

University of Minnesota Nano Fabrication Center

Standard Operating Procedure

Equipment Name: TYLAN Furnace

Badger Name: tylan

Revision Number: 9

Model: Titan

Revisionist: Tony Whipple

Location: Bay 1

Date: 4 Mar 2020

1 Description

The Tylan system is a furnace system for oxidation, annealing, and alloying. The system is a horizontal four tube stack atmospheric furnace with automatic process control. The maximum wafer size is 6 six inches or 150mm. This is supported on a cantilever transport, and is controlled by the system software.

2 Safety

The safety item beyond the normal electrical hazards, are the high temperatures as the system can go to 1150 degrees C. The gases that are normally used are nitrogen, oxygen, and hydrogen. Contact a NFC person about any problems.

3 Restrictions/Requirements

Must be a qualified user on the Tylan system.

To prevent wafers from contaminating the tubes and other user's wafers and large cost:

READ THIS:

Oxidation tubes 13, 14, and 15:

There are to be NO wafers that EVER had metal on them, or have been in any of the following systems:

- PECVD
- RTA
- Sputtering systems
- Electron-beam deposition systems
- Alloy tube 16

Alloy tube 16: See the list of allowed materials in section 8.

General Restrictions:

- Do NOT write on the back of the wafers with any type of the Magic marker, or Sharpie.
- If the wafers have been processed in the Alloy tube 16, they can not be processed through any other tube.
- Wafer cleanliness: All wafers that are to be processed in the system MUST be clean and free of anything that is not a normal semiconductor material. All resist need to be cleaned from the wafer. Washing it off with solvents is not good enough; a clean in the sulfuric acid bath in bay 1 must be done. Some users might want to follow this clean step with doing an RCA clean before loading the wafers into the Tylan system. The cleaner the wafer, the better the film will be. Do not touch with hands the wafers that are to be loaded into the system and DO NOT touch the quartz and SiC boats.

Tube 14 is for very clean wafers, as in new wafers, or wafers that are for making MOS devices. High temperature processing is done in Tube 13 only.

- Wafers that have been in the LPCVD can be processed in any of the Tylan tubes.

- Wafers from tubes 13, 14, and 15 can be put into the LPCVD for processing.
- Wafers from tube 16 CANNOT be subsequently processed in the LPCVD.

See last of section 8 for more detail info on material limits.

4 Required Facilities

The system needs electrical power, oxygen, and hydrogen gas.

5 Definitions

RECIPE = This is the program that controls the sequence of events while running the system.

BOAT or WAFER BOAT = This is the Quartz or SiC item that the wafers sit in while in the system.

TUBE = This is the actual location of where the wafers are to be when ran in the system.

TYCOM terminal = The keyboard and display panel that is used to communicate with the system.

PICKUP Tool = The item that is used to load and unload the boat from the cantilever on each tube.

DI SY ST Short cut for: DISPLAY SYSTEM STATUS

DI ST # Short cut for: DISPLAY STATUS (tube #)

DI DIR Display listing of the recipes that are able to be ran. Short cut for : DISPLAY DISK

6 Setup

No special setup is needed, just have your wafers ready before starting.

7 Operating Instructions

Starting

needed. Make sure that the system is available for the time you will need. Check and reserve the time needed. Make sure that you barcode in to activate the system for the tube you will need.

See section 8 for a quick step by step list of commands, or if you are a former Thermco user.

Recipe name	Allowed tubes	Recipe Description
ALLOY425	16	N2 and H2 mix forming gas, varying time Alloy tube only 425 degrees.
ALLOY450	16	N2 and H2 mix forming gas, varying time Alloy tube only 450 degrees.
ANEL-425	16	N2 gas, varying time Alloy tube only 425 degrees.
ANEL-450	16	N2 gas, varying time Alloy tube only 450 degrees.
ANEL-900	13,14,15	N2 gas, varying time 900 degrees.
ANEL1000	13,14,15	N2 gas, varying time 1000 degrees 1000 degrees.
ANEL1100	13	N2 gas, varying time, high temp tube only 1100 degrees.
ANEL1150	13	N2 gas, varying time, high temp tube only 1150 degrees.
DRY-900	13,14,15	O2 gas, varying time 900 degrees.
DRY1000	13,14,15	O2 gas, varying time 1000 degrees 1000 degrees.

DRY1100	13	O2 gas, varying time, high temp tube only 1100 degrees.
DRY1150	13	O2 gas, varying time, high temp tube only 1150 degrees.
STM-1000	13,14,15	O2 and H2 gas, varying time 1000 degrees.
STM-1100	13	O2 and H2 gas, varying time, high temp tube only 1100 degrees.
STM-1150	13	O2 and H2 gas, varying time, high temp tube only 1150 degrees.
5670FOX	13,14	Field oxide for 5670 EE class.
5670GATE	13,14	Gate oxide for 5670 EE class.
POLYANEL	15	Anneal for Phosply3 LPCVD films.

Table 1 Listing of recipes that can be ran and with which tubes.

Preparing to run wafers:

The size of the BOATs that holds the wafers are 4 inch (100mm) and 6 inch (150mm) size. Smaller size samples can be ran in the system, consult NFC staff on how this can be done.

Check the list from table 1 to make sure you know which recipe will meet your processing needs.

Have your wafers ready and clean so they can be loaded into the system when it is ready. Also make sure that you have your test wafers included.

Make sure that your wafers can go into the tube that you are planning to use. Beware of any contamination issues. If you need a higher temperature process and your wafers had/have metal on them, the RTA could be used. Consult an NFC staff person for options.



Fig. 1 This is the terminal displays, use the keyboard as normal, but everything needs to be in upper case.

Check Status of tube:

Check the status of the tube by typing **DI ST** (display status) followed by the tube number. So for tube 13 you would type **DI ST 13** and press return. (See Fig. 2 and 3) Notice between the DI and the ST there is only one space and also between St and the tube number also. The display screen should now scroll up listing information on the status of that tube. In the upper left corner there is section labeled as: STATUS and it will say RUN, END, STANDBY or READY. RUN means that the tube is already running a recipe, so find out while before doing anything else. END means that a recipe has finished, so type **ACK** and spacebar and the tube press enter and it should now say READY or STANDBY. This means that the tube set to be used, you can now load a recipe.



Fig. 2 This is the terminal display. There are many items listed, the top sections has the needed info.

Load in recipe:

To load a recipe type **LOAD** (recipe name) tube number. You can view the recipe by pressing **F3** to display disk files An example is for loading the STM-1000 recipe in tube 12 type: **LOAD STM-1000 12** and press return. The screen will have a few lines of text at the bottom. If the recipe has a variable amount of time that can be entered, the text will ask for the time needed. Enter all times in the following format, HH:MM:SS where H is the hours, M is the minutes, and S is for seconds. For one hour and 15 minutes the value entered would be **01:15:00** and press return. The main item to watch for is the line which says **GOOD LOAD**. If that is seen then the system loaded the recipe correctly. Typing **DI ST 12** will display the status of tube 12 and the top of the screen, under process is the name of the recipe and it should be the



Fig. 3 A closer view of the top line of **Tube 013**, the status is **READY** with the recipe **IDLE_650** displayed and the step is at **0000**.

Run the recipe:

Now to start the recipe, make sure your wafers are ready to load into the tube, do not start the tube until the wafers are ready. Having the tube open waiting for the wafers only put extra wear on the system. Type **RUN** and the tube number as in **RUN 12** and press return, this will have the tube now running the recipe. There is a space between the command word **RUN** and the tube number. Checking the tube status will show that under the **STATUS** section will now have the word **RUNNING** displayed. The recipe will do several things, and one of them is that the temperature will be checked and controlled to the opening temperature. This might take 5 to 15 minutes.

Load the wafers:

Once the tube reaches step 25 it will go into a waiting step. This can be checked by looking at the tube status display; typing **DI ST 12** and pressing return if we were running tube 12. One the display at the top is the words **STEP**, and under it is the program step numbers. If it is at step 25 it is ready to open. Type in **ACK 12** and this will open the tube. After loading the wafers type **ACK 12** to close the tube. See Fig 4 for both boat sizes.

During the run:

Watch the process as it ramps to temperature, making sure that it does not alarm. If it does, check to see what the step number is and if there are any items displayed on the status screen that lists what the error was caused by. One main error might be due to not reaching the correct temperature in the given amount of time. If this happens it will display step 65, so check the temperature and if it is close, type **ACK** and the tube number to acknowledge the alarm. This will cause the tube to continue and give more time. The temperature might even be reached by the time you notice the error. If the temperature is way low contact NFC staff as this is a problem.

Unload the wafers:

When the processing is complete, the tube will be in step 100. If the step number is at step 100, if it is type **ACK 12** and press return, for the tube to open. Allow some time for the wafers to cool, around 5 to

10 min. and unload the wafers and type **ACK 12** and press return to close the tube. Once this is done you log out of the system. Remember to complete the data in the log book.

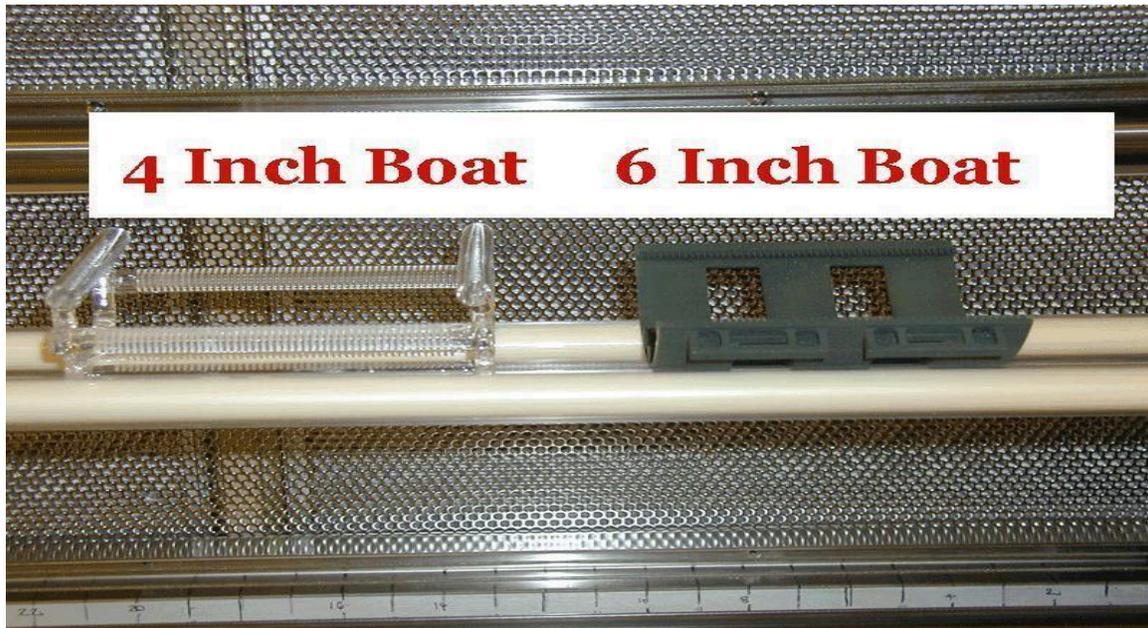


Fig 4. The 4 inch quartz boat is on the left and the 6 inch SiC boat is on the right.

8 Problems/Troubleshooting

List of commands for the Tylan. All things typed on the Tycom keyboard must have the caps lock on, as in all text must be in upper case. Any questions or problems, contact NFC staff.

The sequence to do a run is only 3 steps:

Check what the tube is doing.	-Display status-
Load the recipe to be used.	-Compile the recipe-
Run the recipe.	-Load and unload the wafers-

A normal sequence of commands entered during a normal run. Tube 13 is used for this example.

DI ST 13	If the tube status is END go to next step, if READY skip one step.
ACK 13	check to see if it is now READY.
LOAD STM-1000 13	once the few lines stop scrolling by, see if it says GOOD LOAD.
00:15:00	Time entered, used 15 min for this example.
RUN 13	This will start the recipe running.
ACK 13	open tube load wafers (once it is at step 25)
ACK 13	ACK 13 close tube (after loading wafers) DI ST 13 is tube at step 100? If so go to next step.
ACK 13	opens tube after run is done
ACK 13	closes tube after wafers are removed.

A more examples of the commands that could be used. Tube 13 is used in this example.

Getting status of a tube:

DISPLAY STATUS 13 or **DI ST 13** or press **F2** and then **13** and then press the return key.

Loading a program:

LOAD (recipe name) **13** and then press return

Listing the program names on the disk:

DI DI or **F3** and then press return, this will lists the recipe on the disk.

Running a program:

RUN 13 and then press return

Aborting a program :

ABORT 13 and then press return

Responding to tube error:

ACK 13 and then press return

Tube in hold – waiting:

ACK 13 and then press return as in to load or unload the tube. This happens at steps 25 and 100 only.

Getting the status of all tubes:

DI ST SY and then press return

Get the tube to READY status: Type

ACK 13 and press return.

Forgot to put boat into tube and it is now closed?

Load recipe BOAT for the top three tubes run and ACK it to open and again to close it.
For the Alloy tube run recipe ALOYBOAT to open and close it. You will need to be logged into Coral.

Screen keeps scrolling, how do I stop it?

Press the control key and the letter C at the same time.

Mistake – glove or sleeve touch something and was burned or melted, now what?

Do NOT close the tube with the burnt part inside, leave the tube open and contact NFC staff. If the burnt part is the boat or baffle leave it out, and allow the tube to close. Turn the switch to **RED** and also log the equipment down in Coral, so the stop light shows **RED**.

ERROR Messages:

ILLEGAL LOAD REQUEST -PROCESS RUNNING

- Check that you have the correct tube number and that the status is READY, this error says that is busy running a recipe.

ILLEGAL SLAVE

- This error is saying that you have entered the wrong tube number while trying to load in a recipe. Make sure that you have a space before the tube number and that you have the correct tube selected.

Allowed and prohibited processing and materials

Only these materials are allowed into the top 3 Tylan tubes:

- New silicon wafers
- Wafers that have been previously processed in one of the top three Tylan tubes
- Wafers after ion implantation
- LPCVD films
- Wafers after cleaning RCA or piranha ($H_2SO_4 + H_2O_2$) cleaning in Bay 1 wet benches Wafers after lithography steps or dry etching in STS or Deep trench etcher (These wafers must have a piranha clean on the wafers first)

NOT allowed in the top three Tylan tube:

If wafers were ran in Alloy tube, RTA, metal deposition systems, PECVD, or was contaminated with any film, or was even handled with bare hands. Any of these things will contaminate the tube and cause many parts to be replaced. Not to mention the chance of contaminating someone else wafers, or other process equipment.

These metals/materials are allowed in the ALLOY tube 24:

Al, Ti, Pt, Cr, Nb, Mo, Hf, Ta, W, LPCVD nitride, poly, LTO, Spin on Glass

Materials NOT allowed into the ALLOY tube.

Au (Gold), Pb, Hg, Zn, Cu, Ni, Fe, Mn, In, Sn, Photoresist, Sharpie marker ink or any other marker, tape