

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

This document covers the procedure that should be followed for normal operation of the Cambridge NanoTech: Savannah S100 (Atomic Layer Deposition – ALD). This tool is design to be used with whole 4inch wafers. Smaller pieces can be lost to the pump port. This tool must only be used for deposition less than 50nm. Contact SCIF Staff if thicker depositions are desired. (Remember...ALD) At present there is one precursor  $\text{TiO}_2$ . Submit proposal for other precursors you may want to use. Deviation from this procedure can result loss of access.

### Reference Documents

Stanford Nanofabrication Facility: This information is very useful for the understanding of the Savannah S100 tool.

Website:<https://snf.stanford.edu/SNF/equipment/chemical-vapor-deposition/ald/savannah>

**Prior to usage fill the Log Book the Date, Full Name, Deposition Film, Recipe Name, Number of Cycles, Measured Thickness, Start Time, Stop Time and Substrate: Composition/Comments. Include any odd occurrences.**

The expectation is that a user is seeking to perform depositions of less than 50nm. For thicker depositions, FIRST submit your request to Dr. Anand Gadre for review by SCIF.

### Safety

**CHAMBER IS LIKELY TO BE HOT ! ASSUME THIS TO BE ALWAYS TRUE !**

IMPORTANT: At this elevated temperature, take care that your sample will not off-gas material that could contaminate the chamber and other deposition efforts.

CAUTION: Do not attempt to open chamber lid until target chamber temperature is achieved (~150degrees C).

Read and understand this entire document. Consult SCIF Staff if you have questions.

Please report any problems directly to SCIF and document all issues in the log book.

### Login and Launch Software

This computer is a stand-alone PC. All users will login with these credentials:

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

USER: vpolineni

PWD: Merced\$1

The ALD software is usually left running. If it is closed for some reason then:

Click Cambridge Icon (Shortcut on the desktop), Savannah, V25.7.0.0 (See: 17.1)

Session Setup

Lt-Clk: PUMP button, the button will change to read VENT.

Lt-Clk: HEATER (ON), the button will change to read (OFF).

It will take about 15minutes to get the chamber to the set point temperature of 150°C.

DO NOT ATTEMPT TO OPEN CHAMBER until temperature is achieved. Damage to the Chamber-Lid O-ring seal will occur

IMPORTANT: Assure that your substrate won't OUTGAS when exposed to high temperature.

OPEN Precursor Valve. ONE turn, counter-clock-wise.

Manifold Order: Front to the Rear. Water (no valve), TiO<sub>2</sub>

Load/Edit/Save Recipe

Rt-Clk: Anywhere in the program area

Lt-Clk: LOAD RECIPE. The popup menu will allow you to import an existing recipe

Note: Use recipe as a starting template. PATH: Recipe/Maintenance

Calculate the number of cycles needed to hit the target film thickness. (For Al<sub>2</sub>O<sub>3</sub> 1A/Cycle)

Edit the GOTO command line with this value.

Rt-Clk: SAVE RECIPE. Create a new folder with your NAME. (Place it within the same directory as Maintenance.)

Load Sample

ONLY WHEN THE CHAMBER TARGET TEMPERATURE IS ACHIEVED. (150°C)

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

CAUTION: If loss of sample is a possibility, secure your sample with Kapton tape onto a four inch silicon carrier wafer.

Lt-Clk: VENT Button, the button changes to read PUMP.

The chamber pressure is reflected on the pressure window. (takes <5seconds)

Use the protected lid handle and open the chamber lid.

USE TWEEZER and place substrate to be coated into the wafer recess in the chamber.

Note: Side to be coated should be face up

Use the protected lid handle and lower the chamber lid

Replace the chamber barrier over the chamber.

Lt-Clk: PUMP Button, Button changes to read VENT.

The chamber pressure is reflected on the pressure window. (takes <5seconds)

Allow your wafer to warm up to chamber temperatures (5-10min)

Type 5 sccm for N2 CARRIER and ENTER.

The chamber pressure is reflected on the pressure window. (~100mT)

Run Recipe

Lt-Clk: RUN (START). Button changes to read ABORT.

Lt-Clk: YES, to acknowledge this action in the prompt that appears.

Recipe will automatically run to completion, unless ABORTED by the user.

Recipe progress can be tracked by following the Blue Highlight (Instruction) in the programming area or at the top of the screen.

There are three timers that can be selected. 1) Done At, 2) Time Left, 3) Total Run Time

Alternating pulse signals can be tracked for the selected precursor and the water.

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

Note: At the START, if the precursor pulse is missing, it is likely that the valve is not open. If the water pulse is missing, ABORT THE SESSION. And, notify staff. Water source cylinder is likely empty. It is filled using DI water.

It is recommended that users monitor the progress of their deposition. It is understood that deposition can be lengthy, however assuring that the pulse magnitude is consistent and present insures your deposition is predictable. Precursors will eventually run out and water source requires periodic refills.

RECIPE COMPLETION: The Progress line (at the top of the screen) will display, "RUN HAS COMPLETED", when the recipe terminates normally.

Hint: TIMER is a useful feature in determining when the program will complete.

Abort Recipe

Lt-Clk: RUN (ABORT). Button changes to read START.

Lt-Clk: YES, to acknowledge this action in the prompt that appears

Unload Sample 12.0

Remove the chamber barrier and hang it on the hook on the right side of the cabinet.

Lt-Clk: VENT Button, the button changes to read PUMP.

Use the protected lid handle and open the chamber lid

USE TWEEZER and remove substrate from the wafer recess in the chamber

At this point a second wafer can be inserted.

Purge Manifold is intended to maintain system cleanliness.

NOTIFY SCIF when multiple films on a single substrate are to be deposited.

EDIT/SAVE new recipe with different parameters or initiate another session

Lt-Clk: RUN (START). Starts next deposition session

Purge Manifold (At the end of your session or when changing Film Deposition)

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

CLOSE Precursor Valve. Turn completely clock-wise on ALL the precursors that were used.

Rt-Clk: In the programing area (anywhere)

Lt-Clk: LOAD RECIPE. The popup menu will allow you to import an existing recipe

Note: Use as a starting template. PATH: Recipe/Maintenance Recipe

Dbl-Clk: Purge x, the number (x) corresponds to the precursor position

Lt-Clk: PUMP Button, Button changes to read VENT.

The chamber pressure is reflected on the pressure window. (takes <5seconds)

Lt-Clk: RUN (START). Button changes to read ABORT.

Typically a single pulse will be generated. Precursor valve may be open with multiple pulses are generated and if the size of the pulses do not decrease.

REPEAT from the above steps, if multiple precursor valves were opened.

THE SOFTWARE SHOULD BE LEFT ON

Terminate Software and Log Off (ONLY IN CASE OF AN EMERGENCY)

Lt-Clk: PROGRAM (STOP) Button

Lt-Clk: YES to acknowledge this action in the prompt that appears.

The screen image will change slightly.

Lt-Clk: File/Exit

Log Off normally from the Windows Desktop.

Recipe Command Definition

The parameters you can control in a recipe are listed below with comments about each:

Parameter

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

### Notes

### Heater

Each heater has an unique item number and a value given in degrees Celsius. Do not overheat precursors (all precursors should be below 85C and some should not be heated at all). The reaction chamber should only be operated in the range of 150-250C. The manifold and exhaust lines should be maintained at 150C to avoid any condensation.

### Flow

This controls the flow of nitrogen carrier gas flowing through the system. It is defined in sccm. Typical recipes use a flow of 20sccm, and when in standby the system is lowered to 5sccm flow to reduce N2 usage. The source is the house nitrogen line.

### Pulse

This command is for pulsing a precursor line. It requires an ALD valve number and the amount of time you want the valve open in seconds. The fastest these valves can fire is roughly .015 seconds, so note that even if you define a shorter time that is likely the valve open time you will get. (NOTE: when writing a recipe the time in seconds needs a digit to the left of the decimal place; thus you should use "0.015" instead of ".015" for the minimum duration pulse.)

### goto

Used to define loops in the recipes. This command takes as an input the step to which the recipe should return. The value for this command defines how many times the loop will run.

### stabilize

This command is used to hold a recipe until a heater has reached the desired value. It takes as input a heater ID number and will wait until that heater demonstrates the set temperature with a degree C over a few seconds.

### wait

# Savannah S100 ALD at SCIF, UC Merced

## Standard operating Procedure

This command takes as input a value in seconds that you would like the system to wait before proceeding to the next command. (NOTE: when writing a recipe the time in seconds needs a digit to the left of the decimal place, as noted earlier in Pulse)

stopvalve

This command will close or open the output valve for the reaction chamber depending on a Boolean input. This command is currently not used in any of the standard recipes, but development for recipe use of this feature may be conducted, time permitting.

line ac out

Users should not use this command. It changes the heater voltage on precursor heater wraps.

Source (Arizona State University and Stanford NanoFab labs)