Equipment Name: Varian E-beam evaporation

Badger Name:	Ebevap-varian	**Revision Number:**	9
Model:	3118	**Revisionist**:	Bob Amundson
Location:	Bay 3 - Keller Hall	**Date:**	03/25/2020

1 Description

The electron beam evaporator is used to evaporate solid dielectrics (granules, no powders) onto substrates. Evaporation is done under a high vacuum in a water cooled bell jar chamber. Evaporation is achieved by heating a source with an electron beam. As the source material evaporates, it forms a thin film on the samples.

2 Safety

a If you are evaporating and the building alarm sounds, TURN OFF THE POWER SUPPLY CIRCUIT BREAKER and leave immediately.

b To prevent sodium contamination, wear poly gloves whenever handling the source metals or the inside of the chamber.

c Wear UV glasses when viewing the beam to prevent eye damage.

3 Restrictions/Requirements

a Must be a qualified user

b Log in and out of the system using Badger

c Fill out the logbook.

4 Required Facilities

a Compressed air 60psi

b Process chilled water

c Exhaust

5 Definitions

a. **Ion gauge filament**. Measures the pressure of the chamber while pumping with the diffusion pump (Cryo Pump)

b. **Hearth.** Located inside the chamber and holds the metal sources.

c. **Planetarium**. The fixture that holds the substrates inside the chamber.

d. **Shutter**. A metal paddle that will cover/uncover the source metals.

e. **INFICON (IC6):** The computer where recipes are written and stored.

f. **Cursor Keys:** An array of five keys used to move the display cursor either up, down, left or right the menu key is used to navigate through the displays.

g. **Function Keys:** F1, F2, F3 and F4 are used to select displays or menu items.

h. **Data Entry Keys:** A keypad with numerical numbers 0-9 with telephone style assigned letters for parameter entry. All numerical entries should be followed by ENTER, CLEAR is used to erase data entry errors. If an illegal value was entered CLEAR will erase the error message and re-display the last valid data.

i. **System Switches:** Three keys that provide START, STOP and RESET for process control

6 Setup

a Make sure mode dial is on MAN.

b Turn off ion gauge using IG1 button.

c Switch high vacuum isolation valve to close.

d Switch chamber N2 vent gas valve to open.

e Make certain "Convectron Gauge A" is above 8.1 x 10^2 Torr for 2 minutes.

f Raise bell jar using hoist rocker switch.

g Switch chamber N2 vent gas valve to closed.

h. With the bell jar open, load wafers onto the LIFT-OFF dome. Secure the wafers / holders to the dome with the clips. Fill any empty spots on the dome with samples holders. If using the PLANETARY fixture, the PLANETS should be loaded **before** hanging them on the planet pole fixture, and the load should be evenly distributed around the planet (i.e. equal spacing and weight distribution of wafers if possible.

i. Open shutter and load source. To open shutter in the main menu on the Incficon controller curser over to maintenance then press MENU. Then curser down to source maintenance then curser right to disable by pressing the **Togl** button to enable it will be highlighted blue then press enter to turn dark. Now the option toggle source shutter button F3 will allow user to open and close shutter. After loading source close shutter and disable option by highlighting enable pressing **Togl** and Enter buttons to display disable then curser left and press Menu to return to main menu screen.

i Lower bell jar using hoist rocker switch.

j Make sure chamber N2 vent gas valve is in the closed position.

k Turn the ROTATION on. Make sure the lift off fixture stays rotating before ĂĂ

Pump down. If rotation stops move the bell jar slightly off the alignment Arrows until rotation starts.

l Switch chamber rough valve to open

m Watch rough pump gauge ("A"). Allow it to reach 1 x 10^-1 Torr (~10 min.).

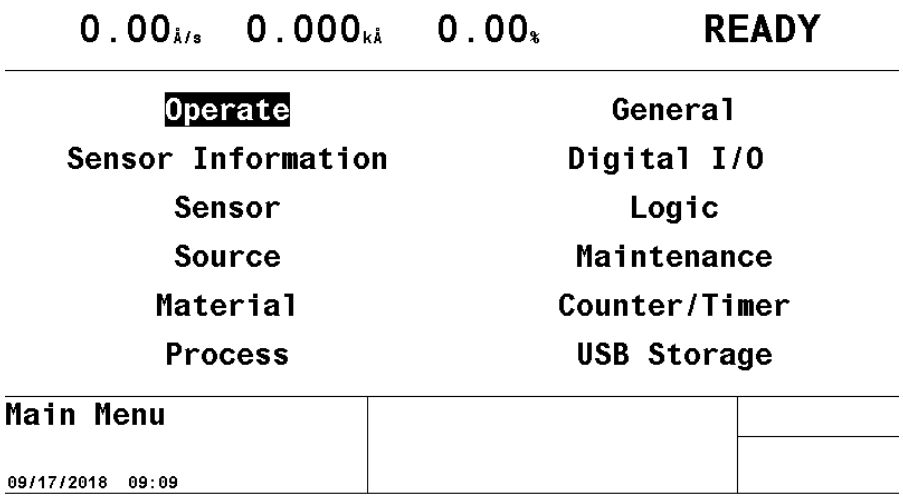
n When 1 x 10^-1 Torr is reached switch chamber rough valve to close

o Switch high vacuum isolation valve to open position.

p Wait 30 seconds after cross-over, then turn Ion Gauge on using "IG1" Button.

7 Operating Instructions

- Pump down for two hour until operating pressure is $5x10^{-6}$ Torr.
- Below is the INFICON IC6 in the main menu screen.



3. Curser down to process and press the menu button the screen below will appear

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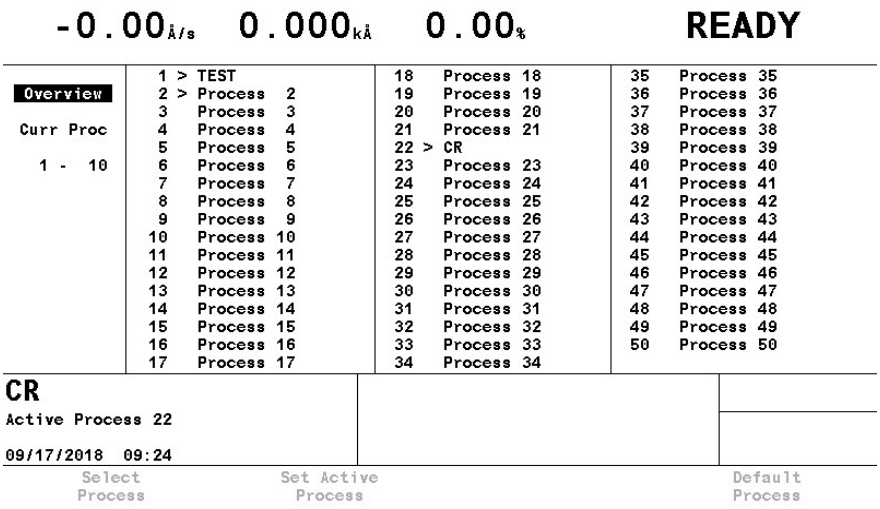
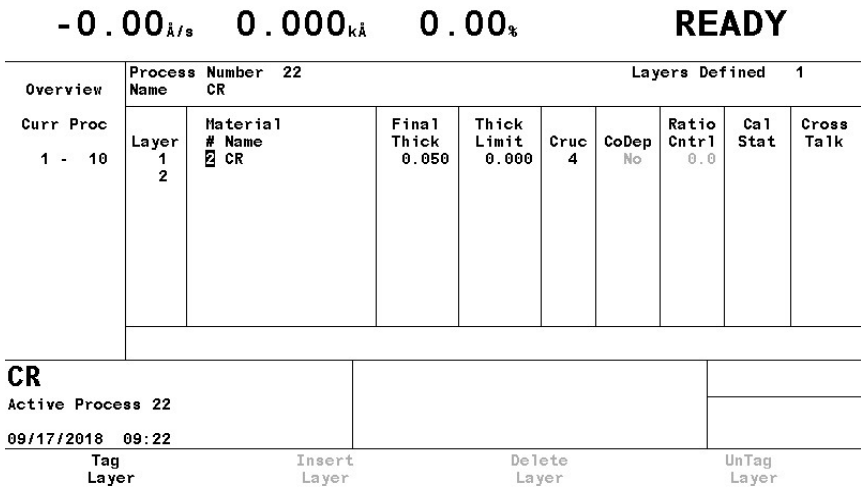
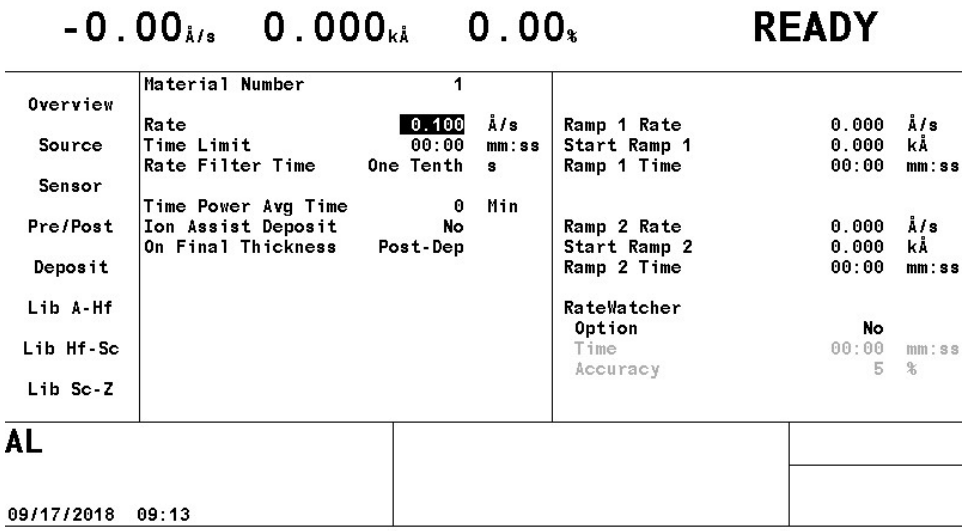


4. Now curser right and highlight source 1, 2 or 3 then select process by pushing the **F1** function key then set the active process by pressing the **F2** function key. Now curser to the 1-10 option (see picture below) in this screen curser right to enter your final thickness in k/Å use the data entry

keys to enter value it should highlight blue then press **F1** function key to tag the layer. In this screen you can also insert and delete layers.





5. Now in the main menu curser and highlight **MATERIAL** and press MENU to enter screen above. In the overview screen curser right to select material 1.2 or 3 and set the rate of deposition below the material number. Then return to main menu and highlight the **OPERATE** option then press **MENU**.

8. POWER SUPPLY SET UP.

1 Make sure the crucible selector is set to the correct position.
2 Turn the circuit breaker to the POWER SUPPLY on.
3 Turn the SOURCE CONTROL POWER on.
4 All four interlocks should light GREEN. If not, the beam cannot be turned
On: Water
Transformer
Vacuum
Doors (closed)
5 Turn the SWEEP CONTROLLER on, it is located on the back of the panel
Off the unit.
6 Turn the HIGH VOLTAGE on. Press the H.V. ON button.
7 Turn the FILAMENT CURRENT on. Press the Fill ON button.
8 Set up the SWEEP PATTERN on the sweep controller
Patter should be set to 1 (circle)
Turn the sweep current ON.
Turn DC Bias ON
Press PRM

9. EVAPORATE

- Turn Oxygen switch on (1 sccm) **OPTIONAL**
- In the main menu in the OPERATION screen press the system switch START button to begin the deposition. Make sure to zero out the last runs thickness using the F1 key. The run will automatically open and close the shutter during the process.

10. SHUTDOWN

1 Press the H.V. RESET on the power supply
2 Press the FIL OFF on the Source Controller.
3 Turn the Circuit Breaker OFF on the POWER SUPPLY.
4 Turn the SOURCE CONTROLLER off.
5 Turn the SWEEP CONTROLLER off.
6 Turn the Oxygen off.
7 Turn the ROTATION off.
8 Turn the Ion Gauge off.
9 Allow source to cool for 5 minutes.

10 Switch high vacuum isolation valve to close.

11 Switch chamber N2 vent gas valve to open.

12 Make certain "Convectron Gauge A" is above 7.0 x 10^2 Torr for 2 minutes.

14 Raise bell jar using hoist rocker switch.

15 Switch chamber N2 vent gas valve to close.

16 Unload samples and source(s) as you normally would.

17 Lower bell jar using hoist rocker switch.

18 Make sure chamber N2 vent gas valve switch is closed

19 Switch chamber rough valve to open.

20 Watch rough pump gauge ("A"). Allow it to reach 1 x 10^-1 Torr

(~10 min.).

21 When 1 x 10^-1 Torr is reached switch chamber rough valve to close

22 Switch high vacuum isolation valve to open position.

23 Wait 30 seconds after cross-over, then turn Ion Gauge on using "IG1"

Button.

11 Problems/Troubleshooting

a The system is not pumping down. If the samples have moisture on them, i.e. water or photoresist, the chamber will take longer to reach the desired pressure.

b If the samples are dry, there may be particles on the O-ring preventing a good seal. Vent the system and wipe off the O-ring with a wipe soaked with methanol And try to pump down the chamber again.

c The T/X light keeps on flashing when the Program Board is turned on. This Indicates that the crystal that monitors the evaporated metal needs to be changed by a staff member or the replaced crystal has been installed improperly.

12 Special Notes on TiO2

Depositing SiO_2 and Al_2O_3 vs Depositing TiO_2 — How They Differ

Al_2O_3 and SiO_2 work fine with crystal feedback, and dep. rate and final thickness can be controlled with crystal controller. Simply program the controller, and it will do everything for you.

TiO2 does not work with the crystal controller, and the dep. rate will be erratic and uninformative. Also, final thickness displayed will be in error.

<u>To deposit TiO_2 effectively</u>:
1) Program TiO_2 with dep. rate 1-5 A/sec and give large (10.00 kA) final thickness to controller.

2) Program Power 1 = 5%, Power 2 = 10% and program Max. Power to either 10, 15, 20, or 25%

3) In practice the controller will go to this max. value and maintain that power while 'seeking' to reach input dep. rate of 1 to 5 A/sec.

4) Simply time run with amount of time shutter is open, and that will determine thickness based on the rates below.

We do not know why TiO2 does not work with crystal control, but it is believed it may be that the crystal is simply too far away from the source.

<u>TiO_2 Deposition Rates</u>
With no oxygen flowing --
10% power = 27 A/min
20% power = 100 A/min
25% power = 140 A/min

With 1 sccm O2 flowing, resulting in 9 x 10^-5 Torr pressure --

25% power = 94 A/min

With 5 sccm O2 flowing, resulting in 1 x 10^-4 Torr pressure --
25% power = 75 A/min