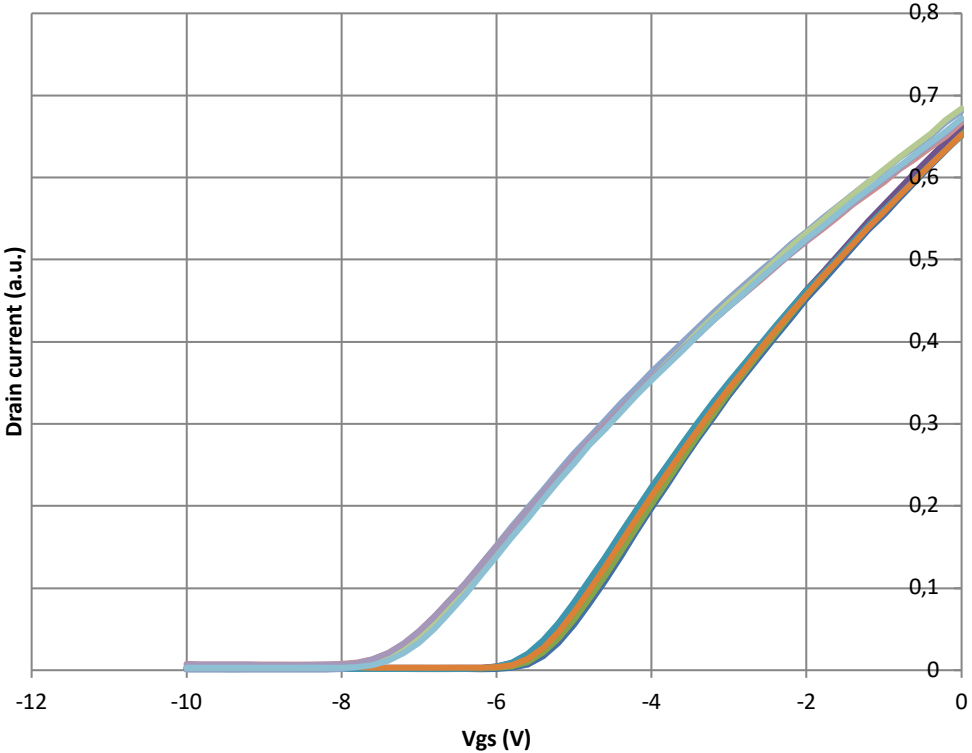
Process	Total process duration (min)	Number of cycles	Period (s)	Etch depth (Å)	Etch rate (Å/cycle)	Etch rate (Å/min)
ALE GaN recess etch	20	300	6	50	0.4	4

TRANSISTOR PERFORMANCES

Drain current for the similar HEMTs

- Left curves : HEMT performances before etching
- Right curves: HEMT performances after ALE-like etching

No deterioration of the drain current is obtained after ALE-like recess etching

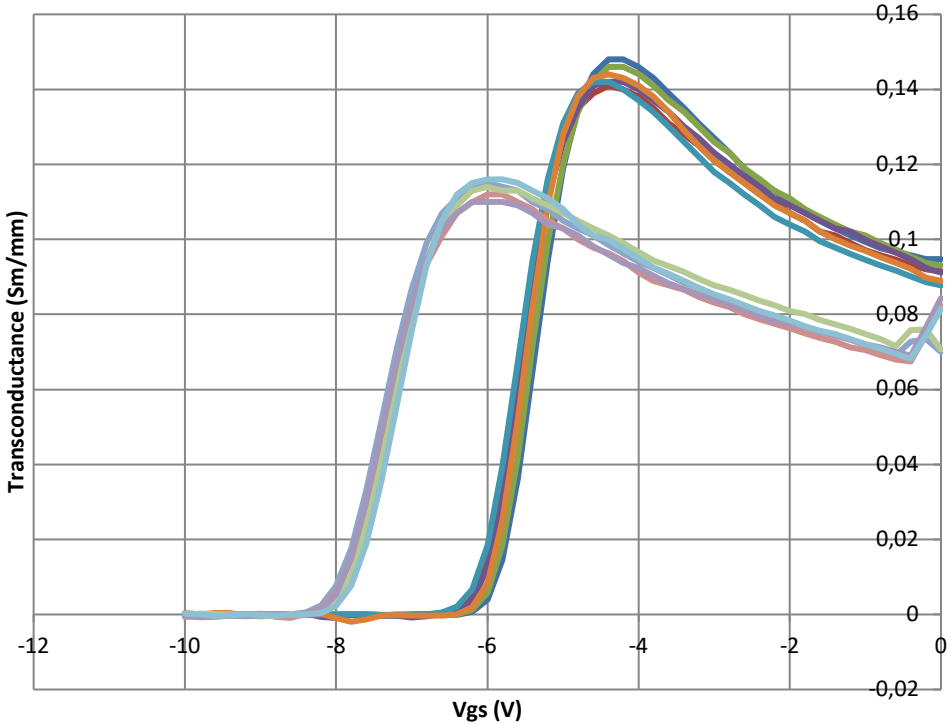


TRANSISTOR PERFORMANCES

Transconductance for the similar HEMTs

- Left curves : HEMT performances before etching
- Right curves: HEMT performances after ALE-like etching

- Higher transconductance is obtained



SOFTWARE DESCRIPTION
COSMA PULSE

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COSMA Pulse is a control software that broadens conventional tools' process capabilities to enable time-multiplexed processes

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COSMA PULSE BENEFITS

Advanced Process Control

Enhanced functionality

ALL PARAMETERS
CAN BE CONTROLLED AND PULSED

Short step times

10 ms
DATA AQUISITION

Cost effective upgrade

FOR CORIAL SYSTEMS INSTALLED AT CUSTOMERS' SITES

Advanced process editing

SET TO, RAMP TO AND PULSE FUNCTIONS

+/-0,1%

ACCURACY
ON BIAS FINE TUNING

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PROCESS EDITING

Intelligent process control, using not only the standard “SET to” and RAMP to” functions, but also an added “PULSE” function

Control and Pulse of any process parameter (such as gas flow rate, RF and ICP power, working pressure, etc.), with a minimum pulsing period of 10 milliseconds

Edit, store, use, and duplicate process recipes with the COSMA Pulse unique user interface

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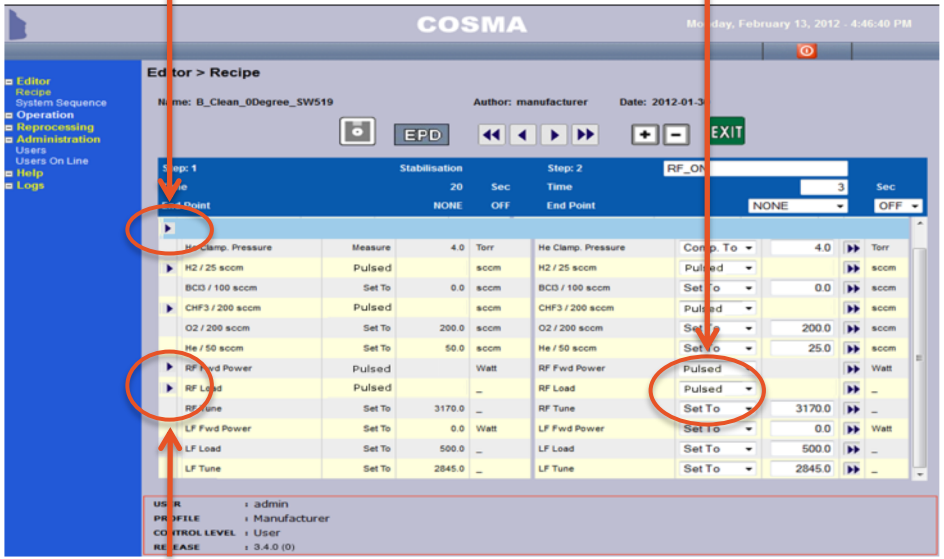
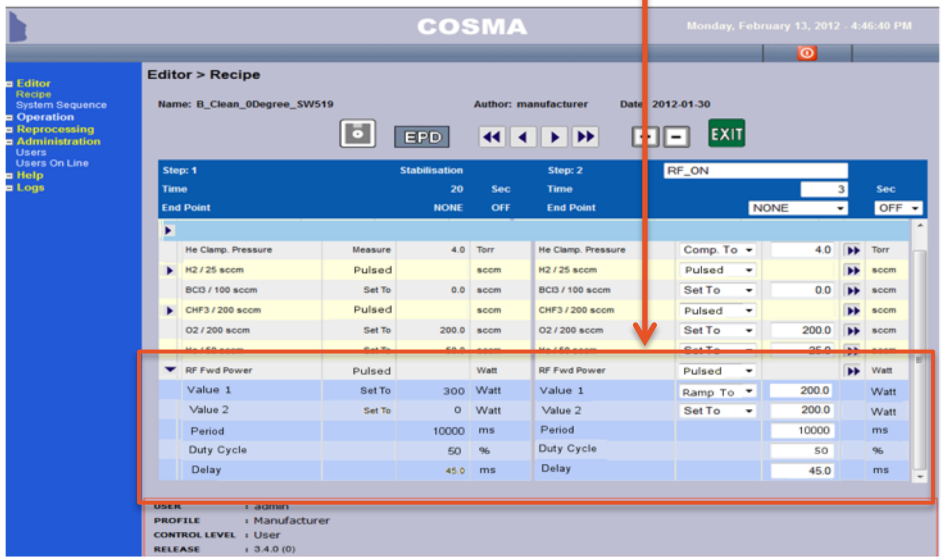
PROCESS EDITING

Details of the pulsed parameter setting

Show/close all the details of the pulsed parameters

Mode: Pulsed





Show the pulsed parameters

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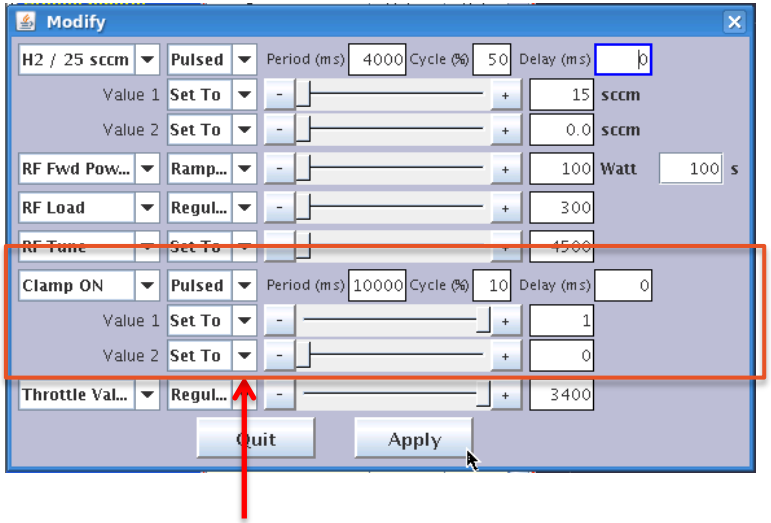
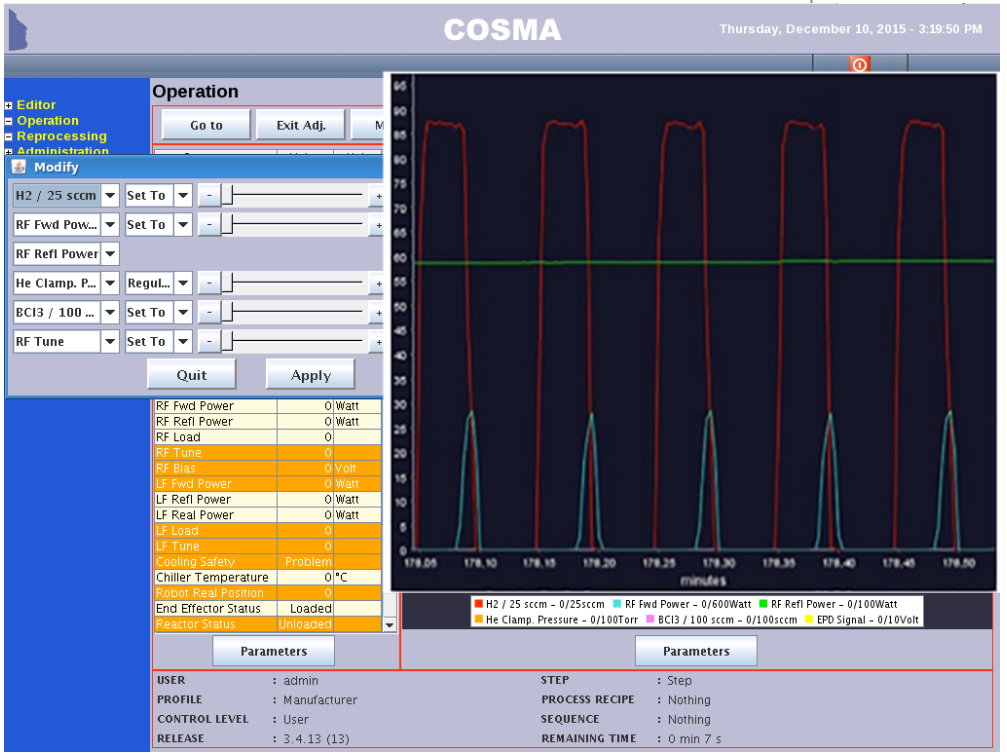
PROCESS ADJUSTMENT

All process parameters can be pulsed and adjusted during process execution



Details of the pulsed parameter setting



Real-time process adjustment

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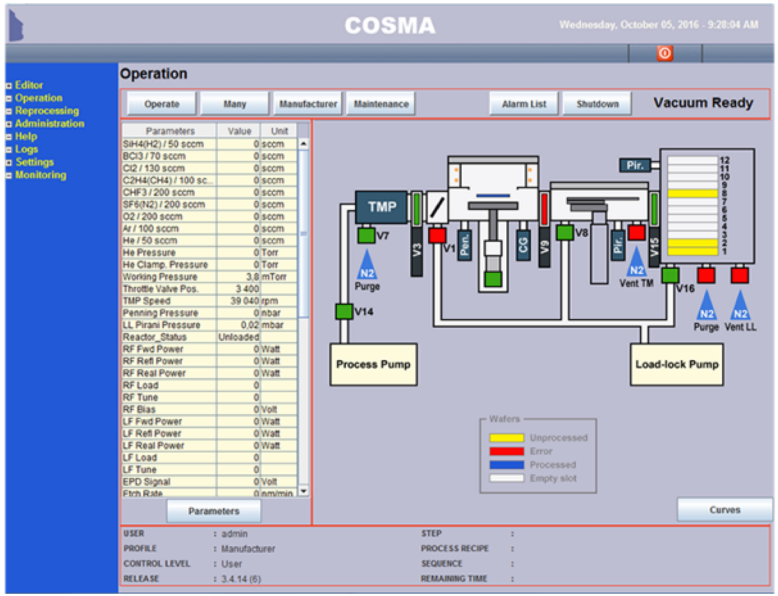
PROCESS OPERATION



Multiple user access rights

PASSWORD CONTROLLED LOGIN WITH DIFFERENT LEVELS OF USER ACCESS

Process reproducibility

TIGHT CONTROL AND MONITORING OF PROCESS STEPS

Real time process data display

ALL PROCESS PARAMTERS CAN BE MONITORED SIMULTANEOUSLY IN REAL TIME DURING PROCESS EXECUTION

Multistep recipes

LOOPS WITH AUTOMATED TRANSITION TO THE NEXT PROCESS STEP BASED ON SIGNALS FROM END POINT DETECTORS

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SYSTEM DESCRIPTION
CORIAL 210IL

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A Plasma-Therm Company

CORIAL EQUIPMENT

Corial 210IL

This machine can be operated in PECVD mode.

- For up to **200 mm substrates,**
- **Compact** footprint,
- Shuttles for **efficient adaptation** of the tool to different wafer sizes,
- **Loadlock** for compatibility with chlorinated chemistries (Cl2, BCl3, etc),
- **95%** uptime,
- **Laser end point detector** for measurement of the etching rate and determination of stop-etch point.

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