

# Plasma Enhanced Chemical Vapor Deposition

## Normal Operation Training Course



# 2017 Training Schedule

## ■ Safety Training

| Manager | Education       | From January to December, 2017                                         |                                                                             |                         |                     |
|---------|-----------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------|---------------------|
|         |                 | Education                                                              | Test                                                                        | No.of people/<br>1 time | Total No.<br>people |
| -       | Safety training | 1/10, 2/7, 3/7, 4/4,<br>5/8, 6/7, 7/4, 8/8,<br>9/12, 10/11, 11/7, 12/5 | 1/13, 2/10, 3/10, 4/7,<br>5/12, 6/9, 7/6, 8/11,<br>9/14, 10/13, 11/10, 12/8 | 5<br>5(foreigner)       | 120                 |

## ■ Equipment Training

| Manager        | Equipment     | From March to December, 2017                                                 |                         |                     |
|----------------|---------------|------------------------------------------------------------------------------|-------------------------|---------------------|
|                |               | Education                                                                    | No.of people/<br>1 time | Total No.<br>people |
| Hae-ra<br>Kang | PE-CVD#1      | 1/25, 2/22, 3/22, 4/19, 5/24, 6/21,<br>7/21, 8/23, 9/20, 10/25, 11/22, 12/20 | 5                       | 60                  |
|                | PE-CVD#2      | 1/25, 2/22, 3/22, 4/19, 5/24, 6/21,<br>7/21, 8/23, 9/20, 10/25, 11/22, 12/20 | 5                       | 50                  |
|                | LP-CVD        | 1/25, 2/22, 3/22, 4/19, 5/24, 6/21,<br>7/21, 8/23, 9/20, 10/25, 11/22, 12/20 | 5                       | 50                  |
|                | FURNACE_DRY   | When there is a request (Equipment of nonscheduled training)                 |                         |                     |
|                | FURNACE_WET   | When there is a request (Equipment of nonscheduled training)                 |                         |                     |
|                | 4point probe  | When there is a request (Equipment of nonscheduled training)                 |                         |                     |
|                | Contact angle | When there is a request (Equipment of nonscheduled training)                 |                         |                     |

# Detail Schedule

| Type of Training           |           |                                 |                                                                                  | date      | time  | place    | remarks                                                                                                                                             |
|----------------------------|-----------|---------------------------------|----------------------------------------------------------------------------------|-----------|-------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Safety training            |           |                                 |                                                                                  | 5th(Tue)  | 10:00 | NSB B101 | ※ Depending on the situation, the schedule can be changed.                                                                                          |
| Safety training Evaluation |           |                                 |                                                                                  | 8th(Fri)  | 14:00 | NSB U109 |                                                                                                                                                     |
| Equipment training         | Photo     | Photolithography_Full Wafer     |                                                                                  | 19st(Tue) | 10:00 | NSB B101 | ※ Photo Process<br>Do not select duplication.<br><br>※ <u>Only people who pass the safety evaluation can participate in the equipment training.</u> |
|                            |           | Photolithography_Piece of wafer |                                                                                  |           | 14:00 |          |                                                                                                                                                     |
|                            | Thin film | RF Sputter                      | - ITO, ZnO, SiO <sub>2</sub> , TiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub> | 20th(Wed) | 9:30  |          |                                                                                                                                                     |
|                            |           | DC Sputter                      | - Ti, Cr, Al, Cu, Ag, Ta, Ni, Co, Mg, Mo, W                                      |           |       |          |                                                                                                                                                     |
|                            |           | ALD                             | - HfO <sub>2</sub> , TiO <sub>2</sub> , Al <sub>2</sub> O <sub>3</sub> , TaN     |           | 11:00 |          |                                                                                                                                                     |
|                            |           | LP-CVD                          | - D-Poly Si, Si <sub>3</sub> N <sub>4</sub>                                      |           | 13:00 |          |                                                                                                                                                     |
|                            |           | PE-CVD                          | - SiO <sub>2</sub> , Si <sub>3</sub> N <sub>4</sub> , SiC                        |           | 14:00 |          |                                                                                                                                                     |
|                            |           | Ellipsometer                    |                                                                                  |           | 15:00 |          |                                                                                                                                                     |
|                            | Measure   | Normal-Sem                      |                                                                                  |           | 16:00 |          |                                                                                                                                                     |
|                            |           | Surface Profiler                |                                                                                  |           | 17:00 |          |                                                                                                                                                     |
|                            |           |                                 |                                                                                  |           |       |          |                                                                                                                                                     |
|                            | Etch      | Dielectric/Metal RIE            |                                                                                  | 21st(Thu) | 9:30  |          |                                                                                                                                                     |
|                            |           | PR asher                        |                                                                                  |           | 11:00 |          |                                                                                                                                                     |
|                            |           | Dielectric/Metal ICP            |                                                                                  |           | 13:30 |          |                                                                                                                                                     |
|                            |           | Wet Station                     |                                                                                  |           | 15:00 |          |                                                                                                                                                     |

※ Applicant should check the training schedule and apply for training in each category.

(Application period: from 2 weeks before the day of training)

※ Training for equipment not mentioned above require a separate e-mail application/request.

※ After 5 minutes of starting participant, will not be allowed into the training session.

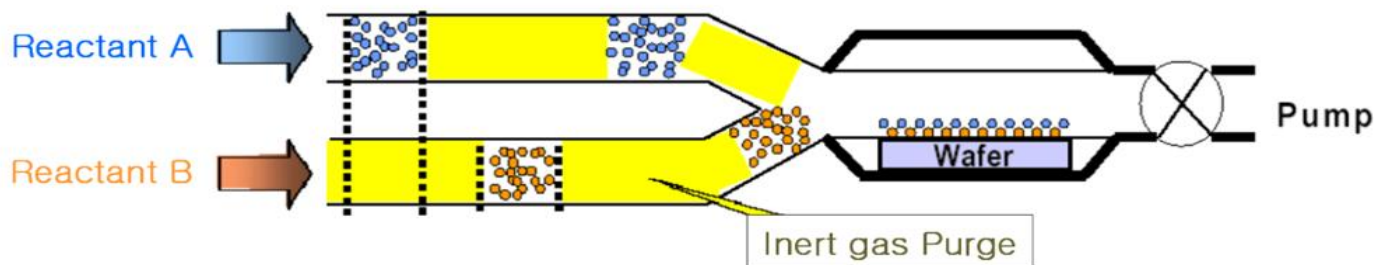
※ Absence without permission will result in exclusion from registration for the next 2 months of all training sessions.

※ The training sessions will be held only once each month.

※ Applications for training are limited to 5 devices for each applicant.

Any questions : UCRF Haera Kang (haera@unist.ac.kr/4167)

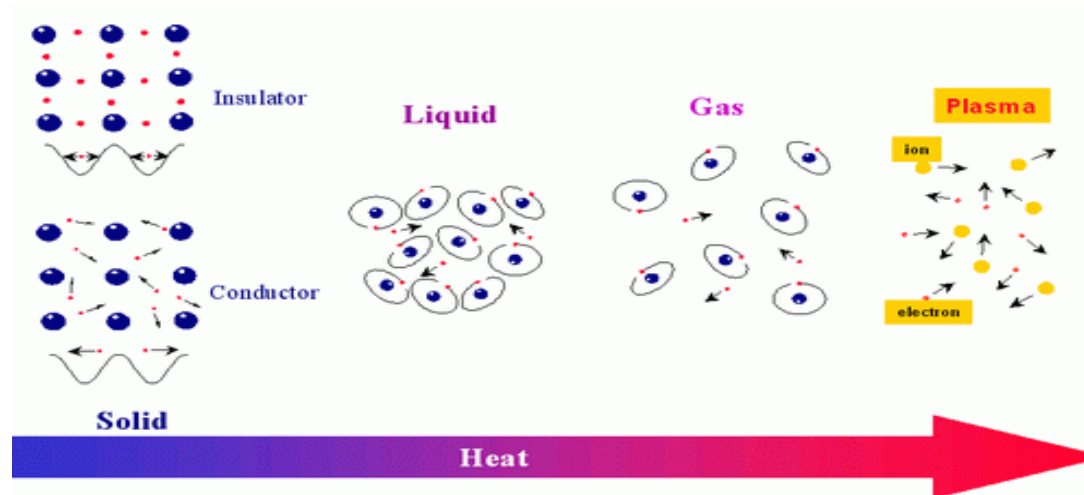
Chemical vapor deposition (CVD) is a process whereby a solid material is deposited from a vapor by a chemical reaction occurring on or in the vicinity of a normally heated substrate surface. The solid material is obtained as a coating, a powder, or as single crystals. By varying the experimental conditions—substrate material, substrate temperature, composition of the reaction gas mixture, total pressure gas flows, etc.—materials with different properties can be grown.



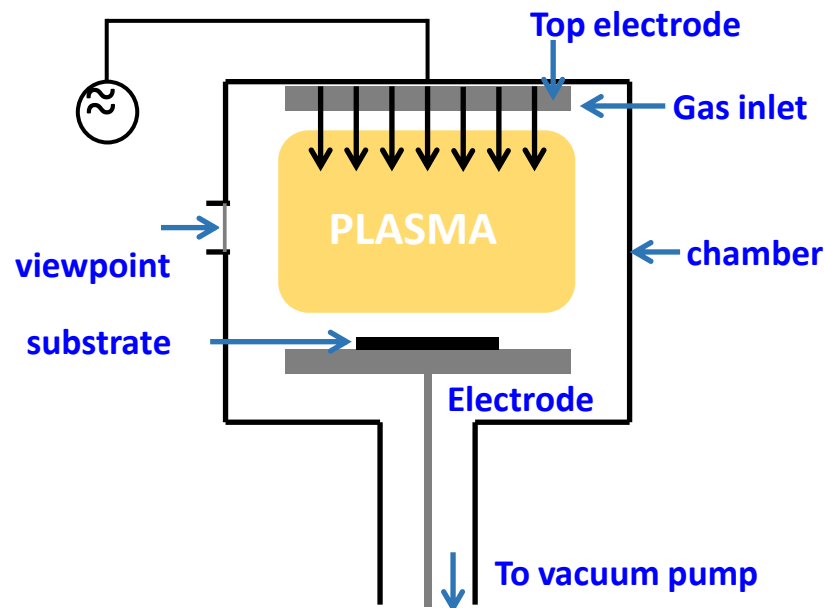
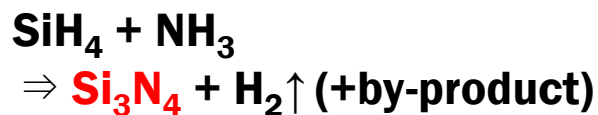
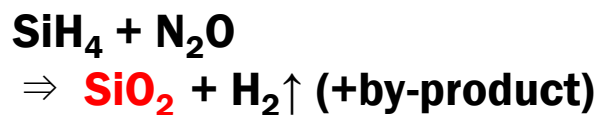
The Deposition of a solid film on a surface from a chemical reaction of gaseous reactants.

# What is Plasma

Plasma is the fourth state of matter. Many places teach that there are three states of matter; solid, liquid and gas, but there are actually four. The fourth is plasma. To put it very simply, a plasma is an ionized gas, a gas into which sufficient energy is provided to free electrons from atoms or molecules and to allow both species, ions and electrons, to coexist.



## Plasma Enhanced CVD



Chamber내에 진공이 형성된 후 증착을 위한 Gas를 유입시켜 Pressure Control System에 의한 공정압력을 확보한 후 RF Power를 Electrode에 가해 플라즈마(Plasma)를 형성하여 Gas를 Ion화하여 그 이온들을 이용하여 물리적 및 화학적 반응을 일으켜 증착하고자 하는 물질을 증착한다.

## Plasma Enhanced CVD

high energetic electron + reactant gases



activated species generation



diffusion/adsorption



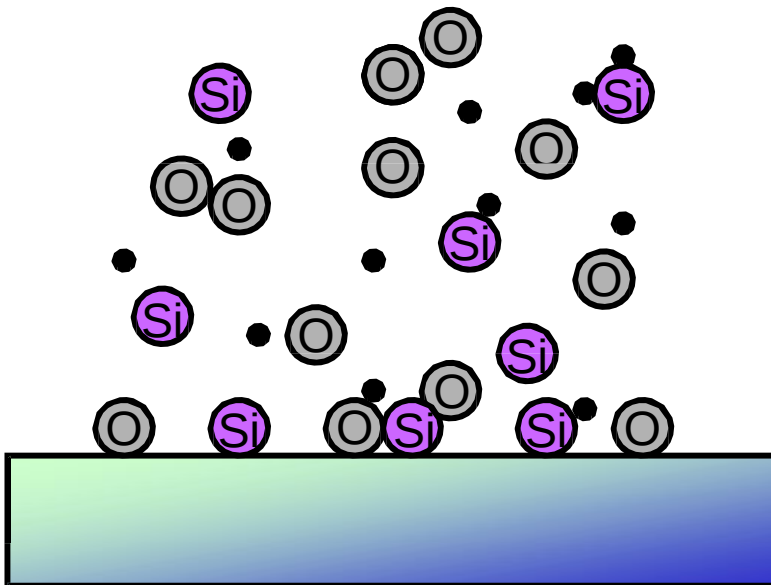
surface reaction



desorption



extraction



## Advantage of using PECVD

- ❑ Low operation temperature
- ❑ Lower chances of cracking deposited layer
- ❑ Good dielectric properties of deposited layer
- ❑ Good step coverage
- ❑ Less temperature dependent

## Disadvantage of using PECVD

- ❑ Toxic byproducts
- ❑ High cost of equipment

## Applications

- ❑ Deposition of silicate layers
- ❑ Deposition of dopants
- ❑ Anti-reflection and anti-scratch layers in optics
- ❑ Solar cells -> amorphous silicon

| Product                | Reactants                                                                        | Method | Temp(℃) | Comments               |
|------------------------|----------------------------------------------------------------------------------|--------|---------|------------------------|
| Poly Si                | SiH <sub>4</sub>                                                                 | LPCVD  | 580-650 | with doping            |
| Silicon nitride        | SiH <sub>4</sub> +NH <sub>3</sub>                                                | LPCVD  | 700-900 |                        |
|                        | SiCl <sub>2</sub> H <sub>2</sub> +NH <sub>3</sub>                                | LPCVD  | 650-700 |                        |
|                        | SiH <sub>4</sub> +NH <sub>3</sub>                                                | PECVD  | 200-350 |                        |
|                        | SiH <sub>4</sub> +N <sub>2</sub>                                                 | PECVD  | 200-350 |                        |
| SiO <sub>2</sub>       | SiH <sub>4</sub> +O <sub>2</sub>                                                 | APCVD  | 300-500 | poor step coverage     |
|                        | SiH <sub>4</sub> +O <sub>2</sub>                                                 | PECVD  | 200-350 | good step coverage     |
|                        | SiH <sub>4</sub> +N <sub>2</sub> O                                               | PECVD  | 200-350 |                        |
|                        | Si(OC <sub>2</sub> H <sub>5</sub> ) <sub>4</sub>                                 | LPCVD  | 350-750 | liq. Source, conformal |
|                        | SiCl <sub>2</sub> H <sub>2</sub> +N <sub>2</sub> O                               | LPCVD  | 850-900 | conformal              |
| Doped SiO <sub>2</sub> | SiH <sub>4</sub> +O <sub>2</sub> +PH <sub>3</sub>                                | APCVD  | 300-500 | PSG                    |
|                        | SiH <sub>4</sub> +O <sub>2</sub> +PH <sub>3</sub>                                | PECVD  | 300-500 | PSG                    |
|                        | SiH <sub>4</sub> +O <sub>2</sub> +PH <sub>3</sub> +B <sub>2</sub> H <sub>6</sub> | APCVD  | 300-500 | BPSG, low temp flow    |
|                        | SiH <sub>4</sub> +O <sub>2</sub> +PH <sub>3</sub> +B <sub>2</sub> H <sub>6</sub> | PECVD  | 300-500 | BPSG, low temp flow    |

# Characteristics and Applications of CVD Reactors

| Process              | Advantages                                                                                                                                      | Disadvantages                                                                                         | Applications                                                                                                                               |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| AP-CVD<br>(Low Temp) | <ul style="list-style-type: none"><li>- Simple reactor</li><li>- Fast deposition</li><li>- Low temperature</li></ul>                            | <ul style="list-style-type: none"><li>- Poor step coverage</li><li>- Particle contamination</li></ul> | <ul style="list-style-type: none"><li>- Low temp oxides, both doped and undoped</li></ul>                                                  |
| LP-CVD               | <ul style="list-style-type: none"><li>- High purity &amp; uniformity</li><li>- Conformal step coverage</li><li>- Large wafer capacity</li></ul> | <ul style="list-style-type: none"><li>- High temperature</li><li>- Low deposition rate</li></ul>      | <ul style="list-style-type: none"><li>- High temp oxide</li><li>- Silicon nitride</li><li>- Poly-Si</li><li>- W, WSi<sub>2</sub></li></ul> |
| PECVD                | <ul style="list-style-type: none"><li>- Low temperature</li><li>- Fast deposition</li><li>- Good step coverage</li></ul>                        | <ul style="list-style-type: none"><li>- Chemical and particle contamination</li></ul>                 | <ul style="list-style-type: none"><li>- PMD(pre metal dielectric)</li><li>- Passivation nitride</li></ul>                                  |

## ● SiO<sub>2</sub> standard recipe

Standby Temp  
350 °C

350 °C

350 °C

| Step           |      | Initial |          |      |            | Process   |          |            |               |               | End   |          |        |
|----------------|------|---------|----------|------|------------|-----------|----------|------------|---------------|---------------|-------|----------|--------|
|                |      | Temp up | Pum ping | Load | Heat delay | SiH4 flow | N2O flow | Gas stable | Process step1 | Process step2 | Purge | Pum ping | Unload |
| Temp           |      | -       | 350      |      |            |           |          |            |               |               |       |          |        |
| Pressure(Torr) |      | 0       | 0        | -    | 1          | 1         | 1        | 1          | 1             | 1             | 0     | 0        | -      |
| RF Power(W)    |      |         |          |      |            |           |          |            | 100           | 100           |       |          |        |
| Gas (SCCM)     | CF4  |         |          |      |            |           |          |            |               |               |       |          |        |
|                | SiH4 |         |          |      |            | 262       | 262      | 262        | 262           | 262           |       |          |        |
|                | NH3  |         |          |      |            |           |          |            |               |               |       |          |        |
|                | N2O  |         |          |      |            |           | 700      | 700        | 700           | 700           |       |          |        |
|                | N2   |         |          |      | 100        |           |          |            |               |               | -     |          |        |
|                | O2   |         |          |      |            |           |          |            |               |               |       |          |        |
| Time(sec)      |      | 1800    | 600      | 600  | 300        | 30        | 30       | 30         | 10            | -             | 300   | 300      | 600    |

⊗ Deposition rate :  
≒ 22 Å/min

○ Temp : 350 °C

○ Thickness Uniformity : ≤ 5%

## ● Si<sub>3</sub>N<sub>4</sub> standard recipe

Standby Temp

350 °C

350 °C

350 °C

| Step           |      | Initial |          |      |            | Process   |          |            |               |               | End   |          |        |
|----------------|------|---------|----------|------|------------|-----------|----------|------------|---------------|---------------|-------|----------|--------|
|                |      | Temp up | Pum ping | Load | Heat delay | SiH4 flow | N2O flow | Gas stable | Process step1 | Process step2 | Purge | Pum ping | Unload |
| Temp           |      | -       | 350      |      |            |           |          |            |               |               |       |          |        |
| Pressure(Torr) |      | 0       | 0        | -    | 1.5        | 1.5       | 1.5      | 1.5        | 1.5           | 1.5           | 0     | 0        | -      |
| RF Power(W)    |      |         |          |      |            |           |          |            | 60            | 60            |       |          |        |
| Gas (SCCM)     | CF4  |         |          |      |            |           |          |            |               |               |       |          |        |
|                | SiH4 |         |          |      |            | 220       |          | 220        | 220           | 220           |       |          |        |
|                | NH3  |         |          |      |            |           | 50       | 50         | 50            | 50            |       |          |        |
|                | N2O  |         |          |      |            |           |          |            |               |               |       |          |        |
|                | N2   |         |          |      | 100        |           |          |            |               |               | -     |          |        |
|                | O2   |         |          |      |            |           |          |            |               |               |       |          |        |
| Time(sec)      |      | 1800    | 600      | 600  | 300        | 30        | 30       | 30         | 10            | -             | 300   | 300      | 600    |

⊗ Deposition rate :  
≒ 22 Å /min

○ Temp : 350 °C

○ Thickness Uniformity : ≤ 5%

# SiC Standard recipe

## ● a-SiC standard recipe (5% SiH<sub>4</sub>\_He balance)

Standby Temp  
350 °C

350 °C

350 °C

| Step           |            | Load | Pumpin<br>g | Main<br>Pumpin<br>g | Leak<br>Check | A-Va<br>cu<br>um | N2<br>Pur<br>ge | A-Va<br>cu<br>um<br>2 | Ve<br>nt<br>1 | Ve<br>nt<br>2 | Pre Dep<br>o | Deposition                                                                        | A-Va<br>cu<br>um | A P<br>urg<br>e 1 | A-Va<br>cu<br>um<br>2 | A P<br>urg<br>e 2 | A-Va<br>cu<br>um<br>3 | A P<br>urg<br>e 3 | Ve<br>nt<br>3 | S-l<br>eak<br>1 | S-l<br>eak<br>2 | S-l<br>eak<br>3 | ATM<br>Check | Unload |
|----------------|------------|------|-------------|---------------------|---------------|------------------|-----------------|-----------------------|---------------|---------------|--------------|-----------------------------------------------------------------------------------|------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|---------------|-----------------|-----------------|-----------------|--------------|--------|
| Gas            | SiH4(SCCM) | 2    |             |                     |               |                  |                 |                       |               |               |              |                                                                                   |                  |                   |                       |                   |                       |                   |               |                 |                 |                 |              |        |
|                | CH4(SCCM)  | 1    |             |                     |               |                  |                 |                       |               |               |              |                                                                                   |                  |                   |                       |                   |                       |                   |               |                 |                 |                 |              |        |
|                | N2         |      |             |                     |               |                  |                 |                       |               |               | 1            | 1                                                                                 |                  |                   |                       |                   |                       |                   |               |                 |                 |                 |              |        |
|                |            |      |             |                     |               |                  |                 |                       |               |               | 60           | 60                                                                                |                  |                   |                       |                   |                       |                   |               |                 |                 |                 |              |        |
| Pressure(Torr) |            |      | 0.1         |                     |               |                  |                 |                       |               |               | 0.98         | 0.98                                                                              |                  |                   |                       |                   |                       |                   |               |                 |                 |                 |              |        |
| Time(Min)      |            | 10   | 10          | 5                   | 3             | 5                | 10              | 5                     | 1             | 5             | 1            |  | 15               | 10                | 5                     | 10                | 5                     | 10                | 5             | 5               | 5               | 5               | 5            | 10     |

◎ D-Poly 2000 Å : 90min

◎ D-Poly 2500 Å : 106min

○ Temp : Top/ Center/ Bottom ⇒ 536/ 532/ 524 °C

○ Deposition rate : ≒ 22 Å/min

○ Thickness Uniformity : ≤ 2%

○ Thickness Uniformity(WTW) : ≤ 3%

○ RS Average : 30~40

○ RS Uniformity : ≤ 2%

# **PECVD#1**

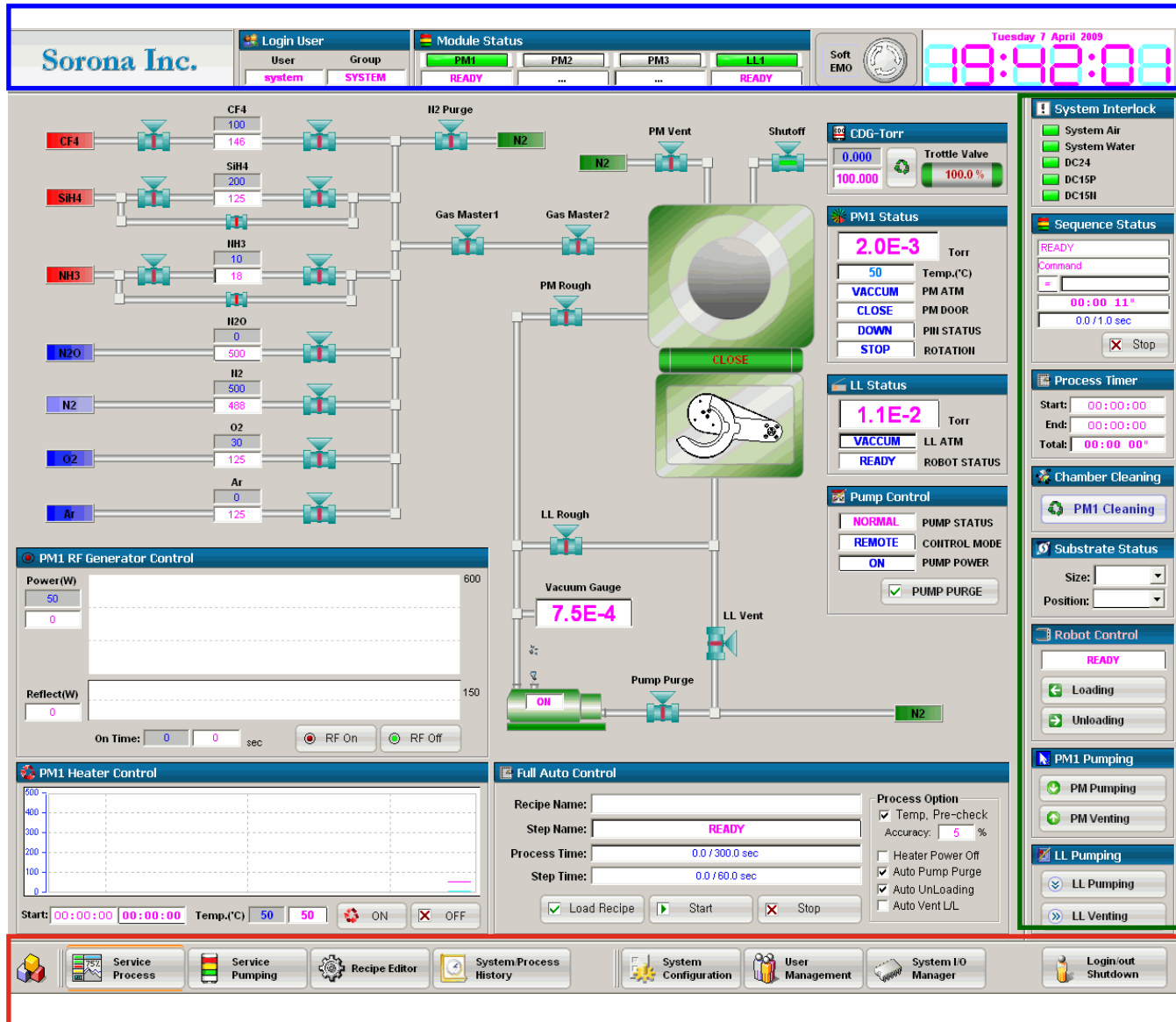
## **Operating manual**

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# Screen layout



## 1. Title screen

Login User  
Module Status  
Log-in operator  
Soft EMO Button  
System Timer

## 2. Sub menu screen

System interlock  
Sequence Status  
Process Timer  
PM Chamber Cleaning  
Substrate Status, Robot Control  
PM Pumping & Venting  
LL Pumping & Venting

## 3. Main menu screen

Service Process  
Service Pumping  
Recipe Editor  
History  
System Configuration  
User Manager  
System Manager  
Login/out  
Shutdown

## Service Process screen

| Window name           | Function                         | Description                                                                     |
|-----------------------|----------------------------------|---------------------------------------------------------------------------------|
| Over view             | All valve monitoring and control | Full auto recipe select                                                         |
|                       | PM and LL Status                 | Full auto Start, Pause, Stop control                                            |
|                       | Pump on/off                      | Module step name                                                                |
| RF Power & Monitoring | RF Power control                 | RF Power set, Forward, reflect, On Time set, RF On/Off, Graphical display       |
| CDG Pressure          | Pressure control                 | Pressure set and monitoring, Throttle valve position display, CDG Valve control |
| Gas flow control      | Process gas control              | Process gas set and monitoring, Valve open/close                                |
| Recipe control        | Recipe select and control        | Recipe load, Auto process start and stop                                        |
| Heater Control        | Heater Temp Control              | PM Chamber Table Heater Control                                                 |
| Process option        | Process option check             | Heater Temperature Pre-Check & Accuracy, heater Power Off, Auto Pump Purge,     |
|                       |                                  | Auto UnLoading, Auto Vent Loadlock Chamber                                      |

## Service Pumping screen

| Window name            | Function                              | Description                                                               |
|------------------------|---------------------------------------|---------------------------------------------------------------------------|
| Pumping                | PM & LL Chamber pumping valve control | Pumping valve control, Vacuum display, Pumping line status display        |
| Robot Manual Control   | Extend / Retract                      | Loading / Unloading position                                              |
|                        | Home                                  | Unloading position                                                        |
|                        | Stop                                  | Stop                                                                      |
| PM Pumping & Venting   | Display                               | Display (15분간의 상황을 실시간 출력)                                                |
| LL & Roughing Pressure | Display                               | Display (15분간의 상황을 실시간 출력)                                                |
| Heater Control         | Heater Temperature Control            | PM Chamber Table Heater Temperature Control                               |
| RF Power & Monitoring  | RF Power control                      | RF Power set, Forward, reflect, On Time set, RF On/Off, Graphical display |

# Recipe Editor Screen

| Window name        | Function             | Description                                             |
|--------------------|----------------------|---------------------------------------------------------|
| Module recipe list | Module recipe select | List display, Module select, Add, Edit, Delete          |
| Recipe Step Data   | Recipe edit          | Recipe step add, delete, insert, Step change, Step copy |
| Recipe Information | Information          | Display Creator, Create date, Modify Date               |

# System / Process Screen (System log)

**Sorona Inc.**

**Login User**  
User: system Group: SYSTEM

**Module Status**  
PM1: READY PM2: ... PM3: ... LL1: READY

**System Log**  
System Log Process Log

**System Interlock**  
System Air  
System Water  
DC24  
DC15P  
DC15H

**Sequence Status**  
READY  
Command  
00:00 11"  
0.0110 sec  
Stop

**Process Timer**  
Start: 00:00:00  
End: 00:00:00  
Total: 00:00:00

**Chamber Cleaning**  
PM1 Cleaning

**Substrate Status**  
Size:   
Position:

**Robot Control**  
READY  
Loading  
Unloading

**PM1 Pumping**  
PM Pumping  
PM Venting

**LL Pumping**  
LL Pumping  
LL Venting

**System Log Details:**  
 [2009-04-06 08:40:55] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 08:40:55] system [Login Changed]  
 [2009-04-06 08:40:55] system [System Load]  
 [2009-04-06 08:41:00] system [System Shutdown]  
 [2009-04-06 08:41:26] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 08:41:26] system [Login Changed]  
 [2009-04-06 08:41:26] system [System Load]  
 [2009-04-06 08:41:29] system [System Shutdown]  
 [2009-04-06 08:41:47] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 08:41:48] system [Login Changed]  
 [2009-04-06 08:41:48] system [System Load]  
 [2009-04-06 08:42:15] system [System Shutdown]  
 [2009-04-06 08:43:05] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 08:43:05] system [Login Changed]  
 [2009-04-06 08:43:05] system [System Load]  
 [2009-04-06 08:43:28] system [Auto Process Start] RecipeName="Heater Check"  
 [2009-04-06 08:45:28] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 08:45:29] system [Login Changed]  
 [2009-04-06 08:45:29] system [System Load]  
 [2009-04-06 08:45:37] system [Auto Process Start] RecipeName="Heater Check"  
 [2009-04-06 11:50:08] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 11:50:08] system [Login Changed]  
 [2009-04-06 11:50:08] system [System Load]  
 [2009-04-06 11:50:12] system [Auto Process Start] RecipeName="Heater Check"  
 [2009-04-06 12:55:47] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 12:55:47] system [Login Changed]  
 [2009-04-06 12:55:47] system [System Load]  
 [2009-04-06 12:55:49] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 12:55:52] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On  
 [2009-04-06 12:55:53] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 12:56:05] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On  
 [2009-04-06 12:56:08] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 12:56:16] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On  
 [2009-04-06 12:56:17] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 12:56:19] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 13:00:36] system [System Shutdown]  
 [2009-04-06 13:02:28] [ERROR] Sequence 가 실행 중입니다.  
 [2009-04-06 13:02:28] system [Login Changed]  
 [2009-04-06 13:02:28] system [System Load]  
 [2009-04-06 13:02:29] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 13:02:31] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On  
 [2009-04-06 13:02:38] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 13:02:40] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 13:02:41] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 13:02:42] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 13:02:47] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On  
 [2009-04-06 13:03:41] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 13:03:42] JB system W\_IB\_V\_DRY\_N2\_PURGE  
 [2009-04-06 13:03:44] COMMO system W\_COM\_PUMP\_ON OFF Dry Pump On  
 [2009-04-06 13:03:44] COMMO system W\_COM\_PUMP\_ON ON Dry Pump On

**Service Process** **Service Pumping** **Recipe Editor** **System Process History** **System Configuration** **User Management** **System I/O Manager** **Login/out Shutdown**

| Window name | Function   | Description                                                   |
|-------------|------------|---------------------------------------------------------------|
| System Log  | Log system | Alarm display, Log-in user display, Operation command display |

# System / Process Screen (Process log)

**Sorona Inc.**

**Login User**  
User: system Group: SYSTEM

**Module Status**  
PM1: READY PM2: ... PM3: ... LL1: READY

Soft EMO

Tuesday 7 April 2009 20:00:00

**Process Log**

Recipe Name: Heater Check  
Module: PM1 Operator: system Log Date: 2009-04-02

| Time        | Pressure | Bias Power | Bias Reflect | CF4 | SH4 | NH3 | N2O | N2  | O2  | Ar  | Get Set | Get Temp |
|-------------|----------|------------|--------------|-----|-----|-----|-----|-----|-----|-----|---------|----------|
| 1 17:55:00  | 100      | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 51       |
| 2 17:55:01  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 74       |
| 3 17:55:02  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 81       |
| 4 17:55:03  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 91       |
| 5 17:55:04  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 111      |
| 6 17:55:05  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 121      |
| 7 17:55:06  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 141      |
| 8 17:55:07  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 151      |
| 9 17:55:08  | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 161      |
| 10 17:55:09 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 300     | 181      |
| 11 17:55:10 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 171      |
| 12 17:55:11 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 161      |
| 13 17:55:12 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 151      |
| 14 17:55:13 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 131      |
| 15 17:55:14 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 121      |
| 16 17:55:15 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 101      |
| 17 17:55:16 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 91       |
| 18 17:55:17 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 81       |
| 19 17:55:18 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 61       |
| 20 17:55:19 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 51       |
| 21 17:55:20 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 41       |
| 22 17:55:21 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 21       |
| 23 17:55:22 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 11       |
| 24 17:55:23 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 25 17:55:24 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 26 17:55:25 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 27 17:55:26 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 28 17:55:27 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 29 17:55:28 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 30 17:55:29 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 31 17:55:30 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 32 17:55:31 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 33 17:55:32 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 34 17:55:33 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 35 17:55:34 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 36 17:55:35 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 37 17:55:36 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 38 17:55:37 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 39 17:55:38 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 40 17:55:39 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 41 17:55:40 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 42 17:55:41 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 43 17:55:42 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 44 17:55:43 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |
| 45 17:55:44 | 1        | 0          | 0            | 146 | 125 | 18  | 500 | 488 | 125 | 125 | 0       | 0        |

**System Interlock**  
System Air  
System Water  
DC24  
DC15P  
DC15N

**Sequence Status**  
READY  
Command  
00:00 11\*  
0.0 / 1.0 sec  
Stop

**Process Timer**  
Start: 00:00:00  
End: 00:00:00  
Total: 00:00 00\*

**Chamber Cleaning**  
PM1 Cleaning

**Substrate Status**  
Size:  
Position:

**Robot Control**  
READY  
Loading  
Unloading

**PM1 Pumping**  
PM Pumping  
PM Venting

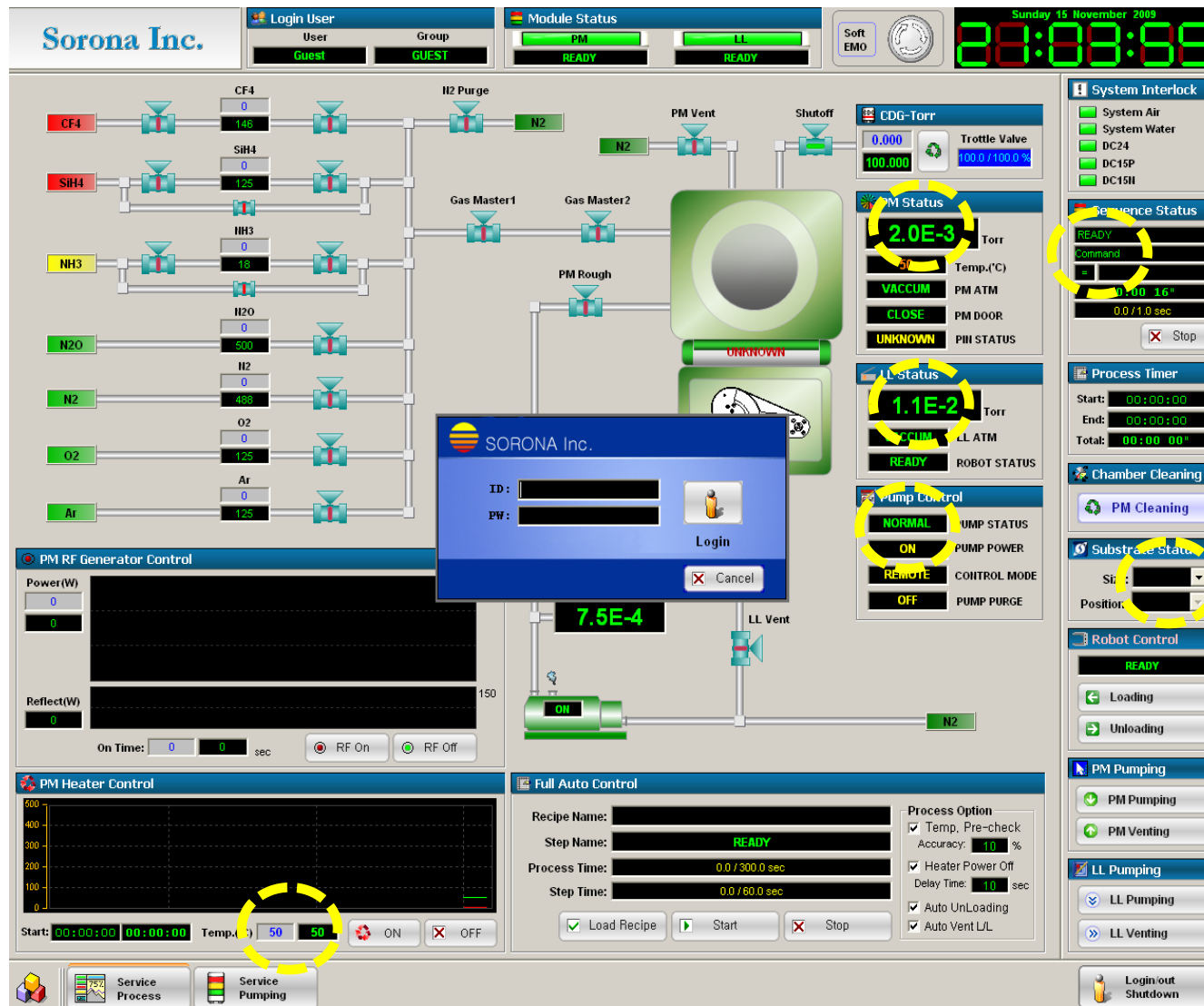
**LL Pumping**  
LL Pumping  
LL Venting

Service Process Service Pumping Recipe Editor System Process History System Configuration User Management System I/O Manager Login-out Shutdown

| Window name | Function    | Description                                                                                                                                              |
|-------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Process Log | Log history | Process time, Work pressure, Throttle valve position, RF Power level, Reflect power, Bias voltage, Process gas flow rate, He Backside cooling flow rate. |

# Process start procedure

※ Process Operation은 장비의 상태와 주위 환경의 점검을 모두 마친 후, 공정을 위한 조건이 모두 갖추어졌을 때 진행 할 것



**Check !**  
**Before process start**

- Burn scrubber
- Utility (Air, gas)
- Substrate temperature
- Wafer Position
- Chamber pressure
- Chamber cleaning
- Process history
- Prame door off

## PM Recipe Select and Start

**Full Auto Control**

Recipe Name:

Step Name: **READY**

Process Time: 0.0 / 300.0 sec

Step Time: 0.0 / 60.0 sec

Process Option

☒ Temp. Pre-check  
Accuracy: 10 %

☒ Heater Power Off  
Delay Time: 10 sec

☒ Auto UnLoading

☒ Auto Vent L/L



**Recipe Select**

Module Recipe List

PM1

Folder 이름을 변경

**Test Recipe**

실행하고자 하는 Recipe Name Click 후 "Select" Button Click

Recipe Step List

|                | 1   | 2    | 3   | 4   | 5 |
|----------------|-----|------|-----|-----|---|
| Step Name      | 2   | 1    | 3   | 4   |   |
| Time(sec)      | 20  | 20   | 30  | 40  |   |
| Pressure(Torr) |     | 20   |     | 0   |   |
| Temperature    | 300 |      |     | 0   |   |
| RF Power(600W) |     |      | 300 | 0   |   |
| CF4(500sccm)   |     |      |     |     |   |
| SiH4(500sccm)  |     | 200  |     | 0   |   |
| NH3(50sccm)    |     |      |     |     |   |
| N2O(2000sccm)  |     | 1000 |     | 0   |   |
| N2(100sccm)    |     |      |     |     |   |
| O2(500sccm)    |     |      |     |     |   |
| Ar(500sccm)    |     |      |     | 300 |   |



**Full Auto Control**

Recipe Name: **Test Recipe**

Step Name: **READY**

Process Time: 0.0 / 300.0 sec

Step Time: 0.0 / 60.0 sec

Process Option

☒ Temp. Pre-check  
Accuracy: 10 %

☒ Heater Power Off  
Delay Time: 10 sec

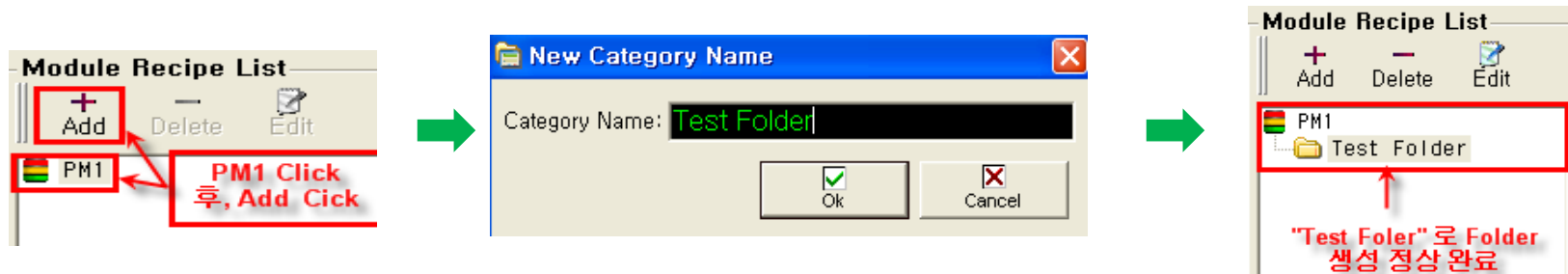
☒ Auto UnLoading

☒ Auto Vent L/L

1. Service Process Screen의 "Full Auto Control" Frame의 "Load Recipe" Button을 Click 한다.  
"Load Recipe" Button Click 시 Recipe를 Select할 수 있는 Window가 활성화 된다.
2. 실행하고자 하는 Recipe Name을 선택한다.
3. Recipe Select가 완료되면, Recipe Select Window는 자동으로 사라지며, Full Auto Control Frame에 Recipe Name, Recipe Step의 총 소요시간, 실행 Step 소요시간이 Setting 된다.
4. Process Option을 설정한다.
  - ★ Process 완료 후에 Wafer를 자동으로 Unloading 하고자 한다면 Auto unloading box를 Check한다.
  - ★ Auto unloading이 되고 난 후에 LL Chamber를 Auto vent 하고자 한다면 Auto vent L/L box를 Check한다.
5. "Start" Button을 Click하면 Recipe가 자동 실행 된다.  
(우측 상단에 "== RUN AUTO ==" Signal 이 활성화 된다.)  
Full Auto 실행 시 Process Stop을 원할 경우는 Full Auto Control Frame의 "Stop" Button click 시 Full Auto 실행이 정지 된다.

# Recipe write/edit/add/delete

- ※ RF Power On 후 Plasma 발생 시 Chamber Diagram 에 Plasma 를 나타내는 붉은색 Plasma Signal이 활성화 된다.
- ※ Plasma 발생 시 Plasma Image가 대략 0.5초 주기로 깜박거린다.
- ※ Process에 관련한 거의 모든 parameter가 Process log 파일에 1sec단위로 저장되며, 관련데이터를 history 에서 확인할 수 있다.



## \* Recipe Category 추가

1. "Recipe Editor" Button을 Click하여 Recipe Editor Screen이 나타나게 한다.
2. 좌측 상단의 Module Recipe List에서 Module (PM1)을 Click 후, "Add" button을 Click한다.
3. 아래와 같이 Category Name을 생성할 수 있는 창이 나타나며, Recipe List를 저장할 수 있는 Category name을 입력하고, "OK" Button을 Click한다.
4. 아래와 같이 Module 아래 Category Folder 생성이 되었는지 확인한다.

\* 기존 Recipe 수정 및 삭제 금지

\* 개인 Recipe 추가를 원할 경우 새로운 이름으로 추가 및 수정할 것

# Recipe write/edit/add/delete

"Test Folder" Click 후  
"Insert" Button Click

Recipe Step Data

|                | 1  | 2    | 3   | 4   | 5 | 6 |
|----------------|----|------|-----|-----|---|---|
| Step Name      |    |      |     |     |   |   |
| Time(sec)      | 10 | 20   | 200 | 200 |   |   |
| Pressure(Torr) |    | 20   |     |     |   |   |
| Temperature    |    |      | 300 |     |   |   |
| RF Power(600W) |    |      |     | 300 |   |   |
| CF4(500sccm)   |    |      |     |     |   |   |
| SiH4(500sccm)  |    | 200  |     |     |   |   |
| NH3(50sccm)    |    |      |     |     |   |   |
| N2O(2000sccm)  |    | 1000 |     |     |   |   |
| N2(100sccm)    |    |      |     |     |   |   |
| O2(500sccm)    |    |      |     |     |   |   |
| Ar(500sccm)    |    |      |     |     |   |   |

New Recipe Name

Recipe Name: Test Recipe

Ok Cancel

PM1  
Test Folder  
Test Recipe

Recipe 저장 완료

## \* Recipe 작성

1. 새롭게 생성된 Folder Click 후 "Recipe Step Data" Screen 의 "Insert Button"을 Click 한다.  
이 때 "Insert" Button Click 시 마다 Recipe Step이 증가한다.
2. Recipe Step에 맞게 Recipe를 작성한다. Recipe Step Data는 해당란을 Double Click 할 경우 바로 입력할 수 있다.
3. "Save" Button을 Click 하여 Recipe를 저장한다. "Save" Button Click시 Recipe name 입력하는 창이 활성화 되며, Recipe Name 입력 후 "OK" Button을 Click 한다.
4. recipe가 정상적으로 저장 완료 되면 다음과 같이 Green LED로 표기된다.

# Recipe write/edit/add/delete

| Module Recipe List  |  | Recipe Step Data |          |      |        |         |
|---------------------|--|------------------|----------|------|--------|---------|
| + Add - Delete Edit |  | ✓ Insert         | - Delete | Save | ← Left | → Right |
| PM1                 |  |                  |          |      |        |         |
| Folder 이름 변경        |  |                  |          |      |        |         |
| Test Recipe         |  |                  |          |      |        |         |
|                     |  | 1                | 2        | 3    |        |         |
| Step Name           |  | 1                | 2        | 3    |        |         |
| Time(sec)           |  | 20               | 20       | 30   |        |         |
| Pressure(Torr)      |  | 20               |          |      |        |         |
| Temperature         |  |                  | 300      |      |        |         |
| RF Power(600W)      |  |                  |          | 300  |        |         |
| CF4(500sccm)        |  |                  |          |      |        |         |
| SiH4(500sccm)       |  | 200              |          |      |        |         |
| NH3(50sccm)         |  |                  |          |      |        |         |
| N20(2000sccm)       |  | 1000             |          |      |        |         |
| N2(100sccm)         |  |                  |          |      |        |         |
| O2(500sccm)         |  |                  |          |      |        |         |
| Ar(500sccm)         |  |                  |          |      |        |         |

Recipe Step Data 변경  
시 Red LED로 변경



| Recipe Step Data |  |          |      |        |         |  |
|------------------|--|----------|------|--------|---------|--|
| ✓ Insert         |  | - Delete | Save | ← Left | → Right |  |
|                  |  | 1        | 2    | 3      |         |  |
| Step Name        |  | 1        | 2    | 3      |         |  |
| Time(sec)        |  | 20       | 20   | 30     |         |  |
| Pressure(Torr)   |  | 20       |      |        |         |  |
| Temperature      |  |          | 300  |        |         |  |
| RF Power(600W)   |  |          |      |        |         |  |
| CF4(500sccm)     |  |          |      |        |         |  |
| SiH4(500sccm)    |  | 200      |      |        |         |  |
| NH3(50sccm)      |  |          |      |        |         |  |
| N20(2000sccm)    |  | 1000     |      |        |         |  |
| N2(100sccm)      |  |          |      |        |         |  |
| O2(500sccm)      |  |          |      |        |         |  |
| Ar(500sccm)      |  |          |      |        |         |  |

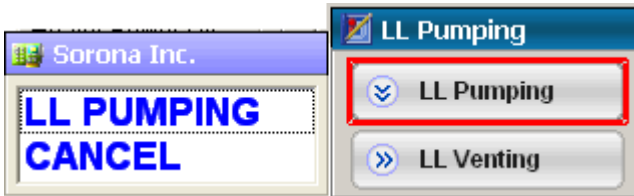
Step No2 삭제 시 Setp No 300  
Click 후 Delete Button Click

## \* Recipe 수정

1. 변경하고자 하는 Recipe Name Click 한다. 해당 Recipe의 Step Data를 변경할 경우에는 Step Data 란을 Double Click 하여 직접 입력한다.
2. Step Data가 변경될 경우 Recipe Name이 Red LED로 변경된다.
3. Data 변경 후 "Save" Button을 Click 하여 Recipe Step Data를 저장한다. 저장이 되면 Recipe Name이 다시 Green LED로 변경된다.
4. 불필요한 Step을 삭제할 경우, 해당 "Step No" Click 후 "Delete" Button을 Click 한다. 변경 완료 후 "Save" Button을 Click하여 저장한다.
5. Step을 추가 및 이동할 경우 "Insert", "Left", "Right" Button을 이용하여 Recipe를 수정할 수 있다.

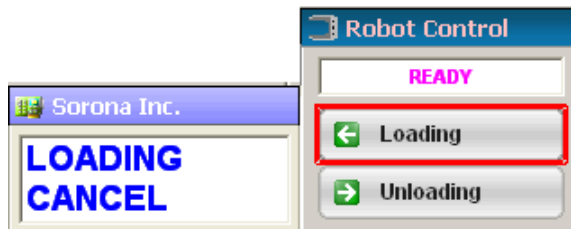
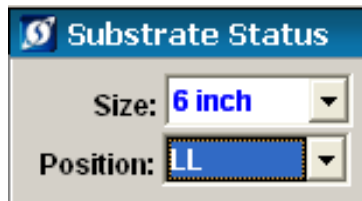
# LL wafer loading/unloading

## Pumping



1. Service pumping window를 활성화 시킨다.
2. LL Pumping Menu에서 Pumping button을 누른다.
3. PUMPING, CANCEL 선택창이 창이 활성화 된다.
4. PUMPING Button을 누른다.
5. 모든 Valve와 Component들이 자동으로 동작한다.
6. Base vacuum 이하로 Pumping이 완료되면 Module status 창에 Ready라고 표시된다.

## Wafer transfer



1. Wafer Status 화면의 Position으로 wafer의 위치를 확인한다.
2. Loading을 진행 할 PM Chamber의 Vacuum 상태를 확인한 후 ATM 이면 Vacuum 상태로 만든다.
3. PM Chamber가 Vacuum 상에 Ready 상태인지 확인한다.
4. Sub menu screen에 있는 LL Robot control menu에서 Loading button을 누른다.
5. Wafer transport를 진행할 건지 확인 창이 활성화 된다.
6. Loading을 클릭한다.
7. Robot이 초기화 되어 Home sequence를 진행하며 Home이 완료가 되면 선택한 Position으로 Wafer를 Process module의 Cooling table에 Loading 한다.
8. Module status 창에는 Moving이라고 표시된다.
9. Loading이 완료되면 Module status 창에 Ready라고 표시된다.

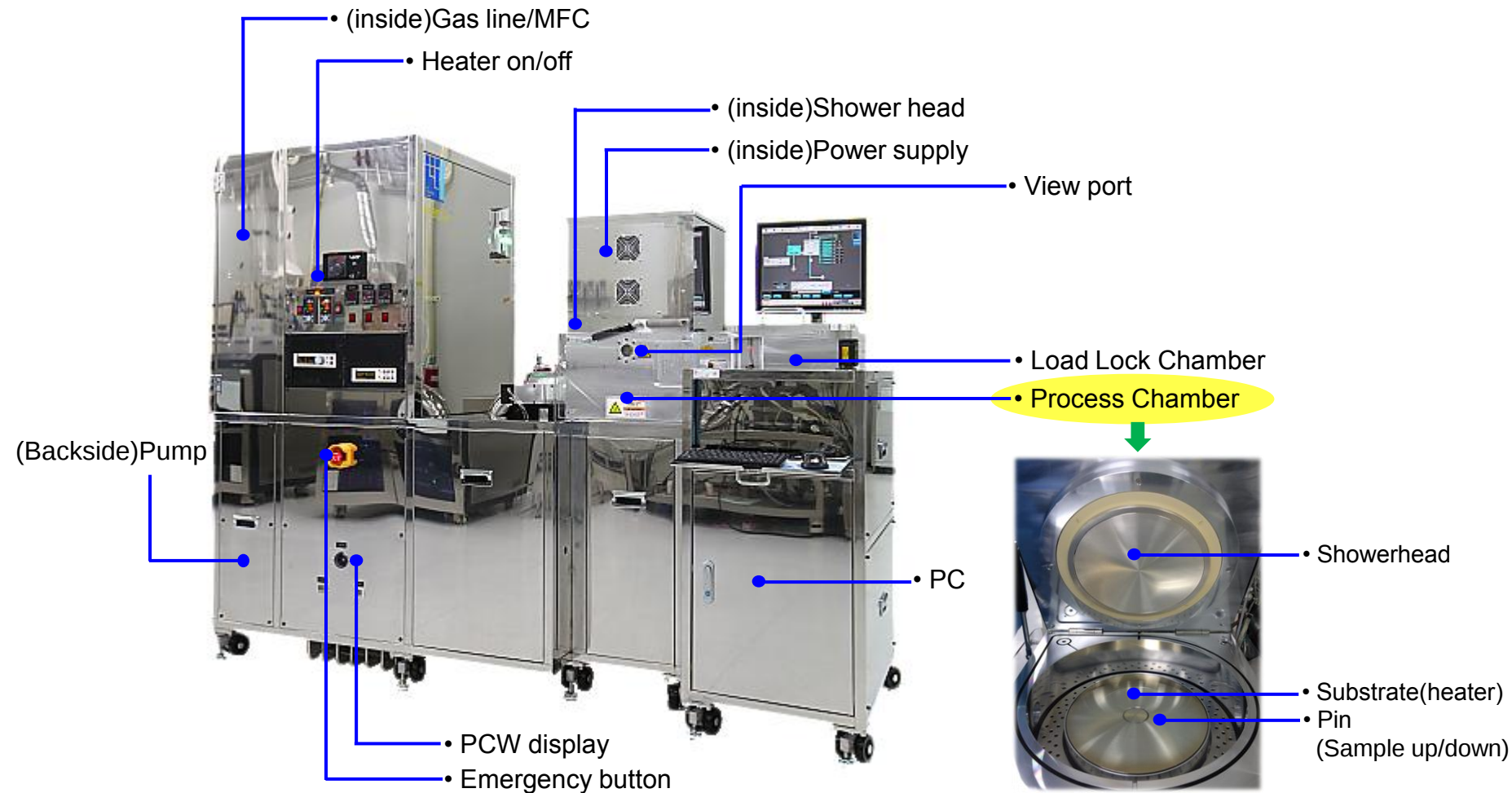
# **PECVD#2**

## **Operating manual**

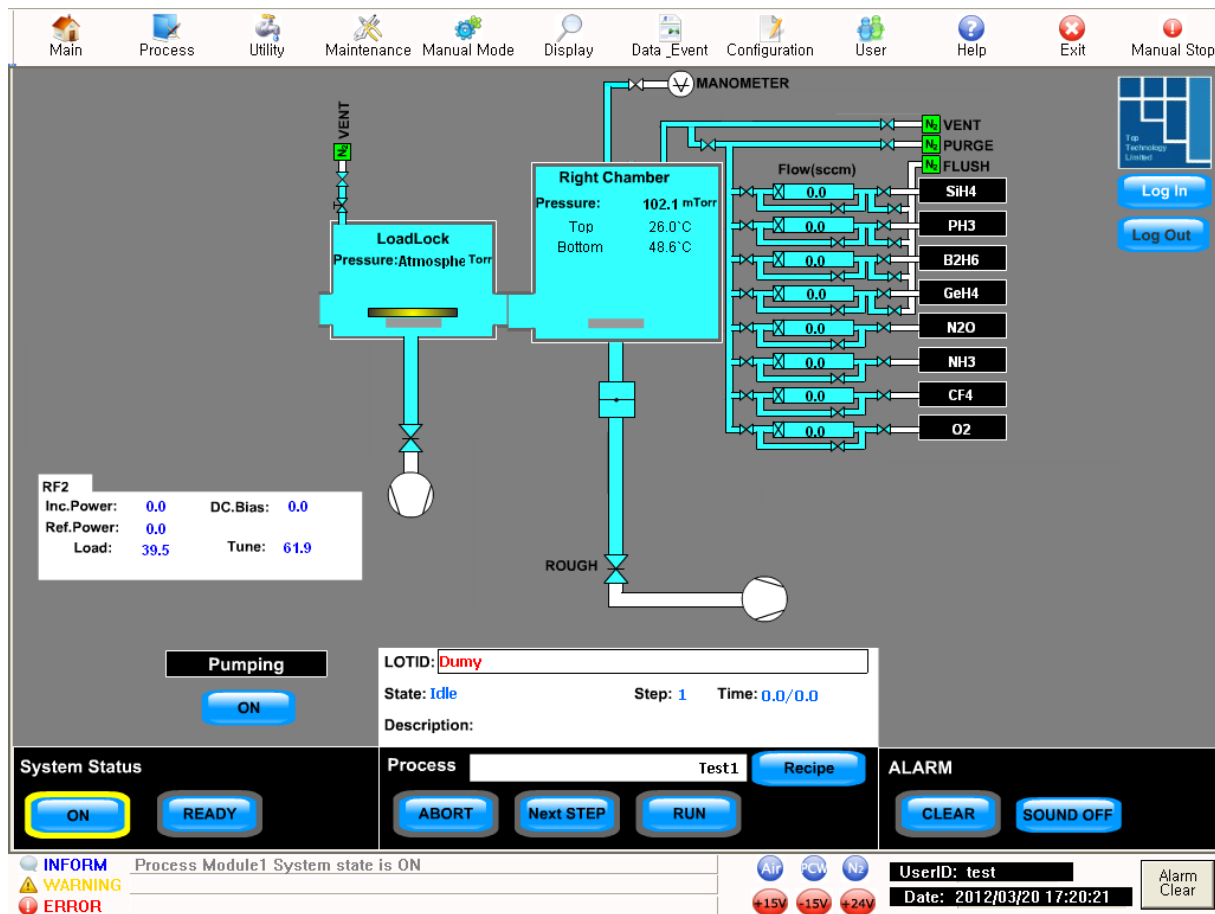
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## 1. 메인 화면



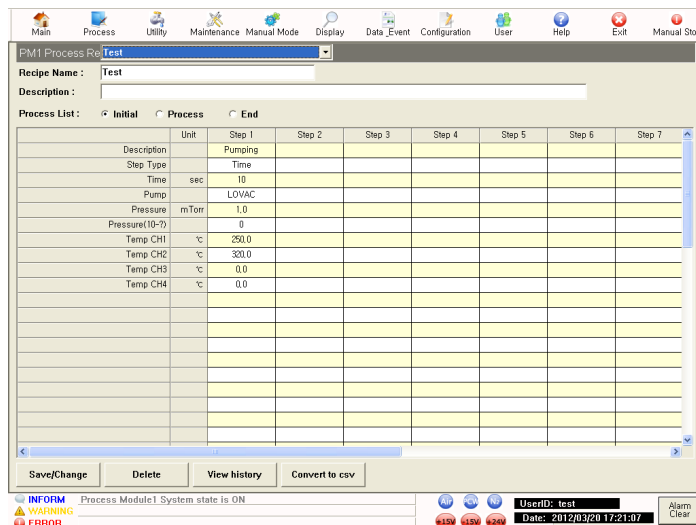
Login이 된 후 처음 나타나는 화면으로써 장비의 전체적인 구조를 나타내고 있다.

화면상에 표시되는 그림은 진공구조를 나타내는 것으로 현재 Pumping상태 및 각종 수치값을 확인할 수 있다.

장비의 Utility상태(CDA, PCW, N2, 각종 Power Supply상태 +24VDC, +15VDC, -15VDC)들을 확인할 수 있으며,

문제가 있을 시에는 창 아래쪽 부분의 Inform, Warning, Error부분에 나타나는 Message를 통해 확인할 수 있다.

## 2. Process menu



Main화면에서 "Process"를 Click하게 되면 위와 같이 Process Menu가 나타나게 된다.

- Initial Step & End Step : 일반적으로 Chamber의 진공상태를 측정하여 충분한 진공상태가 되었는지를 확인 또는 잔류가스를 배출하기 위한 Evacuation Step
- Process Step :
  - Gas Stabilization Step : 가스 및 압력안정화
  - Ignition Step : Plasma Turn-On을 위한 Step
  - Main Processing Step : 실제 공정이 이뤄지는 Step
  - Purge Step : 공정이 종료된 후 N2를 이용하여 잔류가스를 Purging하는 Step

(\*\*\*. 공정 Recipe의 구성은 공정의 특성을 고려하여 여러가지 형태로 변형 할 수 있다.)

- Initial step
  - Temp CH1 : Top Electrode쪽의 온도 설정
  - Temp CH2 : Bottom Plate(Chuck)쪽의 온도 설정

**PM1 Process Recipe Test**

Recipe Name : Test

Description :

Process List : ☐ Initial ☒ Process ☐ End

|                    | Unit  | Step 1     | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 |
|--------------------|-------|------------|--------|--------|--------|--------|--------|--------|
| Description        |       | Gas Stable | Depo.  | Evac.  | Bypass | Flush  | Bypass |        |
| Step Type          |       | Time       | Time   | Time   | Time   | Time   | Time   |        |
| Time               | sec   | 30         | 180    | 30     | 30     | 30     | 30     |        |
| Pump               |       | LOVAC      | LOVAC  | LOVAC  | LOVAC  | LOVAC  | LOVAC  |        |
| Pressure           | mTorr | 400.0      | 400.0  | 1.0    | 1.0    | 1.0    | 1.0    |        |
| Pressure(10-?)     |       | 0          | 0      | 0      | 0      | 0      | 0      |        |
| Temp CH1           | °C    | 250.0      | 250.0  | 250.0  | 250.0  | 250.0  | 250.0  |        |
| Temp CH2           | °C    | 320.0      | 320.0  | 320.0  | 320.0  | 320.0  | 320.0  |        |
| Temp CH3           | °C    | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| Temp CH4           | °C    | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| RF1 Control        |       | NONE       | NONE   | NONE   | NONE   | NONE   | NONE   |        |
| RF1 Setpoint       |       | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| AMN1 Mode          |       | Auto       | Auto   | Auto   | Auto   | Auto   | Auto   |        |
| AMN1 Load Setpoint |       | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| AMN1 Tune Setpoint |       | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| RF2 Control        |       | NONE       | PWR    | NONE   | NONE   | NONE   | NONE   |        |
| RF2 Setpoint       |       | 0.0        | 700.0  | 0.0    | 0.0    | 0.0    | 0.0    |        |
| AMN2 Mode          |       | Auto       | Auto   | Auto   | Auto   | Auto   | Auto   |        |
| AMN2 Load Setpoint |       | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |
| AMN2 Tune Setpoint |       | 0.0        | 0.0    | 0.0    | 0.0    | 0.0    | 0.0    |        |

Save/Change Delete View history Convert to csv

INFORM Process Module1 System state is ON

WARNING

ERROR

UserID: test Date: 2012/03/20 17:21:49

Alarm Clear

## ■ Process Step

### - RF1 Control :

Gas Stable Step, Evacuation Step, Bypass Step, Flush Step 등 Plasma를 켜지 않는 Step에서는 "NONE"으로 설정하며 Deposition Step과 같이 Plasma를 켜는 Step에서는 "PWR"로 설정한다.

### - AMN Mode :

"AUTO"는 Matcher의 Auto-Matching기능을 사용하는 설정이며, "MAN"은 AMN Load Set point와 Tune Set point에 설정된 %값에 고정시킨다. "MAN->AUTO"는 AMN Load Set point와 Tune Set point에 설정된 %값에 설정된 시간만큼 수동으로 머물다가 설정된 시간 후에 Matcher의 Auto-Matching기능을 사용한다.

RF1 : 13.56MHz를 사용하는 High Frequency Power

RF2 : 400KHz를 사용하는 Low Frequency Power

PM1 Process Re **Test**

Recipe Name : **Test**

Description :

Process List : ☐ Initial ☒ Process ☐ End

|             | Unit | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 | Step 7 |
|-------------|------|--------|--------|--------|--------|--------|--------|--------|
| SiH4 Flush  |      | Off    | Off    | Off    | Off    | On     | Off    |        |
| PH3 Flush   |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| B2H6 Flush  |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| GeH4 Flush  |      | Off    | Off    | Off    | Off    | On     | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| SiH4 Bypass |      | Off    | Off    | Off    | On     | Off    | On     |        |
| PH3 Bypass  |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| B2H6 Bypass |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| GeH4 Bypass |      | Off    | Off    | Off    | On     | Off    | On     |        |
| N2O Bypass  |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| NH3 Bypass  |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| CF4 Bypass  |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
| O2 Bypass   |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |
|             |      | Off    | Off    | Off    | Off    | Off    | Off    |        |

Save/Change Delete View history Convert to csv

INFORM Process Module1 System state is ON  
WARNING  
ERROR

UserID: test  
Date: 2012/03/20 17:23:28

Alarm Clear

Process step 아래쪽 메뉴에 대한 화면으로써 Flush와 Bypass 기능을 사용한지를 정해주는 메뉴이다. Flush나 Bypass를 사용하려면 "ON"으로 설정하면 동작하게 된다.

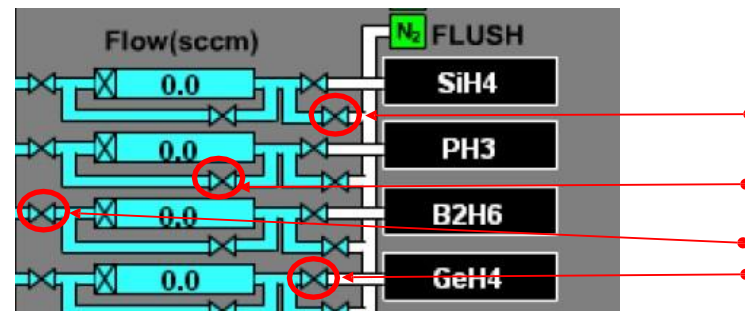
Gas Stable Step, Deposition Step등 주 공정을 위한 Step에서는 "OFF"로 설정하여야 하며 "ON"으로 설정하더라도 Gas Set point가 입력되어있는 Step에서는 동작하지 않는다.

## • Flush 기능

공정 Gas를 흘린 MFC Line의 Gas 공급 Valve를 차단하고, 그 중간에 연결된 N2 Line을 열어 MFC내부에 남아있는 공정 잔류 Gas를 Chamber쪽으로 밀어내어 주는 기능

Flush를 실행할 때 다음과 같은 순서로 진행된다.

1. Process Valve Close  
(Isolation Valve Open, MFC Full Range Flow, Bypass Valve Close)
2. Flush Valve Open
3. Flushing설정 시간 후에 Flush Valve Close  
(다른 Valve 및 MFC도 Close)



## • Byapss 기능

Byapss는 MFC 내부에 남아있는 잔류공정 Gas를 MFC앞뒤에 연결된 우회 Line을 통하여 Chamber쪽으로 배출하는 기능으로써 다음의 순서로 동작한다.

1. Process Valve Close
2. Isolation Valve Open, MFC Full Range Flow
3. Bypass Valve Open

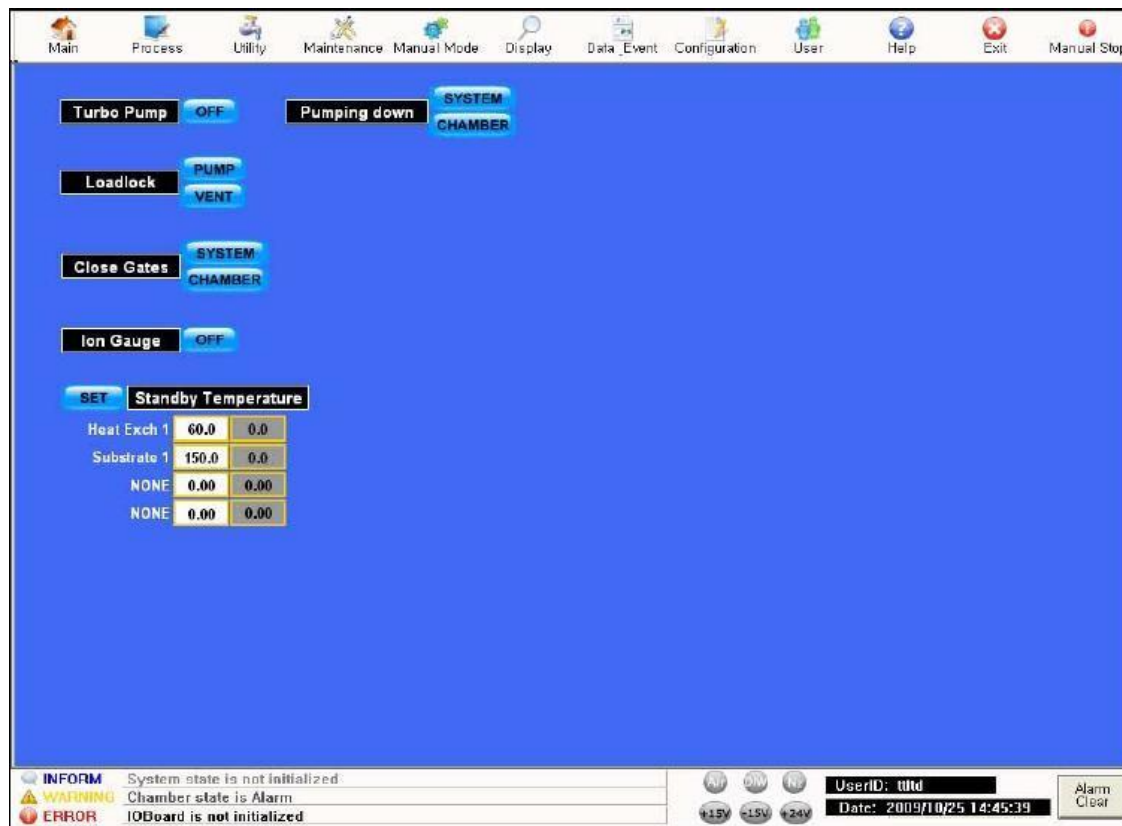
N2 Purge를 ON으로 하게 되면 Gas Line의 Purge Valve가 Open되게 된다.

Gas Set point가 입력되어 있는 Step에서는 N2 Purge를 ON하더라도 동작하지 않는다.

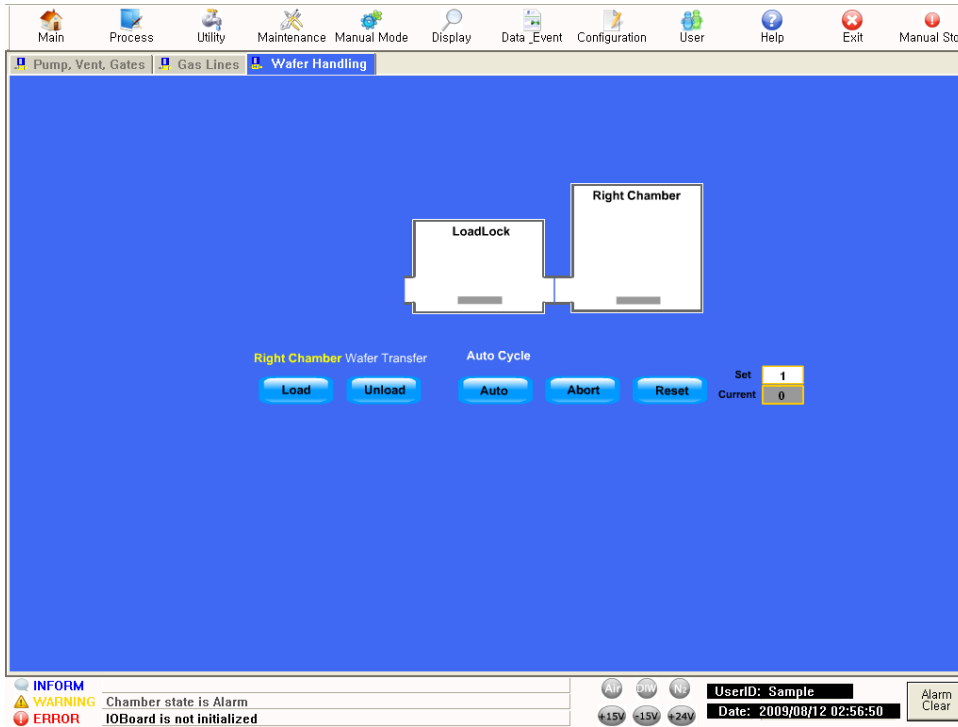
Loop와 Loop Counter는 Loop기능을 사용할 때 설정하는 것으로서, 동일한 Step을 반복적으로 공정하는 것이 필요할 때 사용한다.

Helium Cooler는 Helium Backside Cooling기능을 사용할 때 설정하는 기능이다.

## 3. Utility



- Turbo Pump ON/OFF : Turbo Pump부분에서 "ON"을 Click하면 Turbo Pump가 자동으로 ON상태로 동작되게 된다.  
"OFF" 를 Click하면 자동으로 동작을 중지하게 된다.
- Pumping Down : "System" Click - Loadlock과 Chamber를 같이 Pumping.  
"Chamber" Click - Chamber만 Pumping.
- Loadlock : "Pump"를 Click하면 Loadlock을 Pumping, "Vent"를 Click시에는 Loadlock을 대기압 상태로 Venting하게 된다.
- Close Gates : "System"을 Click하면 Loadlock과 Chamber의 Gate Valve를 동시에 Close하며, "Chamber"를 Click하면 Chamber의 Gate Valve만 Close한다.



- 수동으로 Wafer(혹은 Sample)을 Loading/Unloading 할 때 사용하는 메뉴로써 반드시 Loadlock에 Wafer(Sample)이 놓여져 있는 상태에서 실행할 수 있다.(없을 시에는 Error Message 발생)
  - Loadlock과 Chamber가 반드시 같은 진공상태 혹은 대기압 상태를 유지해야한다.
  - 만일 Loadlock과 Chamber의 진공상태가 다음과 같은 경우 결과치는 우측에 나타나 있는 상태가 된다.

| 상태 | Loadlock | Chamber | 결과                           |
|----|----------|---------|------------------------------|
| 1  | 대기압      | 대기압     | 정상동작                         |
| 2  | 진공       | 진공      | 정상동작                         |
| 3  | 대기압      | 진공      | Loadlock을 진공상태로 만든 후 동작      |
| 4  | 진공       | 대기압     | Loadlock을 대기압상태로 만들어야만 동작 가능 |

"Load" Button을 누르면 Loadlock에서 Chamber로 Wafer(Sample)을 이동시킨다.  
 "Unload" Button을 누르면 Chamber에서 Loadlock으로 Wafer(Sample)을 이동시킴.  
 "Auto"는 "Abort" Button을 누를 때까지 계속해서 Loading/Unloading을 반복함.  
 자동으로 Loading/Unloading시킬 횟수를 지정하려면 "Set"부분에 설정하면됨.  
 Loading/Unloading횟수는 "Current"부분에 표시됨.  
 "Reset" Button은 "Auto"로 Loading/Unloading된 이동횟수를 Reset할 때 사용.

# **Experimental result**

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◆ Deposition rate/Uniformity/Refractive index of Silicon Oxide  
: Gas flow(N<sub>2</sub>O/SiH<sub>4</sub> Ratio)

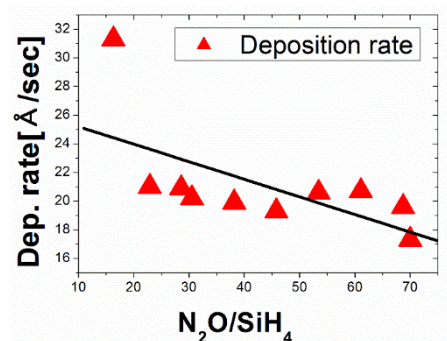
※ R.I 측정 : Ellipsometer

|                  |     |
|------------------|-----|
| Temperature [°C] | 350 |
| Pressure [Torr]  | 1   |
| Power [W]        | 100 |

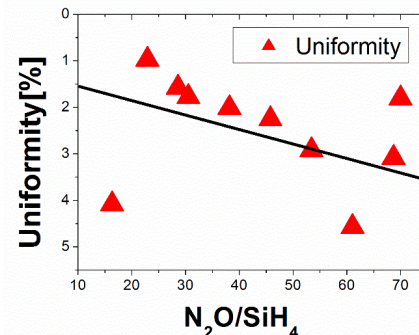
▲ Experimental Conditions

▶ Deposition rate, Uniformity, and Refractive index of SiO<sub>2</sub>

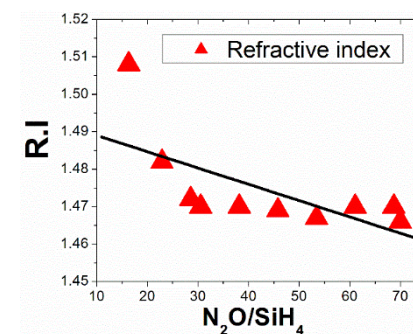
| No. | Process Gas [SCCM]<br>※ SiH <sub>4</sub> : 5%_He Balance |                  | Dep. rate [Å/sec] | Uniform. [%] | R.I   |
|-----|----------------------------------------------------------|------------------|-------------------|--------------|-------|
|     | SiH <sub>4</sub>                                         | N <sub>2</sub> O |                   |              |       |
| 1   | 490                                                      | 400              | 31.3              | 4.08         | 1.508 |
| 2   | 262                                                      | 300              | 21                | 0.97         | 1.482 |
| 3   | 490                                                      | 700              | 20.9              | 1.57         | 1.472 |
| 4   | 262                                                      | 400              | 20.2              | 1.77         | 1.470 |
| 5   | 262                                                      | 500              | 19.9              | 2.01         | 1.470 |
| 6   | 262                                                      | 600              | 19.3              | 2.25         | 1.469 |
| 7   | 262                                                      | 700              | 20.6              | 2.92         | 1.467 |
| 8   | 262                                                      | 800              | 20.7              | 4.57         | 1.470 |
| 9   | 262                                                      | 900              | 19.6              | 3.08         | 1.470 |
| 10  | 200                                                      | 700              | 17.3              | 1.80         | 1.466 |



• Si rich - D.rate ↑



• Si rich - Uniformity ↑



• Si rich - R.I ↑

## ◆ Deposition rate/Uniformity/Refractive index of Silicon Oxide

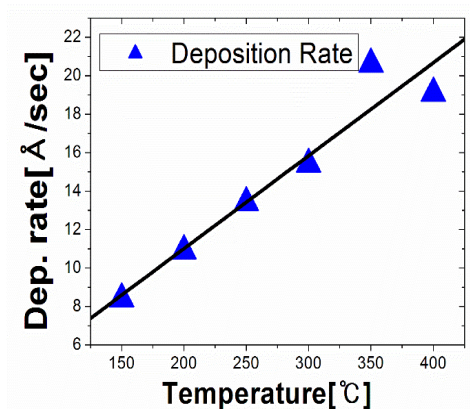
: Substrate Temperature

|                       |                    |     |
|-----------------------|--------------------|-----|
| Process Gas<br>[SCCM] | SiH <sub>4</sub> * | 262 |
|                       | N <sub>2</sub> O   | 700 |
| Pressure<br>[Torr]    |                    | 1   |
| Power<br>[W]          |                    | 100 |

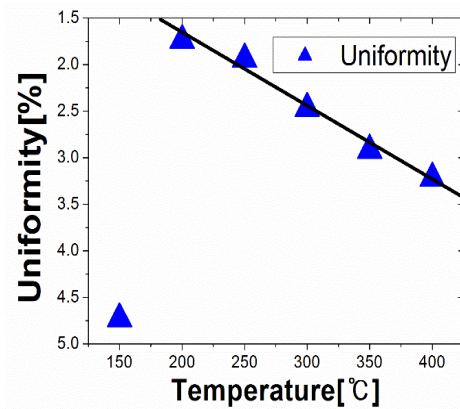
▲ Experimental Conditions

▶ Deposition rate, Uniformity, and Refractive index of SiO<sub>2</sub>

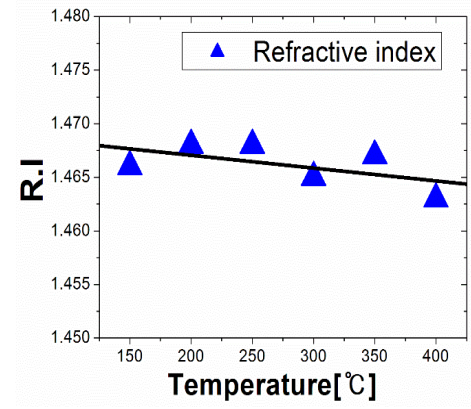
| No. | Temp<br>[°C] | Dep. rate<br>[Å/sec] | Uniform.<br>[%] | R.I   |
|-----|--------------|----------------------|-----------------|-------|
| 1   | 150          | 8.4                  | 4.73            | 1.466 |
| 2   | 200          | 10.9                 | 1.74            | 1.468 |
| 3   | 250          | 13.4                 | 1.94            | 1.468 |
| 4   | 300          | 15.4                 | 2.47            | 1.465 |
| 5   | 350          | 20.6                 | 2.92            | 1.467 |
| 6   | 400          | 19.1                 | 3.22            | 1.463 |



• Temp ↑ D.rate ↑



• Temp ↓ Uniformity ↑



• similar value

## ◆ Deposition rate/Uniformity/Refractive index of Silicon Oxide

: Gas flow(NH<sub>3</sub>/SiH<sub>4</sub> Ratio)

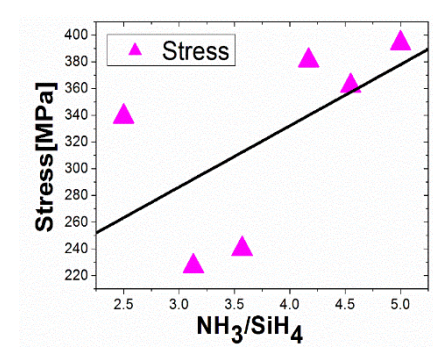
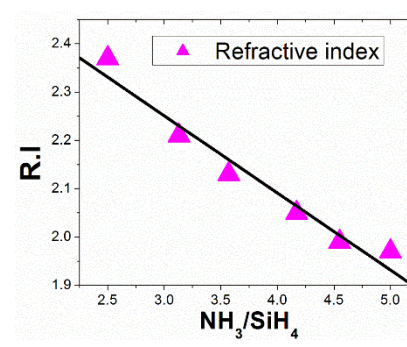
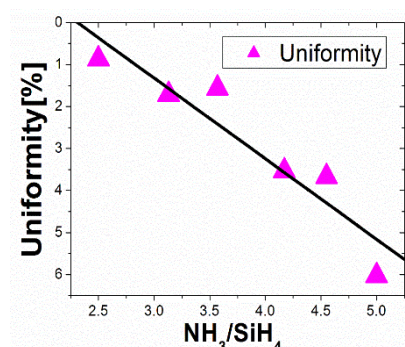
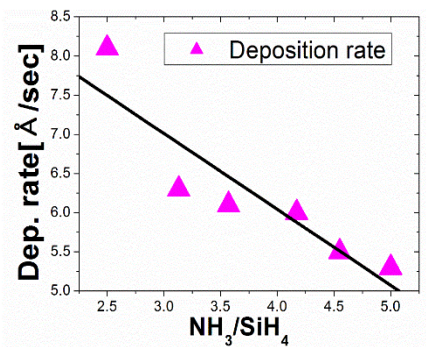
※ Stress측정 : Surface profiler

|                  |     |
|------------------|-----|
| Temperature [°C] | 350 |
| Pressure [Torr]  | 1   |
| Power [W]        | 100 |

▲ Experimental Conditions

▶ Deposition rate, Uniformity, and Refractive index of SiO<sub>2</sub>

| No. | Process Gas [SCCM]<br>※ SiH <sub>4</sub> : 5%_He Balance |                 | Dep.rate [Å/sec] | Uniform. [%] | R.I  | Stress [Mpa] |
|-----|----------------------------------------------------------|-----------------|------------------|--------------|------|--------------|
|     | SiH <sub>4</sub>                                         | NH <sub>3</sub> |                  |              |      |              |
| 1   | 400                                                      | 50              | 8.1              | 0.87         | 2.37 | 339          |
| 2   | 320                                                      | 50              | 6.3              | 1.71         | 2.21 | 227          |
| 3   | 280                                                      | 50              | 6.1              | 1.56         | 2.13 | 240          |
| 4   | 240                                                      | 50              | 6.0              | 3.53         | 2.05 | 381          |
| 5   | 220                                                      | 50              | 5.5              | 3.67         | 2.01 | 362          |
| 6   | 200                                                      | 50              | 5.3              | 6.03         | 1.97 | 394          |



• Si rich - D.rate ↑

• Si rich - Uniformity ↑

• Si rich - R.I ↓

• Si rich - Stress ↓

## ◆ Deposition rate/Uniformity/Refractive index of Silicon Oxide

: Substrate Temperature

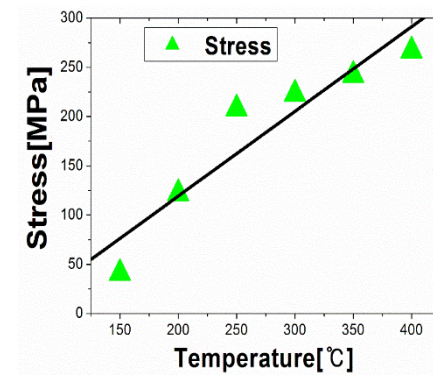
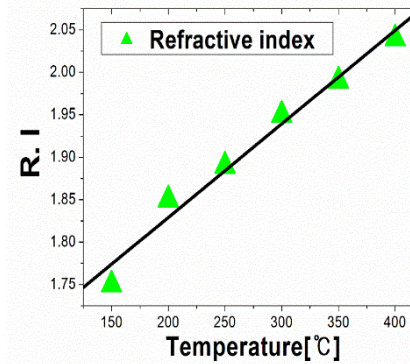
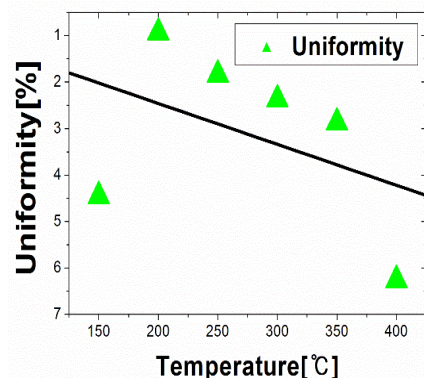
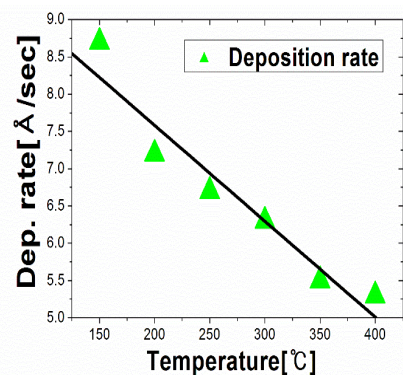
※ Stress측정 : Surface profiler

|                    |                               |     |
|--------------------|-------------------------------|-----|
| Process Gas [SCCM] | SiH <sub>4</sub> <sup>*</sup> | 220 |
|                    | NH <sub>3</sub>               | 50  |
| Pressure[Torr]     |                               | 1   |
| Power[W]           |                               | 100 |

| No. | Temp [°C] | Dep. rate [Å/sec] | Uniform. [%] | R.I  | Stress [Mpa] |
|-----|-----------|-------------------|--------------|------|--------------|
| 1   | 150       | 8.7               | 4.45         | 1.75 | 40.9         |
| 2   | 200       | 7.2               | 0.93         | 1.85 | 122.0        |
| 3   | 250       | 6.7               | 1.84         | 1.89 | 208.0        |
| 4   | 300       | 6.3               | 2.37         | 1.95 | 223.0        |
| 5   | 350       | 5.5               | 2.87         | 1.99 | 242.0        |
| 6   | 400       | 5.3               | 6.26         | 2.04 | 267.0        |

▲ Experimental Conditions

▶ Deposition rate, Uniformity, Refractive index, and Stress of Si<sub>3</sub>N<sub>4</sub>



• Temp ↓ D.rate ↓

• Temp ↑ Uniformity ↑

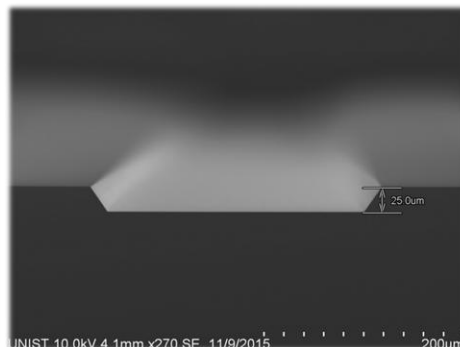
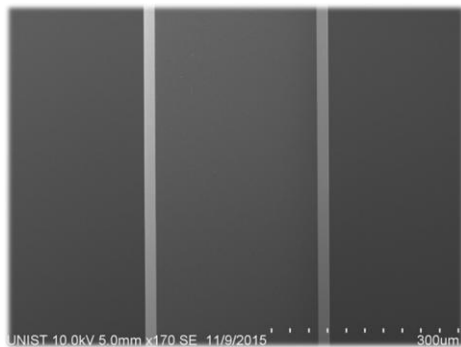
• Temp ↑ R.I ↑

• Temp ↑ Stress ↑

## ◆ Wet Etching

|          |         |
|----------|---------|
| KOH(45%) | 3       |
| DI water | 1       |
| Temp.    | 75~78°C |

| Etching Time<br>[min] | Si Depth<br>[um] | Si <sub>3</sub> N <sub>4</sub> Depth<br>[Å] |
|-----------------------|------------------|---------------------------------------------|
| 0                     | 0                | 2870                                        |
| 5                     | 6.5              | 2785                                        |
| 10                    | 12               | 2730                                        |
| 15                    | 17.6             | 2684                                        |
| 20                    | 25.7             | 2614                                        |

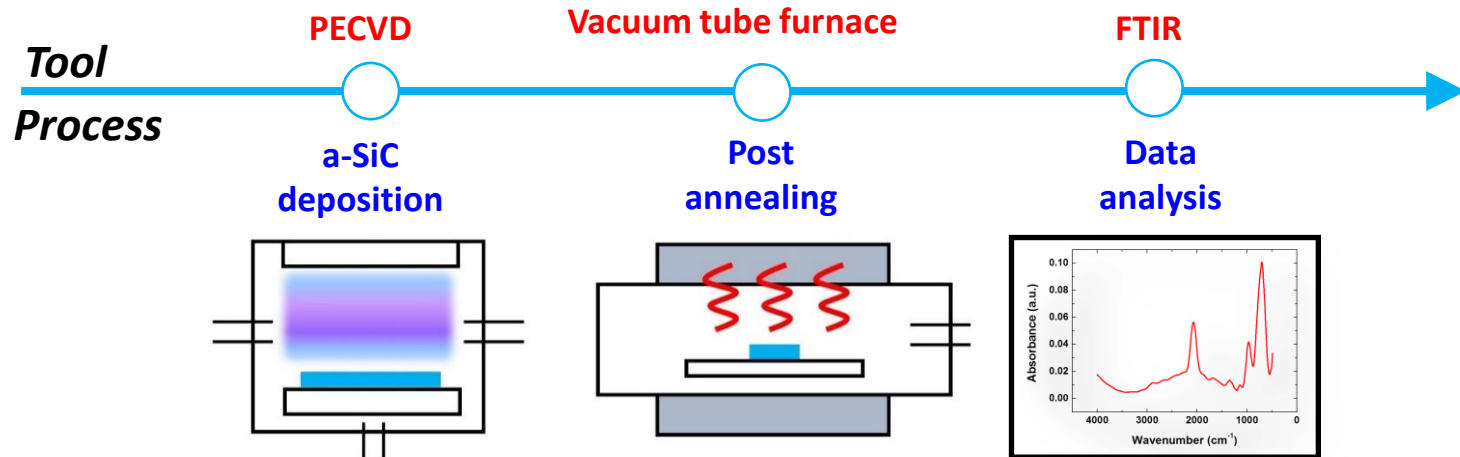


▶ Depth 측정 : Surface Profiler

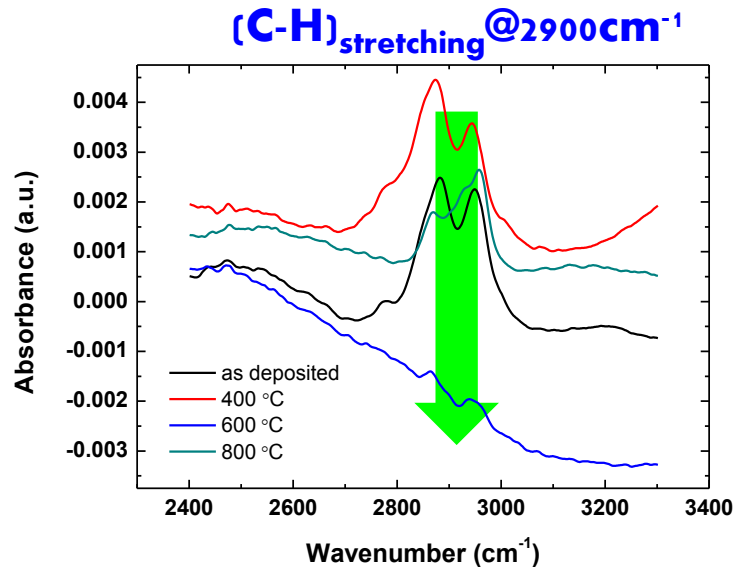
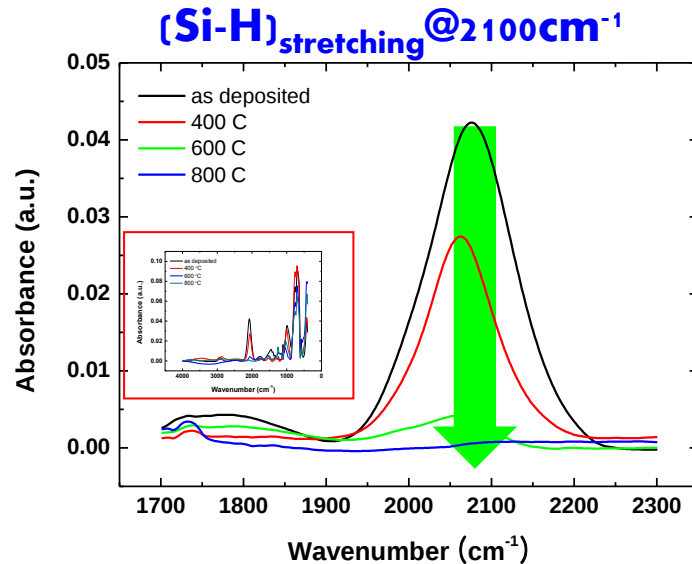
❖ Etch rate  
= 1.25 μm/m

❖ Selectivity  
= 1 : 976

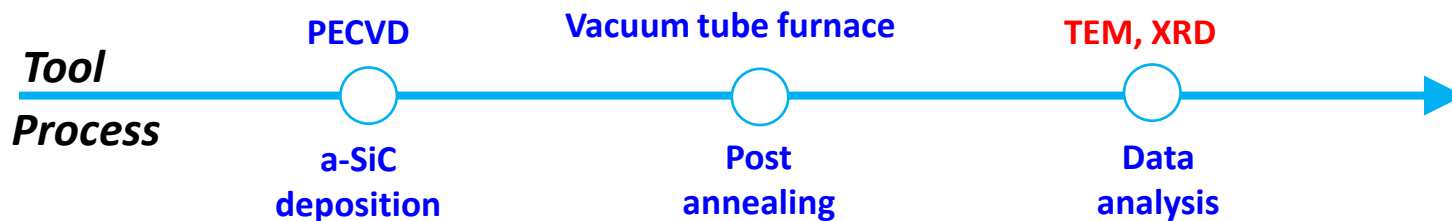
## ◆ Sample post annealing process 200–800 °C



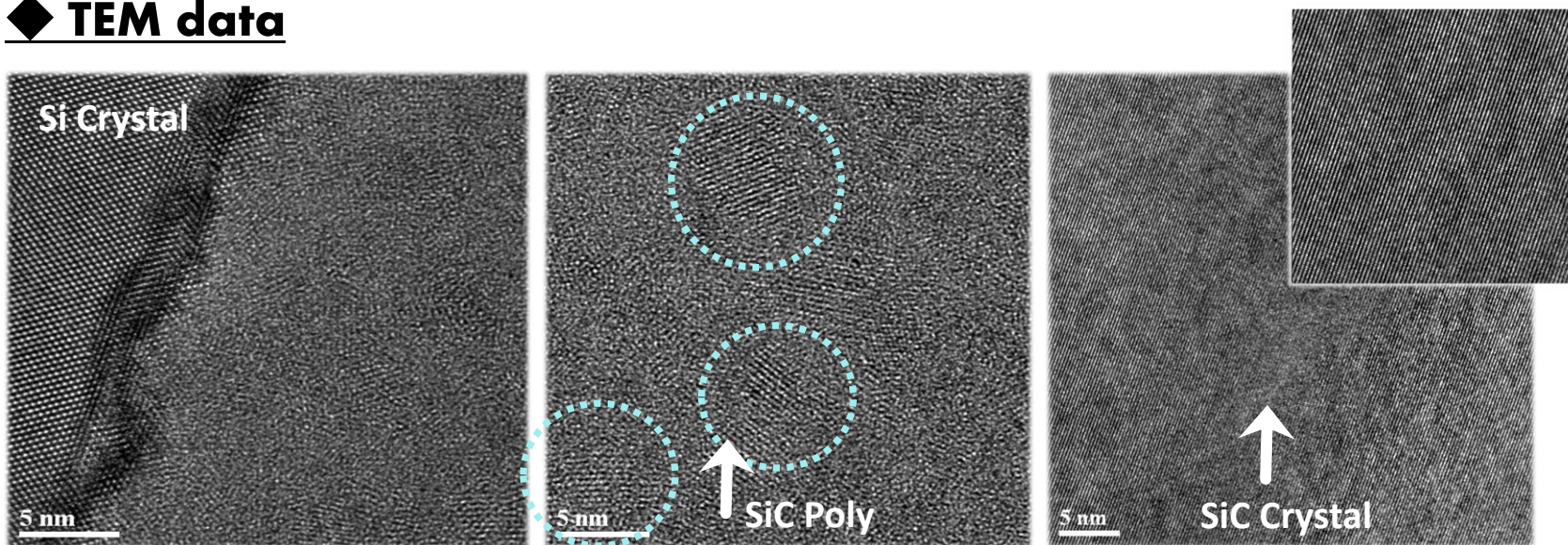
## ◆ FTIR data



## ◆ Sample post annealing process 1000°C



## ◆ TEM data



## Fees-1

| Division                 | Equipment (Model)                            | Unit                                                                                                                               | Fee             |             |                               | Remarks                                                                                                                            |
|--------------------------|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
|                          |                                              |                                                                                                                                    | SELF-User (50%) | UNIST (70%) | Client (100%)                 |                                                                                                                                    |
| Photo                    | E-beam lithography (NB3)                     | 1 operation                                                                                                                        | 100,000         | 140,000     | 200,000                       | - Additional fee 50,000/30min                                                                                                      |
|                          |                                              | - free PMMA, Pattern provided by requestor<br>Data consulting, Job file making, e-beam resist coating, baking and develop are free |                 |             |                               |                                                                                                                                    |
|                          | Mask Aligner #1 (MA6)                        | ≤ 1hr                                                                                                                              | 9,000           | 12,600      | 18,000                        | - PR and Chemical (GXR601, AZ5214, AZ4330, nLOF2035, MIF300) are provided.<br><br>- Free Spin Coater, Wet Station, Oven, Hot plate |
|                          |                                              | 1 operation                                                                                                                        | 6,000           | 8,400       | 12,000                        |                                                                                                                                    |
|                          | Mask Aligner #2 (MDA400S)                    | - individual PR Fee 50% discount                                                                                                   |                 |             |                               |                                                                                                                                    |
|                          |                                              | ≤ 1hr                                                                                                                              | 9,000           | 12,600      | 18,000                        |                                                                                                                                    |
|                          |                                              | 1 operation                                                                                                                        | 4,000           | 5,600       | 8,000                         |                                                                                                                                    |
|                          |                                              | - individual PR Fee 50% discount                                                                                                   |                 |             |                               |                                                                                                                                    |
|                          | Nano Imprinter (ANT-6H)                      | 1 operation ≤ 2hr                                                                                                                  | 100,000         | 140,000     | 200,000                       |                                                                                                                                    |
|                          |                                              | - Additional fee 30,000won/hr                                                                                                      |                 |             |                               |                                                                                                                                    |
| Substrate Bonder (SB-6L) | 1 operation                                  | 40,000                                                                                                                             | 56,000          | 80,000      |                               |                                                                                                                                    |
| Spin Coater (JSP6D)      | 1 operation ≤ 1hr                            | 6,000                                                                                                                              | 8,400           | 12,000      | - Photolitho/NIL user is free |                                                                                                                                    |
| Thin film                | E-beam Evaporator (WC-4000)                  | 1 operation ≤ 0.5μm                                                                                                                | 45,000          | 63,000      | 90,000                        | - Material reimburse expenses (Ai, Pd, Pt, and etc.)                                                                               |
|                          | E-beam Evaporator (Temescal FC-2000)         | 1 operation ≤ 0.5μm                                                                                                                | 45,000          | 63,000      | 90,000                        | - specialized metal and crucible prepared users                                                                                    |
|                          | DC Sputter (SRN-120)                         | 1 operation ≤ 0.5μm                                                                                                                | 30,000          | 42,000      | 60,000                        | - 10,000/0.3μm & 100℃<br>- Individual Target only basic fee applied (≤30min)                                                       |
|                          | RF Sputter (SRN-120)                         | 1 operation ≤ 0.5μm                                                                                                                | 30,000          | 42,000      | 60,000                        |                                                                                                                                    |
|                          | PE CVD #1 (PEH-600)                          | 1 operation ≤ SiO2 1μm, Si3 N4 0.5μm                                                                                               | 45,000          | 63,000      | 90,000                        |                                                                                                                                    |
|                          | PE CVD #2 (FABStar-PECVD)                    | 1 operation ≤ 0.5μm                                                                                                                | 45,000          | 63,000      | 90,000                        |                                                                                                                                    |
|                          | LP CVD (KVL206)                              | 1 operation ≤ 0.5μm                                                                                                                | 150,000         | 210,000     | 300,000                       | - 6" 25ea, 4" 10ea                                                                                                                 |
|                          | Furnace_DRY (KHD-306)                        | 1 operation ≤ 0.3μm                                                                                                                | 150,000         | 210,000     | 300,000                       | - Batch(25ea)                                                                                                                      |
|                          | Furnace_WET (KHD-306)                        | 1 operation ≤ 1μm                                                                                                                  | 150,000         | 210,000     | 300,000                       |                                                                                                                                    |
|                          | Atomic layer deposition (Atomic premium CN1) | 1 operation ≤ 100 Å                                                                                                                | 75,000          | 105,000     | 150,000                       | - Additional fee 40,000/50 Å                                                                                                       |
|                          | Cluster ALD (Lucida D100)                    | 1 operation ≤ 100 Å                                                                                                                | 75,000          | 105,000     | 150,000                       |                                                                                                                                    |

Model : PEH-600 [SORONA, KOREA]



## Principle

- PECVD System is a multipurpose tool capable of deposition silicon oxide, silicon nitride using electron energy (plasma) as the activation method to enable deposition at a low temperature and at a reasonable rate.

## Specifications

- High Plasma Density, High Dep. rate PE-CVD
- Wafer Size : 6", Max Substrate Temperature : 400 °C
- Power Supply : 600 W, 13.56 MHz RF Generator
- Process Gas : N<sub>2</sub>O, N<sub>2</sub>, CF<sub>4</sub>/O<sub>2</sub>, pure SiH<sub>4</sub>/NH<sub>3</sub>
- Process Guarantee : 1000Å ~ 1μm
- With in Wafer Uniformity : ±3%,
- Wafer to Wafer Uniformity : ±3 %
- Uniform process gas flow distribution
- Robotic arm for wafer handling
- RF generator connected to upper electrode through a close coupled automatic matching network.

## Applications

- Passivation layer of semiconductor
- Inter Metal Dielectric of semiconductor
- Inter layer Dielectric of semiconductor

|        |                             |
|--------|-----------------------------|
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| 엔지니어   | (주)소로나                      |
|        | Tel : 031-667-9954          |
|        | email : ngyoon@sorona.co.kr |

## Model : FABStar-PECVD [TTL, KOREA]



|        |                           |
|--------|---------------------------|
| 자산 번호  | 14007715                  |
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| 엔지니어   | (주)티티엘                    |
|        | Tel : 031-203-1048        |
|        | email : dypark@ttltd.net  |

### Principle

- SiC PECVD System is capable of deposition silicon carbide using electron energy (plasma) as the activation method to enable deposition at a low temperature and at a reasonable rate.

### Specifications

- High Plasma Density, High Dep. rate PE-CVD
- Wafer Size : 6", Substrate Temperature : 250~350°C
- Process Gas : N<sub>2</sub>, SF<sub>6</sub>/O<sub>2</sub>, pure SiH<sub>4</sub>/CH<sub>4</sub>
- Power Supply : 600 W, 13.56 MHz RF Generator
- Process Guarantee : 1000Å ~ 1μm
- With in Wafer Uniformity : ±3%,
- Wafer to Wafer Uniformity : ±3 %
- Uniform process gas flow distribution
- Robotic arm for wafer handling
- RF generator connected to upper electrode through a close coupled automatic matching network

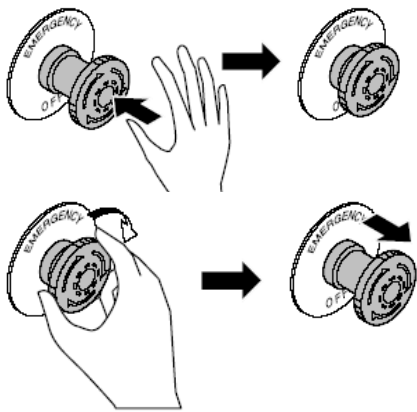
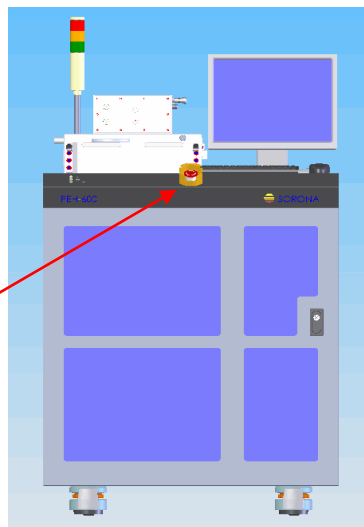
### Applications

- High rate and high quality silicon carbide deposition with stress control
- Passivation layer
- Inter Metal Dielectric of semiconductor
- Inter layer Dielectric of semiconductor

## Emergency **⚠WARNING**

- 위급한 상황이 발생 할 시에는 Operator Emergency Switch를 눌러 Main Power 차단 할 수 있다. EMO switch는 장비의 Front 상단에 위치해 있다. 비상상황이 해제 된 후 System Power 투입 시에는 Procedure에 의한 System Operation을 해야 한다.
- EMO Switch에 의한 강제적인 System Down시 System이 Damage를 입을 수도 있으므로, 위급한 상황이 아닌 일반 상황에서 절대로 EMO Switch를 이용하여 Main Power를 차단하지 않는다.

EMO SWITCH



- 만약 위급사항이 발생했을 경우 왼쪽의 그림과 같이 Emergency switch를 손으로 누르면 Emergency switch가 Push and Lock되고 장비 전체의 전원이 Off 된다.
- EMO Switch를 해제하여 다시 장비 전체의 전원을 on하려면 왼쪽의 그림과 같이 Emergency switch를 오른쪽으로 돌려서 Lock되어 있는 Switch를 해제하고 시스템에 전원을 인가해야 한다.

@ 나노소자공정실(UNFC) 장비 및 시설 배치 현황 (108동 B101호)

■ Photo   
 ■ Thin-film   
 ■ Etch   
 ■ Measurement

