Reactive Ion Etching (RIE) System
STEP BY STEP INSTRUCTIONS

To run in manual mode

Stand by (enables manual mode)

Utility – Vent– Insert Sample

Utility – Pump Chamber – Ion Gauge On (check vacuum) – Ion Gauge Off
Wait until vacuum <= 3×10^{-5} Torr before etching. When ion gauge is on, the real chamber pressure is monitored.
Service – Manual – Gas Flow – Chamber Pressure – Config/RIE – Power – Time

Gas On – Pressure On – RF Power On– Process over– RF Power Off–

N_2 Purge On, if desired – Purge Off or All Off – Exit

Utility – Vent– Take out sample – Utility – Pump Chamber

CF_4	**(R14 / Freon 14)**	**SiO_2 etching**
O_2	**(Oxygen)**	**Polymer etching**
SF_6	**(SulfurHexaFluoride)**	**Silicon etching**
CHF_3	**(R23 / Freon 23) (TriFluoroMethane)**	**SiO_2 etching**

Chamber Cleaning [de-scum] by O2:

Plasma colors:
pink > N_2 (or air leak)
yellow > O_2
purple > F chemistry

Regular de-scum, higher values		**(Light de-scum, in parentheses)**
pressure:	**200 mTorr**	**(50mT light)**
flow:	**20 sccm**	**(10sccm light)**
	[standard cubic cm / min]	
power:	**300 W**	**(200 W light)**
time:	**10 min**	**(5 min light)**

RIE (Reactive Ion Etch) DETAILED INSTRUCTIONS

If the computer needs log in, it is:

Operator: STUDENT
Password: STUDENT

If paper reading IN USE is flipped down over the computer screen, the system is in use by another user, which should also be obvious from the log book. Log in.

EMERGENCY SHUT OFF switch is the large red button on the upper left corner of the main unit (chamber is on top).

The system has a 550 Watt RF (Radio Frequency) induced plasma, auto impedance matching power source.

The vacuum system has a turbo pump and backing/rough pump with small N2 bleed.

The system has continuous water chiller cooling (no user action necessary).

On the bottom of the system diagram page, on the computer, are three status log lines:

Info: PUMPING WITH TURBO PUMP (example)
Warning:
Alarm:

The audio part of the Alarm System is turned off, but an alarm warning registers on the Alarm line. If the alarm is on and/or something is in the Alarm line at the bottom of the screen, you will have to acknowledge the warning before you go on. Make sure there still is not a problem. Go to the bottom right of the screen and click on ALARM (silence) to move on. You might have to also click on HOLD (in Process bar) at bottom of screen.

The RIE chamber should have been left under vacuum (turbo pumping chamber) by the last user. Use gloves when handling anything going into system and clean items.

The schematic diagram page on the computer should show the main chamber, a turbo pump, a rough pump, a butterfly valve (main valve), four gases (CF4, O2, SF6, CHF3), and a purge/leak gas (N2).

Three modes of system are shown on bottom left of screen:

ON (start up and main pumps on/off)
STAND BY (manual operation)
READY (auto operation to run a program, i.e. recipes)

If under Process in system auto mode (ON & READY), processes are in queue ready to run or are running, check log book and do not abort if you are not authorized to do so.

On schematic diagram (i.e. valves, chamber, tubes, gases, pumps, ect):

White: OFF, not active
Blue: ON, active

If menu option letters are grey: line is not an option (disabled).
If menu option letters are black: line is an option (enabled).

To choose a recipe to run in automatic mode click:

Process
Load…

Process Files Right Chamber

File Name:	**Directories**	**OK**
***.prc**	**C:\sysmon\process**	**Cancel**
BIGCLEAN.PRC ^	**[ ] C:**	
FIRSTCLN.PRC	**[ ] sysmon**	
MRCLEAN.PRC	**[ ] process**	
	[ ] user name	
List of File Types	**Drives**	
Process Files (*.PRC)	**[ ] c: ms-dos_6**	

TO RUN SYSTEM IN AUTOMATIC MODE:

Info	**PROCESS: Turbo is ON**	**Process**	**FIRSTCLN**
Warning		**Date**	**1/27/80**
Alarm		**Time**	**11:41:06**

System Status
ON STANDBY **READY**

Process
ABORT END STEP HOLD **RUN** ALARM SILENCE

Process Run Information
Lot# **Run#**
Comment
OK

RUN

Automatic Initial Data: FIRSTCLN Step:1

Description	**usercln**	
Name	**FIRSTCLN**	
	Request	**Actual**
Pump Down	**TURBO**	
Base Pressure	**10**	**0**
Hold Time	**0:10**	
Time Remaining		

Automatic-Process FIRSTCLN Step:2 (then Step:3)

Description	**Gas Channels**		**RF Generators**	
Process PumpTURBO	**Setpt**	**Actual**	**RF Control**	**POWER**
CF4	**10**	**10.0**	**RF Config**	**RIE**
O2	**10**	**10.0**		
				Setpt **Actual**
			Power	**200** **199**
			Ref	**0.0**
			DC	**341**
			RF	**0**
				Setpt **Elapsted**
			Time	**20:00.0** **19:50.0**

Automatic-End: FIRSTCLN Step:4

Description	**usercln**	
Name	**FIRSTCLN**	
	Request	**Actual**
Pump Down	**TURBO**	
Base Pressure	**10**	**0**
Hold Time	**0:10**	
Time Remaining		

Process Complete

STOP Automatic proscess FIRSTCLN

Completed at 13:32:12

OK

RIE PROCESS SAMPLE RECIPES

2.6 Polyimide Etch (Isotropic)

Mode: Reactive Ion Etch (RIE)
Pumps : Mechanical
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
O_2	20	32	40
CF_4	5	8	10
Pressure (mTorr) :	200	200	200
Power (Watts) :	175	200	250

Typical Etch Rate (Å/min.) **:** 5000

Notes:

This process produces undercut and a sloped sidewall, using a mask material that can withstand etching in a fluorine chemistry. The etch rate is dependent on the CF_4 flow and increases with increasing flow until a maximum is obtained at ~30% CF_4. CHF_3 or SF_6 can be substituted for the CF_4 with subtle affects on the sidewall profile.
For failure analysis applications, this process can be used to remove thick polyimide passivation layers. Because of the fluorine content of the process, silicon nitride (and, to a lesser extent, silicon dioxide) will also be etched. Where this is important, the CF_4 can be eliminated at the expense of the polyimide etch rate.

2.7 Photo-Resist/Polyimide Etch (Anisotropic)

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
O_2	5	8	10
He	5	8	10
Pressure (mTorr) :	10	10	10
Power (Watts) :	150	175	200
DC-bias (Volts) :	500	500	500

Typical Etch Rate (Å/min.) 1000
:

Notes:

Optimum performance is obtained using a silicon dioxide mask. Metal masks can cause "grass" to form in the bottom of the etched features due to re-deposition of the mask material . The He is necessary in order to obtain a high degree of anisotropy; if this is not essential, the He can be omitted, with a resultant increase in the etch rate.

2.8 Silicon Dioxide Etch

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo or Mechanical
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
CHF_3	22.5	36	45
O_2	2.5	4	5
Pressure (mTorr) :	40	40	40
Power (Watts) :	150	175	200
DC-bias (Volts) :	440	440	440

Typical Etch Rate (Å/min.) 400-500
:

Notes:

This process will etch thermal oxide, PECVD oxide, TEOS oxide, PSG and BPSG at approximately the same rates. Also, SiN and SiON can be etched using this chemistry with etch rates varying somewhat from the oxides. The process is highly ion driven, and is well suited for anisotropic removal of interlevel dielectrics during failure analysis. For applications requiring pattern definition, an increase in the percentage of oxygen will reduce polymer formation, but will also reduce the selectivity to photoresist. At high oxygen percentages the selectivity over silicon or metals that etch in fluorine is reduced.

2.9 Silicon Nitride Etch (High Rate)

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo or Mechanical
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
CF_4	22.5	36	45
O_2	2.5	4	5
Pressure (mTorr) :	40	40	40
Power (Watts) :	150	175	200
DC-bias (Volts) :	425	425	425

Typical Etch Rate (Å/min.) 1000-2000
:

Notes:

This high rate process can be used when the underlying layer is not attacked by fluorine. The etch rate increases with increasing oxygen at the expense of photoresist etch rate.

2.10 Silicon Nitride Etch (Selective to Si)

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
CHF_3	22.5	36	45
O_2	2.5	4	5
Pressure (mTorr) :	40	40	40
Power (Watts) :	150	175	200
DC-bias (Volts) :	440	440	440

Typical Etch Rate (Å/min.) 400-500
:

Notes:

This SiN etch process is selective to aluminum, silicon and other materials that etch in atomic fluorine. These include molybdenum, niobium, tantalum and tungsten. The silicon nitride etch rate increases with increasing oxygen at the expense of the above selectivities.

2.11 Silicon Nitride Etch (Passivation Removal)

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo or Mechanical
Susceptor Material : Graphite or Aluminum
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
SF_6	16	25	33
O_2	4	5	7
Pressure (mTorr) :	75	75	75
Power (Watts) :	65	75	85

Typical Etch Rate (Å/min.) 1000
:

Notes:

This etch is designed primarily for removal of silicon nitride passivation films for failure analysis (de-layering) applications, although it can be used for other appropriate etches. The process operates at low dc bias and is chemically driven; consequently the etch is isotropic and also results in very low etch rates for materials such as SiO_2, TEOS oxide, PSG, BPSG and metals such as Al and Au. The etch rate is area dependent, and lower etch rates will be found when etching whole wafers as compared to individual chips.

When etching large areas (few square in"), optical emission can be used to determine the end point of the etch. Emission at 337nm (N_2) is observed during etching, and decreases at end point.

2.13 Silicon Trench Etch (Fluorine)

Mode:	Reactive Ion Etch (RIE)
Pumps :	Mechanical or Turbo
Susceptor Material :	Graphite or Ardel
Temperature (°C) **:**	25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
SF_6	12	20	25
O_2	12	20	25
Pressure (mTorr) :	100	100	100
Power (Watts) :	135	155	180
DC-bias (Volts) :	150	150	150
Typical Etch Rate (Å/min.)**:**	5000-7500		

Notes:

This process is load dependent. This means the more exposed silicon there is the lower the etch rate. The recommended mask is SiO_2 instead of photoresist and a selectivity of 10:1 is easily achievable. Some mask undercutting is present but etch factors of 5:1 can be obtained.

2.14 Zinc Sulfide Etch

Mode: Reactive Ion Etch (RIE)
Pumps : Turbo or Mechanical
Susceptor Material : Graphite or Ardel
Temperature (°C) **:** 25

Electrode Size:	**6"**	**8"**	**11"**
Gases (sccm) :			
Ar	10	20	25
H_2	10	20	25
Pressure (mTorr) :	30	30	30
Power (Watts) :	300	400	500
Typical Etch Rate (Å/min.)**:**	250		

Notes:

This process requires a hard mask material to be used due to the high power levels required to etch the ZnS.