

Tempress LPCVD Operation

At this time the Tempress LPCVD system can only be operated by qualified MNFC staff. It should not be operated under any other circumstances. Requests for film deposition should be forwarded to the MNFC staff.

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Reference Documents

Tempress Horizontal Diffusion Furnace TS 6604 User Manuals

Equipment

- Vacuum Wand
- Quartz boat handles (use only the dedicated handles for each tube to prevent cross contamination).
- 6" Wafer flat finder

Process Gases & some Notable Properties

Ammonia (NH₃)

Pungent highly-irritating odor. It is alkaline, corrosive, and toxic

Dichlorosilane (DCS, SiH₂Cl₂)

On contact with air, DCS decomposes into HCl and is extremely irritating to the respiratory tract, eyes, and skin.

Nitrogen (N₂)

In high concentrations can replace oxygen in the air and act as an asphyxiant.

Oxygen (O₂)

Flammable

Phosphine / Silane (PH₃/SiH₄)

Burns readily in air and explodes on contact with oxygen.

Silane (SiH₄)

Pyrogenic. Spontaneously flammable in air. Repulsive odor.

Operation

- 1) All processing must be planned in advanced such that it is completed between the hours of 8am and 5pm, Monday through Friday.
- 2) Log in on the logsheet and note down the appropriate information.
- 3) Only qualified MFNC staff have the required username and password to access and operate the LPCVD system at this time.
- 4) Turn on the vacuum pump corresponding to the tube you will be using (Nitride, Poly Silicon, LTO, p-doped LTO). Only one tube at a time can be operated.
- 5) Go to the desired tube control and run the P_START recipe. This recipe is intended for the release of any stagnant gases present in the tube as well as getting the tube to an acceptable operating temperature.
- 6) To select a recipe:
 - a. Go to MAIN MENU
 - b. Select **4>> Tube Control**
 - c. Enter Username and Password
 - d. Under PROCESS CONTROL MENU select **6>> Select a Process Recipe**
 - e. Enter the 2 digit number associated with P_START in the Normal Recipe Table.
 - f. Press YES after verifying you have the correct recipe.
- 7) To start a recipe:
 - a. Under PROCESS CONTROL MENU select **2>> Start/Stop Process Recipe**
 - b. Press START after verifying that you are starting the correct recipe.
- 8) Wait for the P_START to complete and for the tube to go into standby.
- 9) If the tube needs to be loaded, then run the LOAD-UNL recipe for the desired tube (SEE NORMAL RECIPE TABLE). This recipe takes approximately 15 minutes to run with around 7 minutes for the actual retrieval/placement of the chamber loads.
- 10) When loading/unloading tube A4 (LTO-PSG) wafers use the dedicated handles only! After loading/unloading wafers from this tube, use IPA and cleanroom grade wipes to clean the vacuum wand and the area around the

loading/unloading site to remove the residual white phosphorous powder from the working area.

- 11) If loading then place all prime and dummy wafers into designated slots. Ex: For Tube 3 (LTO) run the LTO recipe to continue the system process. The deposition time for this particular tube is 20 minutes; however the entire process takes about 1hr and 30 minutes. The steps other than deposition include stabilizing the tube temp and properly mixing of the reacting gasses to ensure both quality and uniformity of the film.
- 12) As the process completes, it will return back to the standby step that every recipe is implemented with. At this point it would be desired to run the LOAD-UNL recipe to retrieve your wafers for inspection and measurement calculations.
- 13) NOTE: During ALL process runs, it is a good idea to use the “Graphic Process Control” option in the Monitor Menu to monitor all temp sensors and other digital inputs that may be crucial to the process. If an alarm is activated, and it is process specific, the recipe will be put in standby and stay there regardless if the alarm has been cleared. This is why it is a good idea to routinely check up on the system for any anomalies.
- 14) Recovery from an Abort Situation caused by power outage :

NOTE: A power failure lasting more than 10 seconds will trigger the under voltage detection system which will trip the main switch:

- Make sure the pumps are turned on and operational
- First turn the main switch into the “0” position
- Then switch to “I” to activate to main switch
- The main power cabinet has now returned into Standby mode.
- Locate the tube where the process was interrupted (if any). Check the status on the tube via the graphic controller interface and verify that all conditions are optimal and within operating parameters.
- Go to the recipe selection screen and locate and select the BADABORT recipe.
- After it is selected start the selected recipe to run its cycle. This is to ensure that all toxic, stagnant, gases are evacuated from the tube eliminating any threat to the process engineer or operator.
- Once this recipe has ran successfully, proceed to running the LOAD/UNLOAD recipe to collect and retrieve the batch.

Table 1 – 150 mm Film Parameters

Tube	Program Name	Deposition Time (min)	R-R Average Film Thickness (Å)	% Uniformity p-p, w-w, r-r
Nitride (A1)	LS Nitride	30	1175	< 4.0%
Poly Si (A2)	Flat Poly	60	4571	< 3.0% w-w < 4.0%
LTO (A3)	LTO	50	1173	< 4.0%
p-doped LTO (A4)	LTO-PSG	30	663	< 3.0%

p-p : point-to-point or within wafer
w-w: wafer-to-wafer
r-r: run-to-run

Table 2 – 150 mm Process Parameters Deposition Step

Program	LS Nitride	Nitride	Flat Poly	LTO	LTO-PSG
Tube	A1	A1	A2	A3	A4
Press (mTorr)	180	210	220	140	140
Temp (C)					
Zone 1: Door	800	785	610	408	410
Zone 2: Center	835	805	610	415	410
Zone 3: Pump	870	820	610	398	410
SiH₂Cl₂ (sccm)	200	65	-	-	-
NH₃	50	195	-	-	-
SiH₄ (REAR) (INJ) (FLNG)	-	-	(20) (60) (30)	40	40
N₂	-	-	-	Low: 20	225
O₂	-	-	-	120	140
PH₃/SiH₄	-	-	-	-	20

Table 3 – LPCVD Tubes and Primary Reactions

Tube	Reaction
A1 - Nitride	$\text{SiH}_2\text{Cl}_2 + \text{NH}_3 \rightarrow \text{Si}_3\text{N}_4 + \text{HCl} + \text{H}_2 + \text{NH}_4\text{Cl}$
A2 – Poly Si	$\text{SiH}_4 \rightarrow \text{Si} + \text{H}_2$
A3 - LTO	$\text{SiH}_4 + \text{O}_2 \rightarrow \text{SiO}_2 + \text{H}_2$
A4 – PSG LTO	$\text{SiH}_4 \rightarrow \text{Si} + \text{H}_2$ $\text{PH}_3 \rightarrow \text{P} + \text{H}_2$

Table 4 – LPCVD Tube Normal Recipe Assignments

Recipe	Tube A1	Tube A2	Tube A3	Tube A4
N1	Nitride	Poly	LTO	LTO-PSG
N2	LS Nitride	FlatPoly	-	LTO
N8	Load-Unl	Load-Unl	Load-Unl	Load-Unl
N9	TEST	TEST	TEST	TEST
N10	STANDBY	STANDBY	STANDBY	STANDBY
N11	P_START	P_START	P_START	P_START
N16	Profile	Profile	Profile	Profile

Revision	Description of Change	Change Initiator	Date of Change
0	Release Spec	Omid Mahdavi / Matt Yturalde	9/05/06

APPENDIX

RECIPE DETAILS FOR REFERENCE ONLY

Example: LS NITRIDE

00 STANDBY

Message STANDBY [1]. Sonalert alarm No

Normal recipe 00 Zone1 700.0 °C Slope 10.00 °C/min Zone2 700.0 °C Slope 10.00 °C/min Zone3 700.0°C Slope 10.00 °C/min , profile table A

Boat to 1560.0 mm at 300.0 mm/min with oscillation speed of 0.0 mm/min. Variable Command: No

Gas N2 [1] at 0.00 [SLM] Variable Command: No

Gas DCS [3] at 0 [SCCM] Variable Command: No

Gas NH3 [4] at 0.0 [SCCM] Variable Command: No

Gas N2-LOW [7] at 0 [scm] Variable Command: No

Gas PRESSURE [8] at 0 [MTOR] Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = ON Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = OFF,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = ON,SOFTSTRT[15] = ON,MAINVAC[16] = ON Variable Command: No

Alarm Limit Setting for All Analog Output Channel at 0 %

Alarm on digital in PRESS N2[1] = ON,PRESSAIR[2] = ON,DOORCLSD[3] = ON,VACFAIL[4] = ON,,,TEMP SCR[7] =ON,EXCESS[8] = ON

Alarm on digital in FANCONTR[9] = ON,,,OPERATE[12] = ON,WARNING[13] = ON,FAILURE[14] = ON,N2 PUMP[15] = OFF,

01 PURGE

Message PURGE [12]. Sonalert alarm No

Time: 000:01:00 (hr:min:sec) Variable Command: No

Normal recipe 03 Zone1 850.0 °C Slope 10.00 °C/min Zone2 850.0 °C Slope 10.00 °C/min Zone3 850.0 °C Slope 10.00 °C/min , profile table A

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = ON Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 0 % (± 0 MTOR) Variable Command: No

02 EVAC

Message EVACUATE 3 [10]. Sonalert alarm No

Time: 000:02:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = OFF Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

03 LOOP P-P

Message EVACUATE 3 [10]. Sonalert alarm No

Branch loop for 2.0 times to step PURGE. Sonalert alarm No

04 LEAKCHECK

Message LEAKCHECK [11]. Sonalert alarm No

Time: 000:02:00 (hr:min:sec) Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,,SOFTSTRT[15] = OFF,MAINVAC[16] = OFF Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 2 % (± 40 MTOR) Variable Command: No

Branch on gas/pressure PRESSURE [8] to step PURGE. Sonalert alarm Yes

05 EVAC

Message EVACUATE 3 [10]. Sonalert alarm No

Time: 000:01:30 (hr:min:sec) Variable Command: No

Normal recipe 04 Zone1 850.0 °C Slope 0.00 °C/min Zone2 850.0 °C Slope 0.00 °C/min
Zone3 850.0 °C Slope 0.00 °C/min , profile table A

Digital out N2PROCES[9] = OFF,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 0 % (± 0 MTOR) Variable Command: No

06 TEMP-STAB

Time: 000:15:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = ON Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

07 NH3

Message PURGE [12]. Sonalert alarm No
Time: 000:02:00 (hr:min:sec) Variable Command: No

Gas [NH3 [4]] at [50.0] [SCCM] Variable Command: Yes

Gas [N2-LOW [7]] at [0] [sccm] Variable Command: Yes

Branch on digital input WARNING [13] to step NH3 PURGE. Sonalert alarm Yes

Digital out ,,,,WTRFLNG[6] = ON,,N2 PURGE[8] = OFF Variable Command: No

Branch on digital input FAILURE [14] to step STANDBY. Sonalert alarm Yes

Digital out N2PROCES[9] = OFF,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

08 PRESS

Message SET PRESSURE [5]. Sonalert alarm No

Time: 000:02:00 (hr:min:sec) Variable Command: No

Gas [PRESSURE [8]] at [200] [MTOR] Variable Command: Yes

Alarm limit setting for Gas NH3 [4] at 10 % (± 20.0 SCCM) Variable Command: No

Branch on gas/pressure NH3 [4] to step NH3 PURGE. Sonalert alarm Yes

Branch on digital input OPERATE [12] to step STANDBY. Sonalert alarm Yes

Branch on digital input WARNING [13] to step NH3 PURGE. Sonalert alarm Yes

Branch on digital input FAILURE [14] to step STANDBY. Sonalert alarm Yes

09 DEP

Message DEPOSITION [13]. Sonalert alarm No

Time: [000:30:00] (hr:min:sec) Variable Command: Yes

Gas [DCS [3]] at [200] [SCCM] Variable Command: Yes

Alarm limit setting for Gas DCS [3] at 10 % (± 50 SCCM) Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 5 % (± 100 MTOR) Variable Command: No

Branch on gas/pressure DCS [3] to step NH3 PURGE. Sonalert alarm Yes

Branch on gas/pressure NH3 [4] to step NH3 PURGE. Sonalert alarm Yes

Branch on gas/pressure PRESSURE [8] to step NH3 PURGE. Sonalert alarm Yes

Branch on digital input OPERATE [12] to step STANDBY. Sonalert alarm Yes

Branch on digital input WARNING [13] to step NH3 PURGE. Sonalert alarm Yes

Branch on digital input FAILURE [14] to step STANDBY. Sonalert alarm Yes

10 NH3 PURGE

Message PURGE [12]. Sonalert alarm No

Time: [000:05:00] (hr:min:sec) Variable Command: Yes

Normal recipe 00 Zone1 700.0 °C Slope 10.00 °C/min Zone2 700.0 °C Slope 10.00 °C/min Zone3 700.0 °C Slope 10.00 °C/min , profile table A

Gas DCS [3] at 0 [SCCM] Variable Command: No

Gas NH3 [4] at 50.0 [SCCM] Variable Command: No

Gas N2-LOW [7] at 0 [sccm] Variable Command: No

Gas PRESSURE [8] at 500 [MTOR] Variable Command: No

Digital out ,,,,WTRFLNG[6] = ON,,N2 PURGE[8] = OFF Variable Command: No

Digital out N2PROCES[9] = OFF,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,,SOFTSTRIT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Alarm Limit Setting for All Analog Output Channel at 0 %

Branch on digital input OPERATE [12] to step STANDBY. Sonalert alarm Yes

Branch on digital input FAILURE [14] to step STANDBY. Sonalert alarm Yes

Branch on digital input N2 PUMP [15] to step STANDBY. Sonalert alarm Yes

11 EVAC

Message EVACUATE 3 [10]. Sonalert alarm No

Time: 000:05:00 (hr:min:sec) Variable Command: No

Gas NH3 [4] at 0.0 [SCCM] Variable Command: No

Gas N2-LOW [7] at 0 [sccm] Variable Command: No

Gas PRESSURE [8] at 0 [MTOR] Variable Command: No

Digital out N2PROCES[9] = OFF,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] =

OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = OFF Variable Command: No

Alarm Limit Setting for All Analog Output Channel at 0 %

12 PURGE

Message PURGE [12]. Sonalert alarm No

Time: 000:01:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = ON Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 0 % (± 0 MTOR) Variable Command: No

13 EVAC

Message EVACUATE 3 [10]. Sonalert alarm No

Time: 000:02:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = OFF Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = ON Variable Command: No

14 LOOP P-P

Message EVACUATE 3 [10]. Sonalert alarm No

Branch loop for 2.0 times to step PURGE. Sonalert alarm No

15 LEAKCHECK

Message LEAKCHECK [11]. Sonalert alarm No

Time: 000:02:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = OFF Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12] = OFF,,PMPSTNDB[14] = OFF,SOFTSTRT[15] = OFF,MAINVAC[16] = OFF Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 2 % (± 40 MTOR) Variable Command: No

Branch on gas/pressure PRESSURE [8] to step PURGE. Sonalert alarm Yes

16 COOLDOWN

Message COOLDOWN [7]. Sonalert alarm No

Time: 001:00:00 (hr:min:sec) Variable Command: No

Digital out ,,,,WTRFLNG[6] = OFF,,N2 PURGE[8] = ON Variable Command: No

Digital out N2PROCES[9] = ON,PROCESS[10] = ON,EVAC DCS[11] = OFF,EVAC NH3[12]
= OFF,,PMPSTNDB[14] =
OFF,SOFTSTRIT[15] = OFF,MAINVAC[16] = ON Variable Command: No

Alarm limit setting for Gas PRESSURE [8] at 0 % (± 0 MTOR) Variable Command: No

Wait for temp 725 ($^{\circ}$ C) at centre Zn