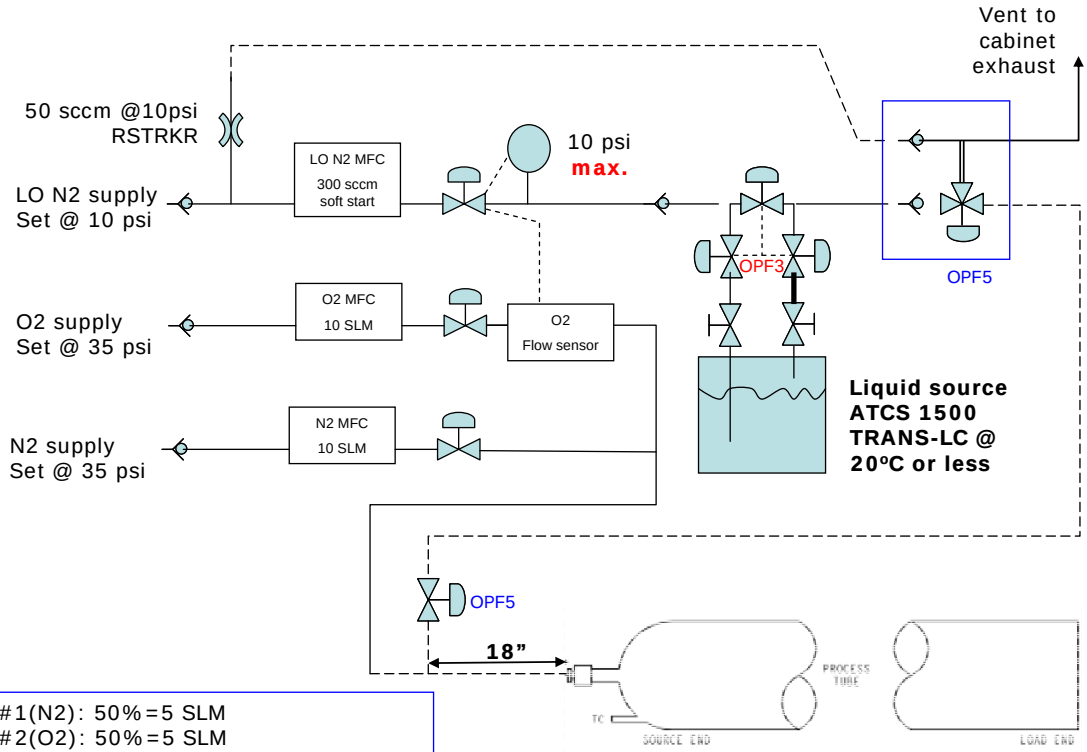
Trans-LC HCl Dry Oxidation

SOP

1 INTRODUCTION

This oxidation is done in tube #4 of DUTT1. This tube has the capability of in-situ generating HCl gas from trans-LC ($C_2H_2Cl_2$) liquid source at high temperatures. The process is dedicated for "Gate Oxidation" in order to improve gate oxide quality and to reduce surface sate density. The tube #4 of DUTT1 uses N_2 pass through trans-LC bubbler to introduce trans-LC into the tube pre-charged with O_2 at temperature over 900^{o}C for in-situ generating HCl gas. This way eliminates the troublesome handling of HCl gas and made the system environmental friendly in operation. HCl is intentionally generated before dry oxidation to improve both the oxide and the underlying silicon properties. Oxide improvements include a reduction in sodium ion contamination, an increased dielectric breakdown strength, and a reduce interface trap density.

The gas control schematic and the furnace loading rack are shown in the following:



Gas #1(N2): 50%=5 SLM
Gas #2(O2): 50%=5 SLM
Gas #5(Carrier N2): 50%=150 sccm
Gas#6: OPF#3 (ON for trans-LC)
Gas#7: OPF#5 (ON for trans-LC to tube)
HCl process: Gas#6 & 7 ON
Purge lines: Gas#6 OFF / Gas #7 ON

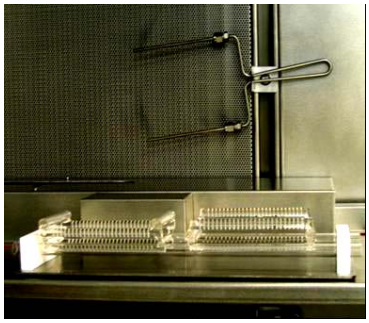

During a run the temperature is ramped from a low temperature (900^{o}C) to the oxidation temperature. A description of of each interval for the recipe of trans-LC dry oxidation is given below.

Interval 1: boat in
Interval 2: allow the temperature to stabilize
Interval 3: heat up of the furnace to the desired oxidation temperature (8^{o}C/min.)
Interval 4: allow the temperature to stabilize
Interval 5: pure O2 dry oxidation for at least 1min to enrich O2 in the tube ambient **(Note: this is important because the trans-LC will turn into carbon if not enough O2 available, this will contaminate the system.)**
Interval 6: HCl cleaning for 5min with O2:HCl=50%(10LPM):50%(300SCCM)
Interval 7: HCl dry oxidation
Interval 8: cool down furnace (8^{o}C/min.)
Interval 9: boat out

The total gas flowin the tubes should always be 5 LPM, Drive-ins should be done using DUTT1.

2 TOOLS AND MATERIALS

2.1 Tubes may be used to process either 4-inch or 6-inch wafers.
2.2 Each tube has dedicated cassettes and a single baffle that may be used for either size of wafer.
2.3 Material Safety Data Sheets for Nitrogen, Oxygen, Hydrogen, Forming Gas (10%H2 balanced N2), Trans LC and TCA.
2.4 Boat forks for each tube are located on the end of the boat loader.



3 SAFETY PRECAUTIONS

3.1 Personal Safety Hazards

3.1.1 This equipment uses high voltages. Do not operate with the covers off.

3.1.2 The furnaces operate at high temperatures. *Never touch any part of the furnace or any of the quartzware with your bare hands.*

3.1.3 Compressed Oxygen, Nitrogen, Hydrogen and Forming Gas are used in this equipment. Some of the tubes use Trans LC or TCA. Be sure to understand MSDS for each of these and know the hazards of working with compressed gases.

3.2 Hazards to the Tool

3.2.1 **Contamination**

3.2.1.1 Never process wafers with metal or photoresist on them.

3.2.1.2 To avoid cross contamination always use the tube that is intended for the process you need.

3.2.1.3 Only process clean wafers in the furnaces.

3.2.1.4 Do not touch the wafers or boats and do not place them in areas that are not clean.

3.2.2 **Computer**

3.2.2.1 Never edit a recipe that is not yours. The recipe should be copied to a new recipe number, the name should be changed and then the new recipe may be edited.

3.2.2.2 Do not open too many files at once because the computer may lock up and not allow you to run a recipe.

3.2.3 **Gas line pressure:** do not adjust the pressure to any of the gas lines or bottles. Seek staff assistance.

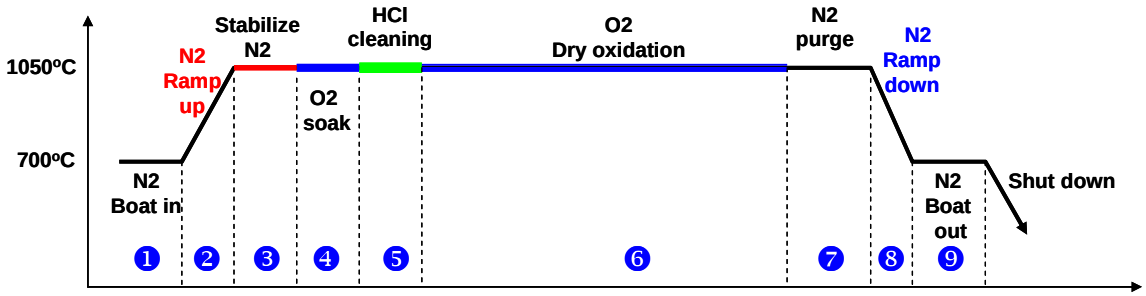
4 Operating Instructions

1. Turn on the trans-LC bubbler and have temperature set at 20^{o}C.
2. Turn on any necessary gases. (N2, O2, H2/N2, H2, compressed air). The pressure at furnace panel should be low-P N2 (to the trans-LC bubbler) at 10 psi, N2 at ~20 psi, O2 at ~20 psi, H2 at ~20 psi.
3. Turn on cooling water and heat-exchange fan
4. Program the controller of DUTT1_tube#4 (This tube has been modified for trans-LC, no automatic control program is to be called). For the detailed program settings, please refer to the Appendix.
5. Using interval 0 set the temperature to the low temperature (700~900^{o}C) before oxidation and have N2 flowing (50%, 5LPM). Have the N2 flowing at least 10 minutes before continuing.
6. Take the boat out and put the carrier on the quartz rods. Put the boat back in.
7. Load the wafers onto the carrier.
8. Take the boat out again and load the carrier onto the paddle. Increase Interval number to #1, press the start button (white) on the DDC controller to initiate the run.
9. Periodically monitor the progress of the machine by checking the “status”. This is particularly important when O2 must soak the tube for 1min before N2 (Gas channel-5 open) start bubbling through the trans-LC bubbler is flowing.
10. When the run has finished the DDC beeper will go off and a highlighted “cycle complete” will appear on the CRT. Press “ACK” to stop the beeper. At this point the boat should be taken out.
11. Place the wafer carrier on the quartz rods and put the boat back in.
12. When the carrier has cooled unload the wafers, take the boat out and load the empty carrier onto the paddle and put the boat back in.
13. Using interval 0 set the temperature to 0^{o}C (temperature group #3) and turn off N2 gas valve (gas channel#1 OFF).
14. Leave the furnace heat exchange water running until the temperature of the tubes is less than 400^{o}C. The fans should be left on until the temperature is less than 100^{o}C.
15. Finally, turn off the fan and cooling water
16. Shut Down (In the Support Area)
    i. Turn off trans-LC bubbler
    ii. Turn off gas valves (O2, N2), valve for compressed air can be left on.
    iii. Close valves to the gas cylinders

NOTE: Remember leave a record on the logsheet after oxide film thickness measurement.

Last Update
July 11, 2008 by Edward, Huaping XU

Appendix:



Gas settings

Gas group	Gas1 (N2)	Gas2 (O2)	Gas3	Gas4	Gas5 (LP-N2)	Gas6	Gas7
#1	50%						
#2		50%					
#3		50%			50%		

Interval: gas valve control

Interval #1	Gas1 (boat in)
Interval #2	Gas1 (ramp up)
Interval #3	Gas1 (stabilize)
Interval #4	Gas1 OFF, Gas2 ON (O2 soak for 1min)
Interval #5	Gas2 ON, Gas 5,6,7 ON (HCl cleaning for 5 min)
Interval #6	Gas2 ON, Gas 7 ON (dry oxidation, LP-N2 purge trans-LC line)
Interval #7	Gas1
Interval #8	Gas1
Interval #9	Gas1

Gas6 valve: the valves on top of the trans-LC bubbler
Gas7 valve: by-passed LP-N2 purge trans-LC away to the exhaust

Temperature settings

Temp group	Heater			Profile		
	load	center	source	load	center	source
#1	700	700	700	700	700	700
#2	1050	1050	1050	1050	1050	1050
#3	0	0	0	0	0	0

Interval Control Points:

Itvl.0 (warm up)	Temp[#1], mode[#3], gas[#1], prepare furnace at 700°C
Itvl.1 (boat in)	Temp[#1], mode[#1], gas[#1], 2min
Itvl.2 (ramp up)	Temp[#2], mode[#1], gas[#1], 50min
Itvl.3 (stabilize)	Temp[#2], mode[#1], gas[#1], 10min
Itvl.4 (soak O2)	Temp[#2], mode[#3], gas[#2], 1min
Itvl.5 (HCl)	Temp[#2], mode[#3], gas[#3], 5min
Itvl.6	Temp[#2], mode[#1], gas[#3], 90min (~100nm oxide)
Itvl.7	Temp[#2], mode[#1], gas[#1], 10min
Itvl.8	Temp[#1], mode[#1], gas[#1], 60min
Itvl.9 boat out	Temp[#1], mode[#1], gas[#1], 10min
Itvl.0	Temp[#3], mode[#3], gas[#1] to Temp<100°C