

CTR LPCVD SOP

1 Scope

1.1 This SOP provides the instructions to operate the CTR LPCVD Furnaces.

2 Table of Contents

1	Scope	1
2	Table of Contents	1
3	Reference Documents	2
3.1	External Documents	2
4	Equipment and/or Materials	2
5	Safety	2
6	General Information	2
7	Pre-Clean	4
7.6	Organic Clean Bath Preparation	4
7.7	SC-1 Bath Preparation	4
7.8	Oxide Removal Bath Preparation	4
7.9	SC-2 Bath Preparation	5
8	Furnace Operating Procedures	5
8.1	Log On	5
8.2	Unlock Tool in HSC	6
8.3	Check Furnace Status	6
8.3.3	Review Current Status	6
8.4	Load Boat	8
8.4.1	Remove Boat Cover (LTO/PSG always, Poly optional)	8
8.4.2	Load Wafers	9
8.4.2.4	LTO/PSG	9
8.4.2.5	Poly	9
8.4.2.6	Nitride/TEOS	10
8.4.3	Replace Boat Cover (LTO/PSG and Doped Poly only)	10
8.5	Initialize Graph	11
8.6	Change Deposition Time	11
8.7	Download Recipe File	12
8.8	Select Recipe	13
8.9	Run Recipe	13
8.10	Wait for Run Completion	13
8.11	Unload Boat	14
8.12	Remove Boat Cover (LTO/PSG and Doped Poly)	14
8.13	Unload Wafers	14
8.14	Replace Boat Cover (LTO/PSG always, Poly optional)	14
8.15	Measure Monitor Wafers	15
8.16	Place System in Standby	15
8.17	Lock Tool in HSC	15
9	Process Notes	15
10	Revision History	16
	Figure 1, Boat Fork	3

Figure 2, Boat Loading Diagram.....	3
Figure 3, LTO/PSG Loading Diagram	9
Figure 4, Poly Loading Diagram.....	10
Figure 5, Nitride/TEOS Loading Diagram.....	10
TABLE 1, FURNACE PRE-CLEAN	5
TABLE 2, LOG IN INFORMATION	6
TABLE 3, RECIPE FILE LOCATION	12
TABLE 4, PROCESS SUMMARY DATA	15

3 Reference Documents

3.1 External Documents

- 3.1.1 SMBB Lab User Guide

4 Equipment and/or Materials

- 4.1 CTR LPCVD Furnaces
- 4.2 Quartzware
- 4.3 Boat fork
- 4.4 Monitor wafers
 - 4.4.1 Poly: 1000 Å oxide on silicon
 - 4.4.2 Others: bare silicon, <100>, n-type or p-type
- 4.5 Filler wafers

5 Safety

- 5.1 Follow all Nanofab safety procedures.
- 5.2 Ensure all Cooldown cycles are complete before handling any quartzware, wafers, or samples.



CAUTION



All recipes include the necessary cool down time to ensure the quartzware, wafers, and samples are cool enough to be touched and handled.

Do not touch or handle quartzware, wafers, or samples unless the current run is COMPLETE.



CAUTION



6 General Information

- 6.1 Ensure all samples are authorized to be loaded into a furnace.

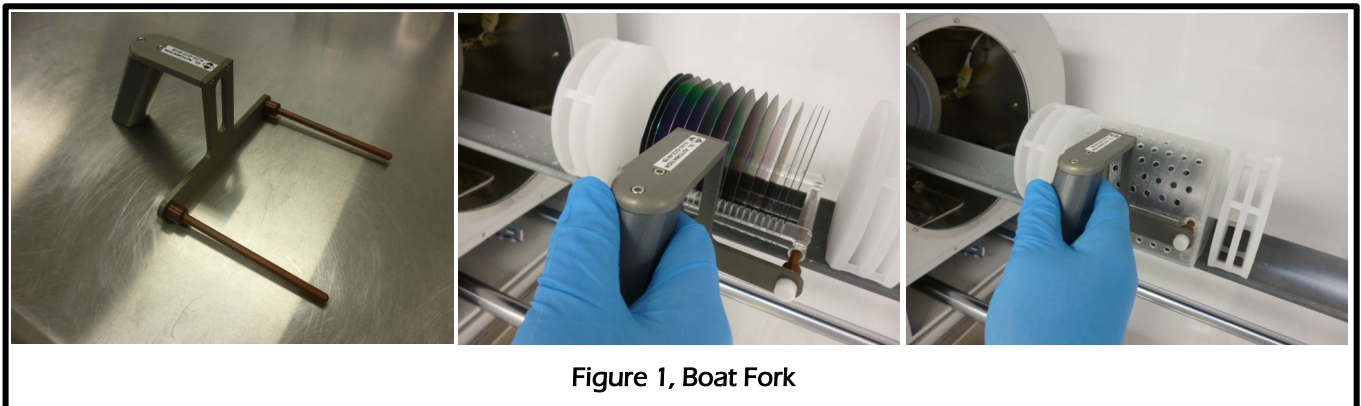
!!! WARNING !!!

No photoresist, kapton tape, metals, glass, or other foreign material is allowed in the furnace.

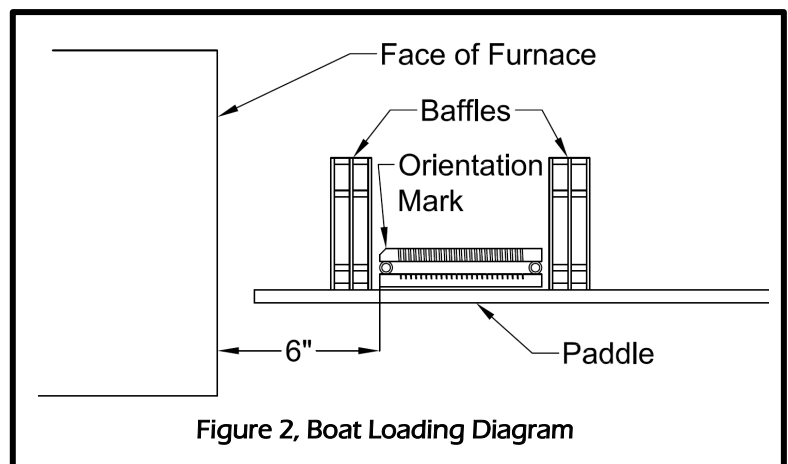
Only quartz, silicon, silicon carbide, silicon dioxide, silicon nitride, and/or Polysilicon are allowed without PRIOR approval of lab staff.

!!! WARNING !!!

- 6.2 Ensure all samples are clean, dry, and particle-free.
- 6.3 Place quartzware on a quartz plate, silicon carbide cantilever paddle, or a cleanroom wipe.
 - 6.3.1 Do NOT directly place quartzware on stainless steel.
- 6.4 Before touching a quartz baffle, put on a second pair of clean blue nitrile gloves.
- 6.5 Do NOT touch boats or boat covers with your hands.
 - 6.5.1 Use the boat fork (see **Figure 1, Boat Fork**) to move boats and boat covers.
 - 6.5.1.1 Insert the tines of the fork into the pick-up tubing on the boat or boat cover.



- 6.6 The slots on the quartz boat are cut at 3° from vertical and there is an orientation mark on one end of the boat.
 - 6.6.1 The furnace-side end of the boat should be 6" from the face of the furnace (see Figure 2, Boat Loading Diagram).
 - 6.6.2 Position the boat with the orientation mark closest to the furnace.
 - 6.6.3 Place the quartz baffles within ¼" of each end of the boat.



7 Pre-Clean

- 7.1 **For new, unused bare silicon wafers**, a Pre-Diffusion Clean prior to processing through any furnace cycle is recommended.
- 7.2 **For all other samples/substrates/wafers**, a Pre-Diffusion Clean prior to processing through any furnace cycle is **REQUIRED**.
- 7.3 Complete the Pre-Diffusion Clean in the Pre-Diffusion wet bench.
NOTE: The dedicated baths should be used for whole wafers, since the SC-1 bath includes a megasonic clean for improved particle removal. However, for partial wafers the specified mixtures may be used in smaller beakers/containers, if necessary.
- 7.4 Refer to **TABLE 1, FURNACE PRE-CLEAN** for the correct mixtures, temperatures, and times.
- 7.5 If the Organic Clean bath temperature is above 100°C and has not been used within the last 2 hours, add 100ml of Hydrogen Peroxide.

7.5.1 Wait at least 5 minutes before using the bath.

7.6 Organic Clean Bath Preparation

- 7.6.1 **If using an alternate bath container**, ensure the container is compatible with temperatures up to 200°C (e.g., pyrex, quartz, teflon).
- 7.6.2 Add the necessary amount of Sulfuric Acid to an empty container.
- 7.6.3 Turn on the heater.
- 7.6.4 Wait for the heater to exceed 100°C.
- 7.6.5 Add the necessary amount of Hydrogen Peroxide.
- 7.6.6 Wait until the bath temperature has reached setpoint.
- 7.6.7 Wait at least 5 minutes before using the bath.

7.7 SC-1 Bath Preparation

- 7.7.1 **If using an alternate bath container**, ensure the container is compatible with temperatures up to 100°C (e.g., pyrex, quartz, teflon).
- 7.7.2 Add the necessary amount of Ultra Pure Water (UPW) to an empty container.
- 7.7.3 Add the necessary amount of Ammonium Hydroxide.
- 7.7.4 Turn on the heater.
- 7.7.5 Wait for the heater to exceed 65°C.
- 7.7.6 Add the necessary amount of Hydrogen Peroxide.
- 7.7.7 Wait until the bath temperature has reached setpoint.
- 7.7.8 Wait at least 5 minutes before using the bath.

7.8 Oxide Removal Bath Preparation

- 7.8.1 **If using an alternate bath container**, ensure the container is compatible with Hydrofluoric Acid (e.g., plastic, teflon).
- 7.8.2 Add the necessary amount of Ultra Pure Water (UPW) to an empty container.
- 7.8.3 Add the necessary amount of Hydrofluoric Acid.

7.8.4 Wait at least 5 minutes before using the bath.

7.9 SC-2 Bath Preparation

7.9.1 **If using an alternate bath container**, ensure the container is compatible with temperatures up to 100°C (e.g., pyrex, quartz, teflon).

7.9.2 Add the necessary amount of Ultra Pure Water (UPW) to an empty container.

7.9.3 Add the necessary amount of Hydrochloric Acid.

7.9.4 Turn on the heater.

7.9.5 Wait for the heater to exceed 65°C.

7.9.6 Add the necessary amount of Hydrogen Peroxide.

7.9.7 Wait until the bath temperature has reached setpoint.

7.9.8 Wait at least 5 minutes before using the bath.

Step	Description	Container Type	Ratio ¹	Chemical	Quantity (ml)	Temp (°C)	Time (mm:ss)
1	Organic clean (pirahna)	Pyrex Quartz Teflon	5 1	Sulfuric Acid Hydrogen Peroxide, 30%	2500 500	120	10:00
2	Rinse			Ultra Pure Water (UPW)			5:00
3	SC-1	Pyrex Quartz Teflon	5 1 0.4	Ultra Pure Water (UPW) Ammonium Hydroxide Hydrogen Peroxide	6250 1250 500	75	10:00
4	Rinse			Ultra Pure Water (UPW)			5:00
5	Oxide Removal	Plastic Teflon	50 1	Ultra Pure Water (UPW) Hydrofluoric Acid, 49%	2000 40		01:00
6	Rinse			Ultra Pure Water (UPW)			5:00
7	SC-2	Pyrex Quartz Teflon	6 1 1	Ultra Pure Water (UPW) Hydrochloric Acid, 37% Hydrogen Peroxide	3900 650 650	75	10:00
8	Rinse			Ultra Pure Water (UPW)			5:00
9	Spin-Rinse Dry			As programmed			

¹Maintain this ratio when using the alternate bath containers.
²If the Organic clean bath temperature is greater than 100°C and has been unused for more than 2 hours, add 100ml of Hydrogen Peroxide prior to use.

8 Furnace Operating Procedures

8.1 Log On

8.1.1 From the CTR host computer, select the TymPlex program.

8.1.1.1 **If necessary**, open the TymPlex program.

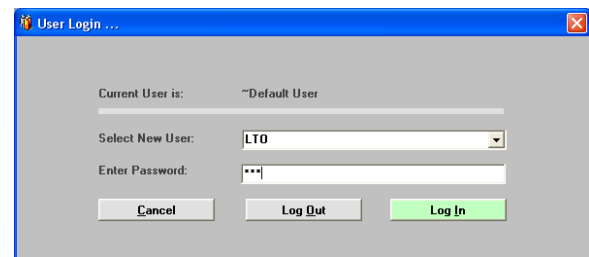
8.1.2 From the **Overview** Screen, click the **Log In** button.

8.1.3 Type the Username and password (in CAPS) for the applicable furnace. (See **TABLE 2, LOG IN INFORMATION.**)

8.1.4 From the **User Login ...** dialog box, click the **Log In** button.



Furnace	LTO	Poly	Nitride	TEOS
Username	LTO	POLY	NITRIDE	TEOS
Password	LTO	POLY	NITRIDE	TEOS



8.2 Unlock Tool in HSC

8.2.1 Unlock the tool in HSC.

8.3 Check Furnace Status

8.3.1 Select the main tab for the desired furnace.

8.3.2 Select the **Operate** subtab.

8.3.3 Review Current Status

NOTE: If the current recipe is "IDLE WITH COMPLETED SAMPLES ON BOAT", samples from the previous run have not been removed from the boat.

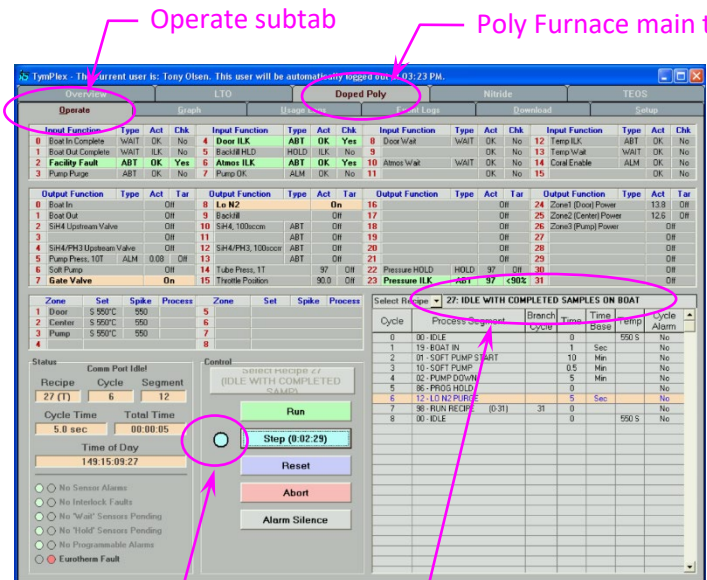
8.3.3.1 **If the current recipe is "IDLE WITH COMPLETED SAMPLES ON BOAT",** do the following:

8.3.3.1.1 **If there are no instructions from the previous user,** contact that user and get instructions before proceeding.

8.3.3.1.2 **If the instructions from the previous user are "Do Not Disturb",** do not proceed.

8.3.3.1.3

If the instructions from the previous user authorize you to handle their samples, continue.



8.3.3.2

If there is a blue dot next to the **Step** button, the furnace is on Hold.

8.3.3.2.1

Click the **Run** button.

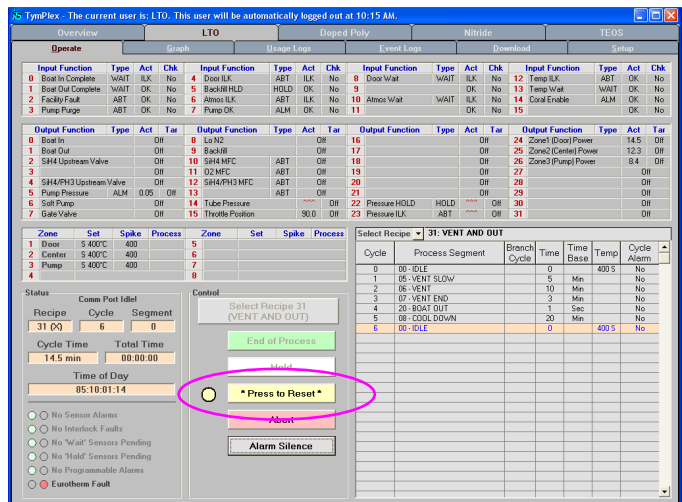
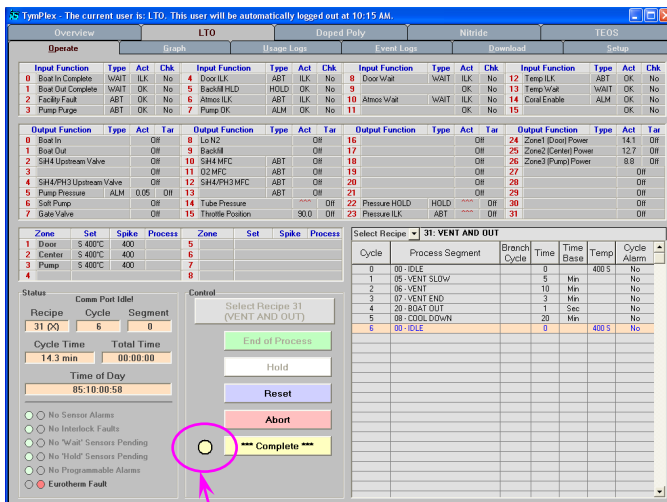
8.3.3.2.2

Wait for the current run to complete.

NOTE: The **Alarm Silence** button will be replaced by a yellow ***** Complete ***** button with a yellow dot.

8.3.3.3

If there is a yellow dot next to the ***** Complete ***** button, the current recipe has completed.



Yellow dot

8.3.3.3.1 Click the ***** Complete ***** button.

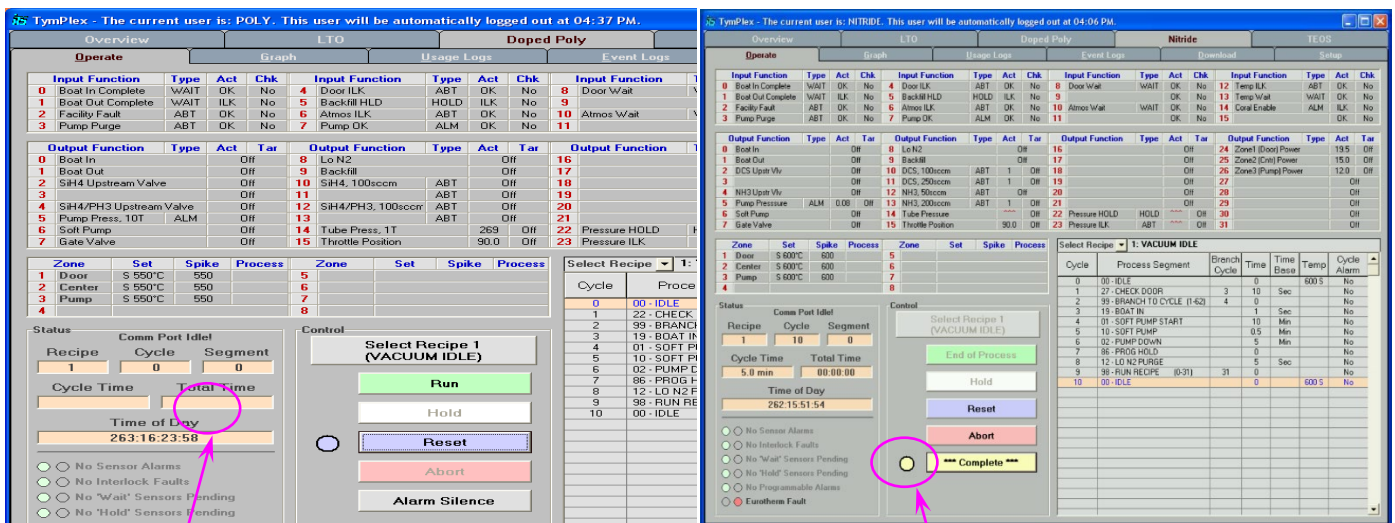
8.3.3.3.2 Click the *** Press to Reset *** button.

8.3.3.4 **If the cantilever is in and there is a blue dot next to the **Reset** button,** download and run the "VENT AND OUT" recipe per paragraphs 8.7 Download Recipe File through 8.9 Run Recipe.

8.3.3.5 **If the cantilever is in and there is a yellow dot next to the ***** Complete ***** button,** click the ***** Complete ***** button.

8.3.3.5.1 Download and run the "VENT AND OUT" recipe per paragraphs 8.7 Download Recipe File through 8.9 Run Recipe.

8.3.3.6 **If the cantilever is out,** the furnace is ready for use.



Blue dot

Yellow dot

8.3.3.7 **If samples from another member are loaded on the boat AND he/she has authorized you to handle their samples,** follow their instructions to remove the samples.

8.4 Load Boat

8.4.1 Remove Boat Cover (LTO/PSG always, Poly optional)

8.4.1.1 Using the boat fork, carefully lift the cover over the boat and wafers.

8.4.1.2 Place the cover in an authorized storage location.

NOTE: If the cover is to be used on the next run, a convenient location is on the paddle, adjacent to the door baffle. Otherwise, it should be placed on a quartz plate.

8.4.1.3 Remove the boat fork from the cover.

8.4.2 Load Wafers

!!! WARNING !!!

No photoresist, kapton tape, metals, glass, or other foreign material is allowed in the furnace.

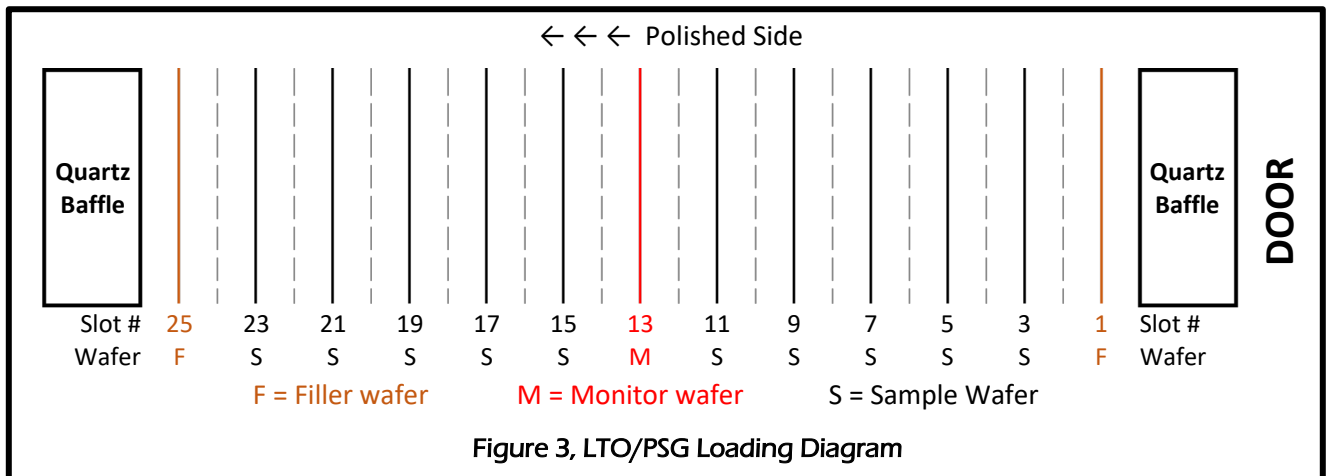
Only quartz, silicon, silicon carbide, silicon dioxide, silicon nitride, and/or Polysilicon are allowed without PRIOR approval of lab staff.

!!! WARNING !!!

- 8.4.2.1 Unless otherwise noted, load all wafers with the polished side toward the furnace.
- 8.4.2.2 Load the wafers with the wafer flat up.
- 8.4.2.3 Load one wafer per slot.

8.4.2.4 LTO/PSG

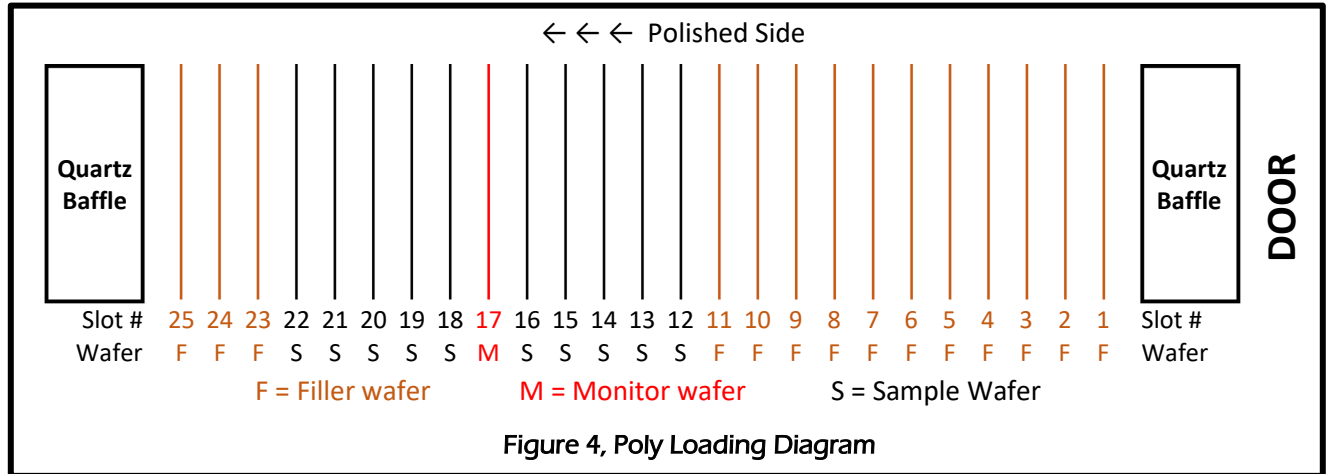
- 8.4.2.4.1 Load wafers in every other slot (odd-numbered slots).
- 8.4.2.4.2 Load monitor wafers onto the boat in slot 13 (see **Figure 3, LTO/PSG Loading Diagram**).
- NOTE: Monitor wafers for LTO/PSG are bare silicon. Sample wafers that are bare silicon may be used as monitors.*
- 8.4.2.4.3 Load sample wafers in slots 3, 5, 7, 9, 11, 15, 17, 19, 21, and/or 23, starting at the center.
- 8.4.2.4.4 Load filler wafers in slots 1, 25, and all unused slots.
- 8.4.2.4.5 Ensure there is a sample, monitor, or filler wafer in every other slot (13 total wafers).



8.4.2.5 Poly

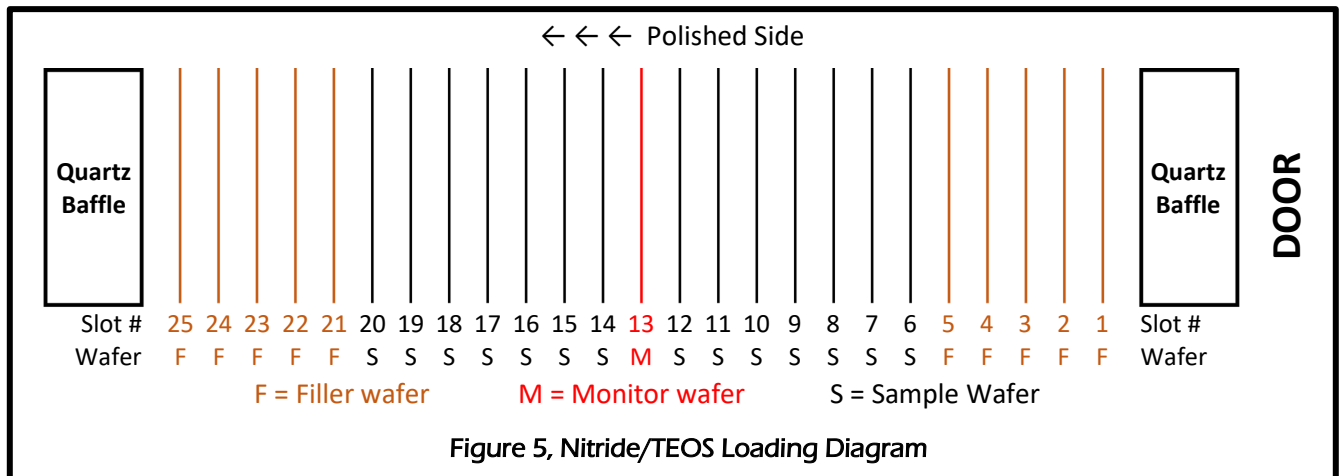
- 8.4.2.5.1 Load a monitor wafer onto the boat in slot 17 (see **Figure 4, Poly Loading Diagram**).
- NOTE: Monitor wafers for Poly are 1000Å oxide on silicon.*
- 8.4.2.5.2 Load sample wafers in slots 12-16 and/or 18-22, starting at the center.

- 8.4.2.5.3 Load filler wafers in slots 1-11, 23-25, and all unused slots.
- 8.4.2.5.4 Ensure there is a sample, monitor, or filler wafer in every slot.



8.4.2.6 Nitride/TEOS

- 8.4.2.6.1 Load monitor wafers onto the boat in slot 13 (see **Figure 5, Nitride/TEOS Loading Diagram**).
- NOTE: Monitor wafers for Nitride and TEOS are bare silicon. Sample wafers that are bare silicon may be used as monitors.*
- 8.4.2.6.2 Load sample wafers in slots 6 – 12 and/or 14 – 20, starting at the center.
 - 8.4.2.6.3 Load filler wafers in slots 1 - 5, 21 - 25, and all unused slots.
 - 8.4.2.6.4 Ensure there is a sample, monitor, or filler wafer in every slot.



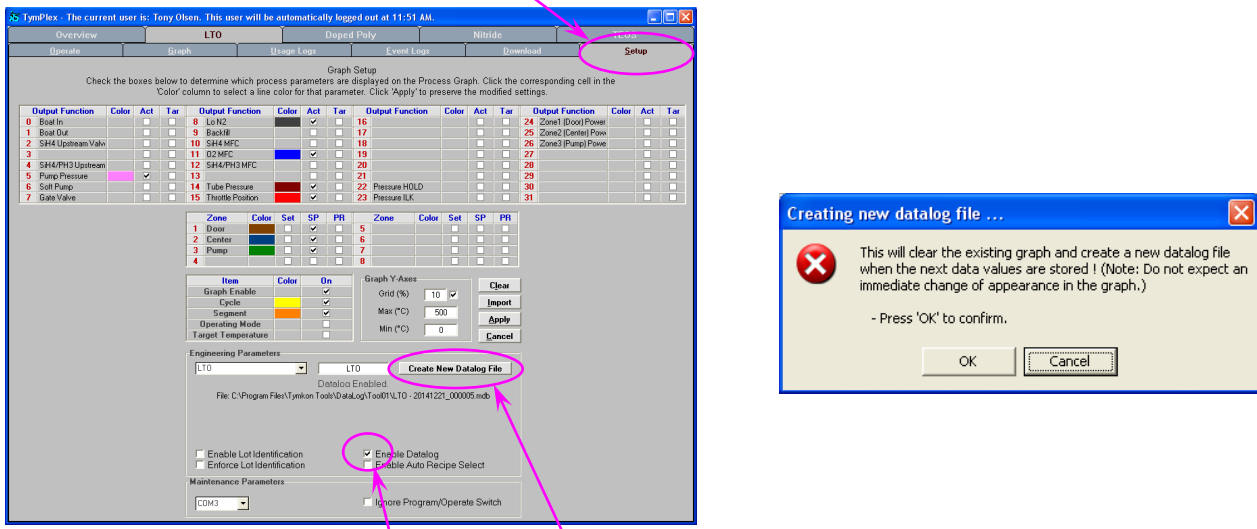
8.4.3 Replace Boat Cover (LTO/PSG and Doped Poly only)

- 8.4.3.1 Using the boat fork, carefully place the cover over the boat and wafers.
- 8.4.3.2 Remove the boat fork from the boat.

8.5 Initialize Graph

- 8.5.1 Select the **Setup** subtab.
- 8.5.2 Ensure the **Enable Datalog** check box is checked.
- 8.5.3 Press the **Create New Datalog File** File button.
- 8.5.4 At the **Creating new datalog file ...** box, click **OK**.

Setup subtab

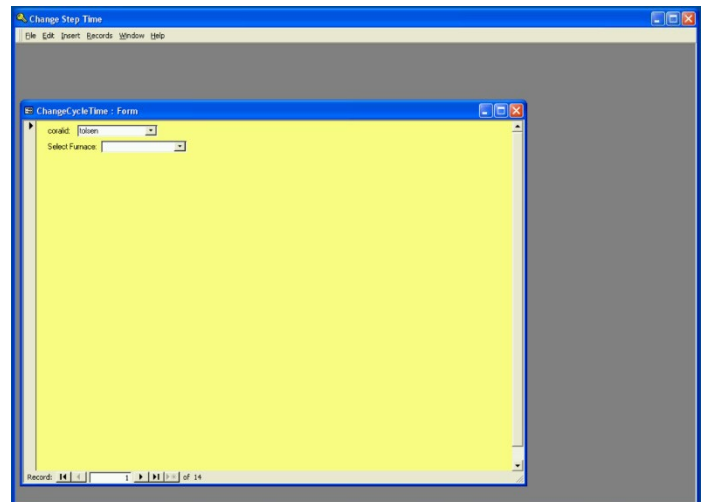


Enable Datalog check box

Create New Datalog File button

8.6 Change Deposition Time

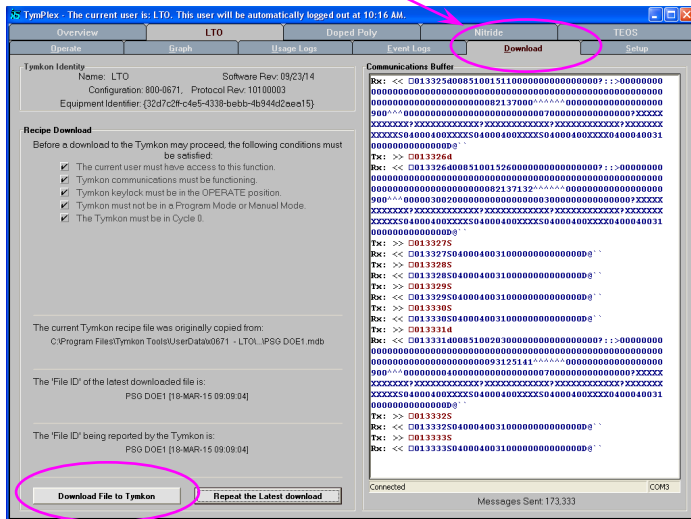
- 8.6.1 From the desktop, open the "Change Step Time" utility.
- 8.6.2 Enter/select your Coral ID.
- 8.6.3 Following the prompts, change the deposition time, if needed.



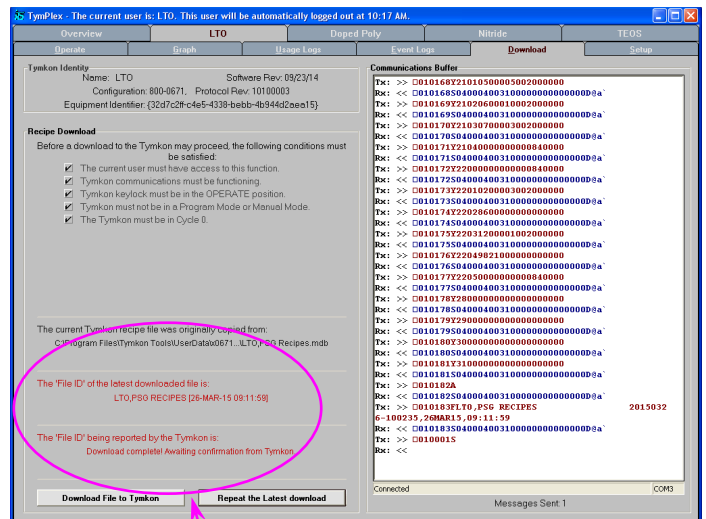
8.7 Download Recipe File

- 8.7.1 To download a new recipe file, select the **Download** subtab.
- 8.7.2 Click the **Download File to Tymkon** button.
- 8.7.3 From the dialog box, locate and select the correct recipe file (see **TABLE 3, RECIPE FILE LOCATION**).
- 8.7.4 From the **Ready to Download** dialog box, click the **Begin Download** button.
- 8.7.5 Wait for the recipe to complete downloading. (Sections will change from red to black text.)

Download subtab



Download File to Tymkon button



This text changes from red to black when download is complete.

TABLE 3, RECIPE FILE LOCATION			
Furnace	Path	Recipe Type	Recipe File
LTO	[MainPath]\x0671 - LTO\LTO Recipes	LTO, 400°C, 300 mTorr	LTO Recipes.mdb
		PSG, 400°C, 300 mTorr	PSG Recipes.mdb
		PSG, 450°C, 200 mTorr	
NITRIDE	[MainPath]\x0674 - Nitride\Nitride Recipes	LOW STRESS STOICHIOMETRIC	Nitride Recipes.mdb
POLY	[MainPath]\x0672 - Poly\Poly Recipes	DOPED POLY	Poly Recipes.mdb
		UNDOPED POLY	
TEOS	[MainPath]\x0673 - TEOS\TEOS Recipes	TEOS	TEOS Recipes.mdb

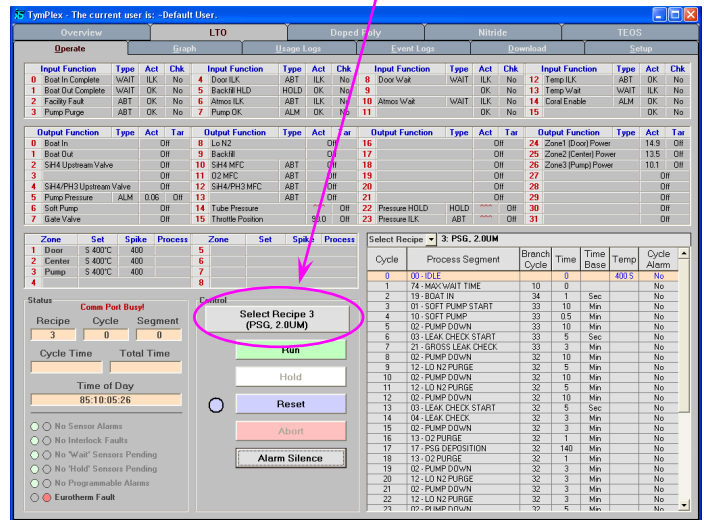
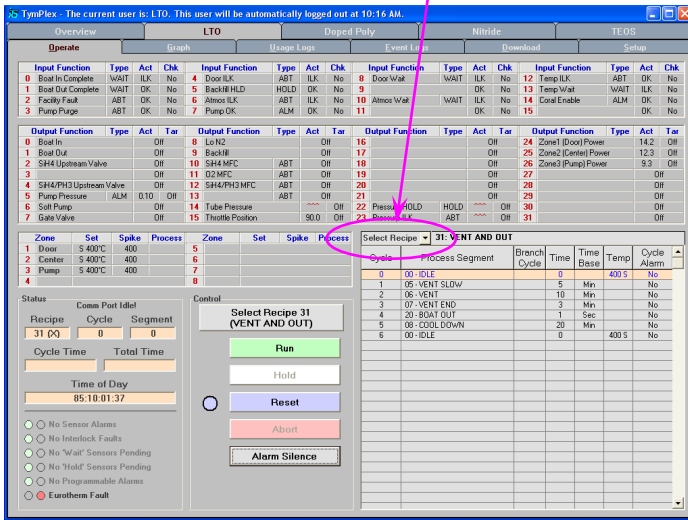
[MainPath] = C:\Program Files\TymkonTools\UserData

8.8 Select Recipe

- 8.8.1 Select the **Operate** subtab.
- 8.8.2 Click the **Select Recipe** pull down box.
- 8.8.3 Select the desired recipe.
- 8.8.4 Activate the recipe by clicking the **Select Recipe # (recipe name)** button.

Select Recipe pull down box.

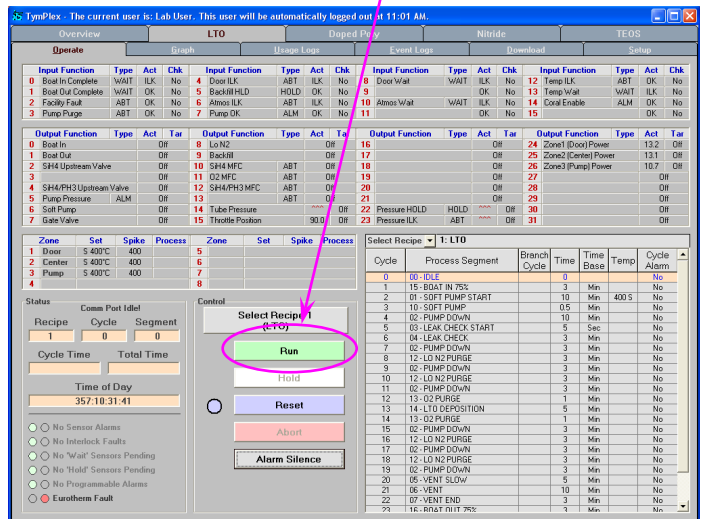
Select Recipe button



8.9 Run Recipe

- 8.9.1 From the **Operate** subtab, click the **Run** button.

Run button



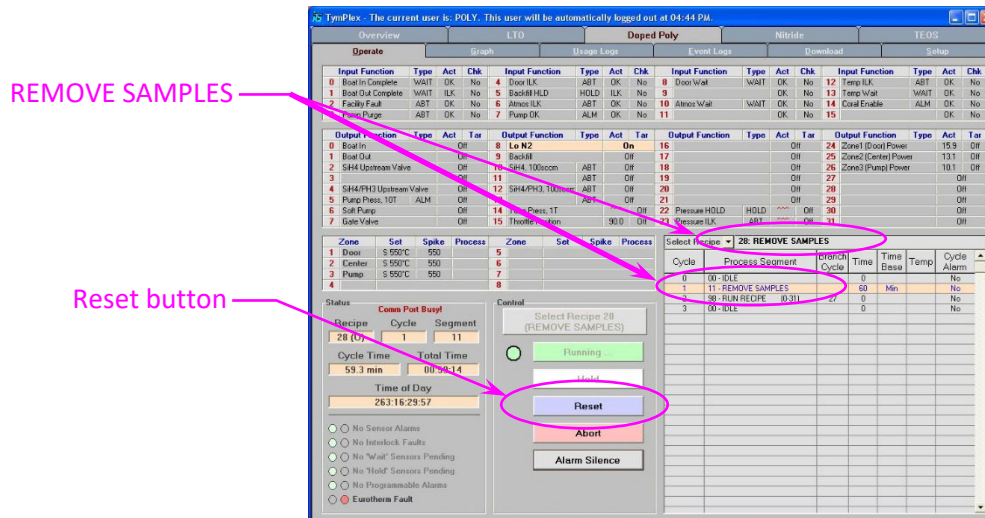
8.10 Wait for Run Completion

- 8.10.1 Wait for the cooldown cycle to complete.

NOTE: The boat will be out, the current recipe will be "REMOVE SAMPLES" and the current cycle will be "REMOVE SAMPLES". If this recipe is not reset within a programmed amount of time, the system will start the "IDLE WITH COMPLETED SAMPLES ON BOAT" and the load will push back into the furnace.

8.10.2 Click the **Reset** button.

8.10.3 At the **Reset the current recipe ?** dialog box, click the **OK** button.



8.11 Unload Boat

8.11.1 Ensure the run has completed.



CAUTION



All recipes include the necessary cool down time to ensure the quartzware, wafers, and samples are cool enough to be touched and handled.

Do not touch or handle quartzware, wafers, or samples unless the current run is COMPLETE.



CAUTION



8.12 Remove Boat Cover (LTO/PSG and Doped Poly)

8.12.1 Using the boat fork, carefully lift the cover over the boat and wafers.

8.12.2 Place the cover in an authorized storage location.

NOTE: If the cover is to be used on the next run, a convenient location is on the paddle, adjacent to the door baffle. Otherwise, it should be placed on a quartz plate.

8.12.3 Remove the boat fork from the cover.

8.13 Unload Wafers

8.13.1 Remove the monitor wafers and samples from the boat.

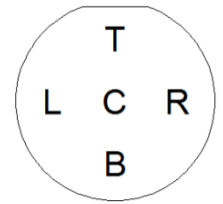
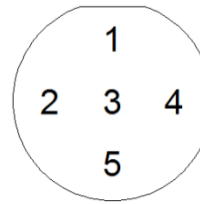
8.14 Replace Boat Cover (LTO/PSG always, Poly optional)

8.14.1 Using the boat fork, carefully place the cover over the boat and wafers.

8.14.2 Remove the boat fork from the cover.

8.15 Measure Monitor Wafers

8.15.1 Measure the thickness at 5 sites on each monitor wafer.



8.16 Place System in Standby

8.16.1 Select the "VACUUM IDLE" recipe.

8.16.2 Run the recipe.

NOTE: The cantilever will go in, the system will pump down, and go on hold.

8.17 Lock Tool in HSC

8.17.1 Lock the furnace in HSC.

8.17.2 Complete and submit the requested Data Collection Form.

9 Process Notes

9.1 Process Summary

9.1.1 **TABLE 4, PROCESS SUMMARY DATA** lists the basic information for the various processes.

Furnace	Recipe	Temp (°C)	Pressure (mTorr)	NH3 (sccm)	DCS (sccm)	SiH4 (sccm)	6%PH3 in SiH4 (sccm)	O2 (sccm)	TEOS (sccm)	Approx. Dep Rate (Å / min)
LTO/PSG	LTO, 400C, 300MT	400	300			60		90		240.0
LTO/PSG	PSG, 400C, 300MT	400	300				60	90		90.0
LTO/PSG	PSG, 450C, 200MT	450	200				60	90		TBD
Poly	DOPED POLY	630	200			90	10			22.0
Poly	UNDOPED POLY	630	200			60				118.0
Nitride	LOW STRESS	825	200	10	80					37.0
Nitride	NIT DEP, 200MPA	825	200	15	75					38.5
Nitride	STOICHIOMETRIC	780	200	80	20					32.0
TEOS	TEOS	700	700						60	100.0

10 Revision History

Rev	Date	Originator	Description of Changes
5	06 Mar 2023	T. Olsen	Added details for placement of boat and baffles, replaced Coral with HSC, corrected wafer designations on LTO/PSG Loading Diagram, added NIT DEP, 200MPA recipe to the Process Summary Data table.
4	10 Jun 2019	T. Olsen	Updated to new template style. Added Pre-Clean Section.
3	22 May 2018	T. Olsen	General layout changes to blend graphics with text for easier reading. Updated Run Complete instructions for implementation of "Remove Samples" at the end of a process cycle.
2	13 Jan 2017	T. Olsen	Add General Information section. Implement use of boat fork and new LTO boat cover, including new loading diagram for LTO/PSG. Add Table 2, Recipe File Location. Update Table 3, Process Summary Data (recipes, gas flows, and dep rates).
1	18 Aug 2015	T. Olsen	Original Release.