

UiB NanoStructures Laboratory
Standard Operating Procedure
Temescal FC-2000 E-beam Evaporator

Purpose of the instrument:

The Temescal FC-2000 E-beam Evaporator is used for the deposition of metal and oxide thin films.

Location of the instrument:

Allégaten 55, room 286 (entrance via 276, E-Beam lithography Lab)

Primary Staff Contacts:

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Available source materials:

Gold (inside Tungsten Crucible), Chrome, Tungsten, Nickel, Aluminum, Silicon-oxide, Titanium (currently not loaded into source).



Figure 1: Temescal FC-2000 E-beam evaporator

WARNINGS

The instrument operates with a **high-power, high-voltage supply** delivering potentially lethal electrical currents. Under no circumstances operate the instrument with removed side-panels or without training.

Hot titanium may ignite when in contact with oxygen. Since titanium is a deposition material, users must wait for the system to cool down to a temperature below 40° C before opening the chamber. If the chamber is opened while the titanium is hot, a flash fire may occur.

The UiB NanoStructures Lab is operated for the benefit of all researchers. YOU MUST HAVE RECEIVED PERSONAL TRAINING ON THE INSTRUMENT TO BE PERMITTED TO OPERATE IT! IF YOU HAVE BEEN TRAINED AND ARE STILL UNCERTAIN AS TO HOW TO OPERATE THE INSTRUMENT CONTACT ONE OF THE STAFF MEMBERS. If you encounter any problems with this piece of equipment, please contact the staff member listed above immediately. There is never a penalty for asking questions. If the equipment is not behaving exactly the way it should, contact a staff member. This SOP only serves as a quick reference. For further details consult the manual and/or service engineers.

Basic Usage (Evaporate Metal or Oxide using pre-existing recipe)

The SYSTEM MAP screen on the computer located in the electronics rack of the system gives basic status information of the system:

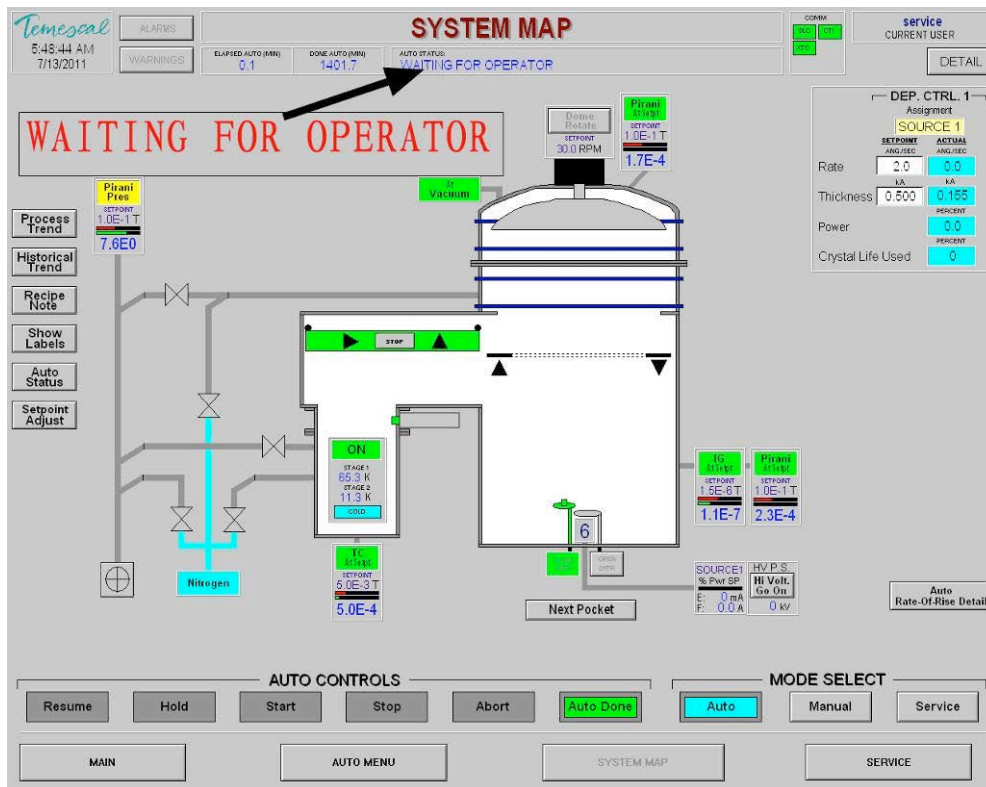


Figure 2: SYSTEM MAP

BELOW IS THE SCREEN COLOR CONVENTIONS TAKEN FROM THE TEMESCAL BJD-2000 USER'S MANUAL.

COLOR	MEANING
Gray	Off, Closed, not in position, or cannot be selected. A gray valve is closed.
Yellow	Turning On; turning Off; changing. An opening valve is yellow.
Orange	A closing valve is orange. The chamber vacuum status blocks turn orange when pressure approaches atmosphere.
Green	On or open. A green valve is open. On a bar graph, displays the actual value.
Red	Problem exists. A red valve means an alarm condition. On a bar graph, a red bar shows the set-point value.
Dark Red	Water jacket (on System Map) displayed as DARK RED when HOT is selected.
Black	Static information.
Blue	On a control, the digital display of the actual value.
Purple	On a control, the digital display of the set-point value.

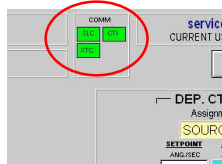
Figure 3: Screen color conventions

To evaporate a thin film, use the following procedure:

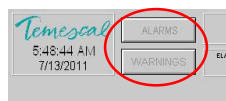
1. Fill in the log sheet located next to the machine.
2. Log into the Temescal Software if necessary. (Currently we use as username and password: 'service' and 'factory', respectively).
3. Switch the screen to the SYSTEM MAP using the corresponding one of the four buttons located at the bottom of the screen.



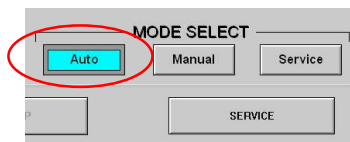
4. Check that communication indicators (CTI, XTC, and SLC) are green. The indicators are located on the computer screen in the upper right hand corner of the SYSTEM MAP screen. If any of the indicators are red (see Figure 2), there is a communication error and a Shared Facilities staff member needs to be notified.



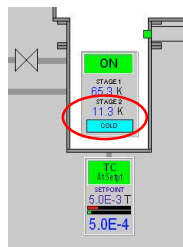
5. Check that there are no Alarms or Warnings blinking at the upper left of the SYSTEM MAP (see Figure 2).



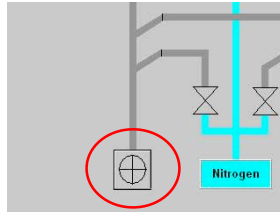
6. The system should be in Auto-Mode. If not, click on 'Auto' and make sure the system successfully switches to Auto-Mode. Otherwise contact a staff member (Do not run processes in Manual mode unless you have been trained to do so.).



7. Check that the **STAGE 2** cryo pump temperature as shown on the SYSTEM MAP is below 14 K (see Figure 2). **NOTE:** If the temperature is above 18 K, then regeneration of the cryopump needs to be conducted. Contact a Shared Facilities staff member if the cryopump has been turned off or if there are any alarms.



8. Check that the nitrogen supply is at about 7 bar on the pressure gauge at the back of the system (If not get a staff member to check the pressure regulator in room 186 and the nitrogen generator in the Fyrron).
9. Check that the pressurized air is at about 7 bar (For now check in the service corridor of the cleanroom in room 286).
10. Check that the mechanical dry-pump is running as indicated on the SYSTEM MAP (During times of prolonged inactivity, the dry-pump should be turned off.) To turn it on, switch to Manual Mode and click on the button that is also the indicator.



11. Switch to the Auto-Menu screen.

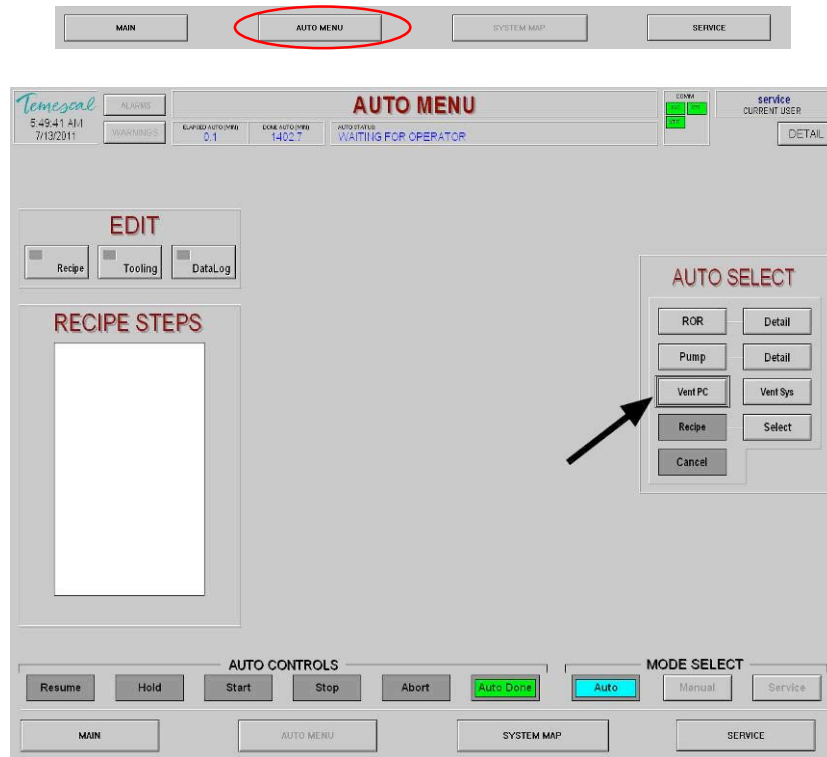
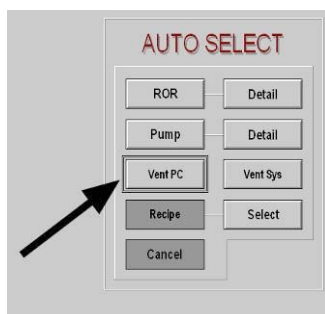


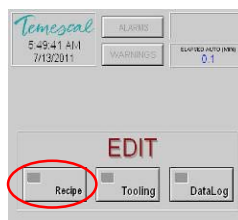
Figure 4: AUTO MENU

12. Vent the process chamber by clicking on 'Vent-PC'.

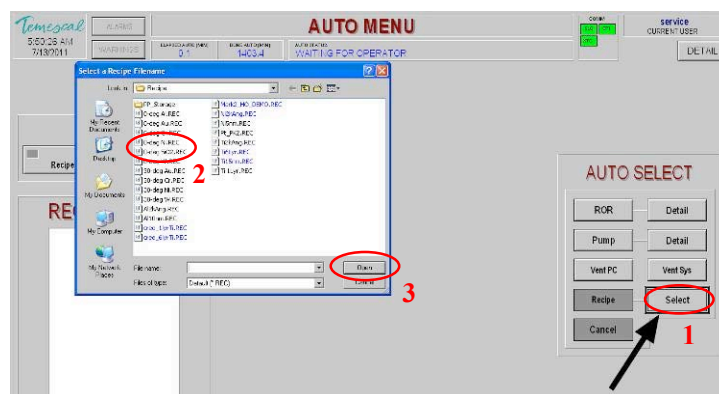


13. The pressure in the process chamber is indicated with the red-numbered display on top of the dome-shaped vacuum chamber (=process chamber). Once the indicated pressure is close to zero, lifting it at the handle in the front upwards and towards the back can open the chamber.
14. Examine the state of the inside of the chamber. If metal flakes start to peel off from the metal plates that line the inside of the chamber ('Liners'), a staff member should be contacted. A second set of liners exists that can be mounted, while the contaminated one is sent off for bead blasting.

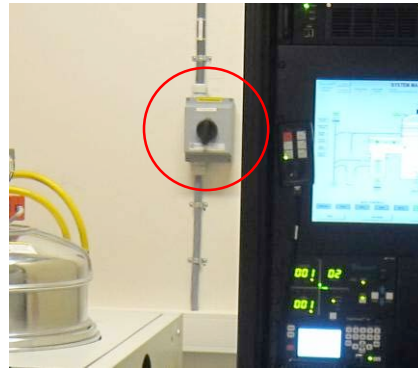
15. Remove the disc-shaped sample holder from the angular rotation mount, and place it up side down next to the chamber (so that the side with the metallic mounting clips faces upwards). YOU MUST WEAR LATEX GLOVES TO TOUCH THE SAMPLE HOLDER OR ANYTHING INSIDE THE VACUUM CHAMBER! (Even small fingerprints can severely affect chamber evacuation times. Also the thin metal flakes produced during evaporation may have adverse health effects when in direct contact or inhaled!)
16. Mount your sample(s) using the mounting clips. Ensure that they cannot fall off when the holder is facing downwards! Samples falling into the source can cause substantial damage!
17. Mount the sample holder back on the angular rotation mount inside the process chamber.
18. Close the dome-shaped process chamber door.
19. Edit the recipe for the material to be deposited, mainly to select the desired film thickness.
 - a) In the Edit-Menu select 'Recipe'.



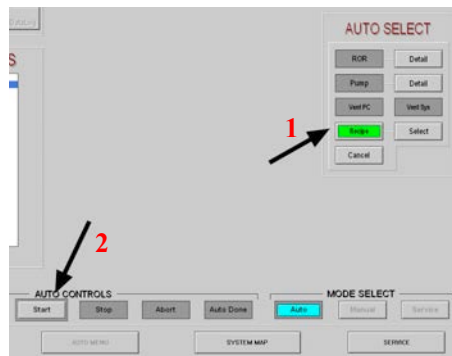
- b) Select the recipe file for the desired material ('0 deg' refers to normal incidence evaporation - i.e. the sample plate has been mounted horizontally. For other angles the tooling file needs to be adapted as otherwise the measured film thicknesses will be incorrect.).
 - c) Select the evaporation step and click on 'Edit'.
 - d) By clicking on 'Next Page' go to the page detailing the 'Final Thickness'.
 - e) Change to the desired value. Note the curious units!
 - f) By clicking on 'Previous Page' return to the first page and click on 'Save' to save the adapted deposition step.
 - g) Close the recipe file.
20. In the Auto-Menu click on 'Select' and choose the recipe file edited in the sub-procedure above.



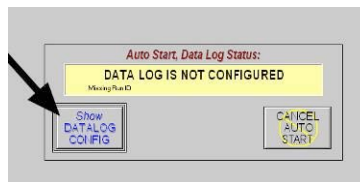
21. Switch on the High Voltage Power Supply 'CV-12SLX' at the bottom of the electronics rack. If the LEDs do not turn on, check that the large Power Switch on the wall behind the system is in the 'on' position.



22. Click on 'Recipe' and then 'Start' under 'Auto Controls'.

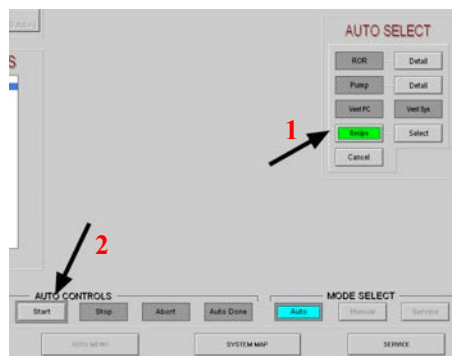


23. A warning that the Data Log has not been configured. Click on 'Show Datalog Config'.



24. Edit the first line in the Datalog Config. Enter in the following order: date, time, your name, the material you are going to deposit, and the planned film thickness in nm. Close the Datalog config window.

25. Again, click on 'Recipe' and then 'Start' under 'Auto Controls'. This time the evaporation procedure should start. The progress can be observed by switching back to the 'System Map' Display.



26. After evacuation of the chamber the evaporation process goes through the following stages:

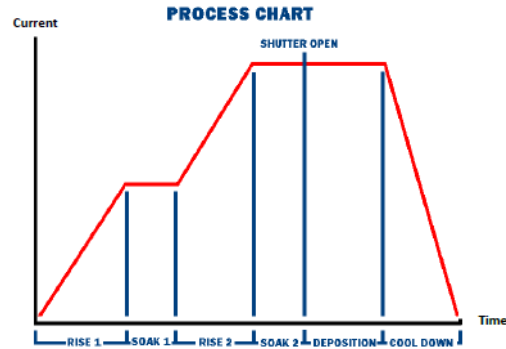
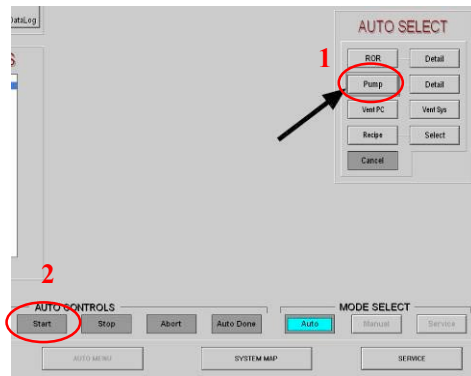


Figure 5: Process chart

27. Once the E-beam has heated up and during the actual evaporation when the shutters have opened the evaporating metal in the source can be observed using the view port. **WARNING: THE EMITTED LIGHT CAN BE VERY INTENSE: PROCEED WITH CAUTION.** Vary the intensity of the transmitted light using the Polarizer Wheel. The port is protected by a transparent plastic film, which can be forwarded using the other wheel, once too much metal has been deposited on it. The position of the e-beam on the source pocket fluctuates intentionally due to the sweep generator. Please make sure that the sweep pattern is centered on the source pocket, if not contact a staff member, who will re-align the e-beam with the pocket. Misalignment can cause severe damage to the source, and evaporate other materials onto your sample.



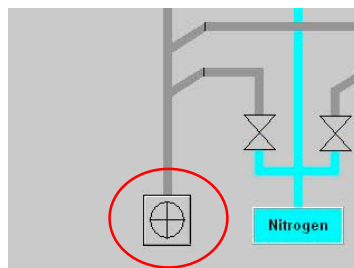
28. The Auto-procedure will automatically vent the process chamber after a successful evaporation step. That process chamber is vented and ready is again indicated by the pressure gauge on top of the dome-shaped vacuum chamber. Also the computer will show the message 'Auto-process completed.'
29. Remove your sample repeating the steps 13.-18. This time remove the sample and place it in a suitable container (e.g. Fluoroware)
30. In the Auto-Menu select 'Pump' and then 'Start' to pump down the process chamber. (The chamber should not be left in a vented state.)



31. Turn off the High Voltage Power supply 'CV-12SLX'.



32. If the system will be inactive for some time (e.g. weekend) switch to 'manual mode' on the System Map screen and click on the mechanical pump button.



Maintenance Procedures

- 1) Source cleaning and replenishment
- 2) Exchange of thickness monitor crystal
- 3) Regeneration of cryo-pump
- 4) Exchange of chamber liners
- 5) After power cut
- 6) Power down of instrument
- 7) Power up of instrument
- 8) Monthly operation check
- 9) Accounting procedures

Document History

Version 0.1, Nov-2011, Author: Xiaodong Guo, Changes: Basic Usage Procedure

Version 0.2, 19-JAN-2012, Author: Thomas Reisinger, Changes: Front Page, Basic Usage and Layout

Version 0.3, Aug-2014, Author: Melanie Ostermann, Update: Primary staff contacts, main figure captions
(cross-references, page numbers)