Thermal Evaporator — Operating Procedure & Step Explanations

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1. Quick Operating Instructions

Follow the steps below in order. Terms are explained at the point where you first need them.

1.1 Before You Touch the Machine

1. Wear the required Nanofab cleanroom PPE and follow posted facility safety rules.
2. Make sure the machine is OFF and pressure in glass bell jar is at atmospheric pressure.
3. Inspect the bell jar before use. Do not use it if the glass is cracked, chipped, or visibly damaged; contact Nanofab staff.
4. Make sure the evaporation coil inside the chamber is cool and intact.
5. Have the substrate and coating metal ready.
6. Do not adjust, repair, bypass, or improvise with vacuum-system hardware or controls.

1.2 Open the Chamber



1. Hold the steel cage securely and lift the bell jar straight up from the metal baseplate without dragging the glass across the sealing surface.
2. Set the bell jar upside down in its designated location and check the large rubber gasket around the sealing surface. Make sure gasket has not fallen out or shifted.

1.3 Mount the Sample

1. Find the large metal sample holder hanging above the evaporation source.
2. Attach the sample securely to the underside of the holder using mounting materials established for this tool. The sample must fit completely on the holder and must not touch the evaporation source, bell jar, or surrounding chamber hardware.
3. The surface you want coated faces down.
4. Put the sample as close as possible to the middle of the holder, directly above the evaporation source.

Think of it vertically - top to bottom:

Sample holder

↓

Sample — surface to be coated faces down

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Evaporation source

The evaporation source (crucible) should be directly beneath the substrate. Do not touch crucible.

1.4 Load the Deposition Metal

1. Find the silver evaporation basket (crucible) below the sample holder.



2. Check that the basket contains about 1/2–3/4 of a 6 mm airsoft BB-sized amount of silver (Ag). If there is less, add only the Ag supplied or approved for this tool.
3. Make sure chamber-protection foil is not covering an electrical contact, gauge connection, or the evaporation source.

1.5 Replace the Bell Jar

1. Check that the gasket is present and seated normally on the circular sealing surface.
2. Hold the steel cage securely and lower the bell jar straight down onto the baseplate. Do not drag it across the gasket.
3. Center the bell jar so the spacing around the seal is approximately even.
4. Check the entire bottom edge. The gasket must not be rolled, pinched, shifted, or outside its groove.
5. If the bell jar is crooked or the gasket is out of place, correct the seal before moving the selector to PUMPDOWN.

1.6 Begin Pump-Down

Vacuum pumping removes air from the sealed chamber so its pressure falls below atmospheric pressure. The front selector has three positions: SEAL isolates the chamber from venting and pumping; PUMPDOWN connects the chamber to the vacuum-pumping path; VENT lets room air back into the chamber.

1. Put the front PUMPDOWN / SEAL / VENT selector on SEAL.



2. Turn the machine ON using the rear power-strip switch. The roughing pump starts and performs the first stage of vacuum pumping.
3. Move the selector from SEAL to PUMPDOWN.
4. Watch the Convectron gauge, the red-digit pressure display used during rough pumping. Pressure should decrease from 999 as air is removed.
5. Continue waiting until the Convectron reads 50 mTorr.

Pressure units: A Torr is a pressure unit; 1 atm is normal atmospheric pressure; 1 mTorr = 0.001 Torr. Vacuum means pressure below atmospheric pressure



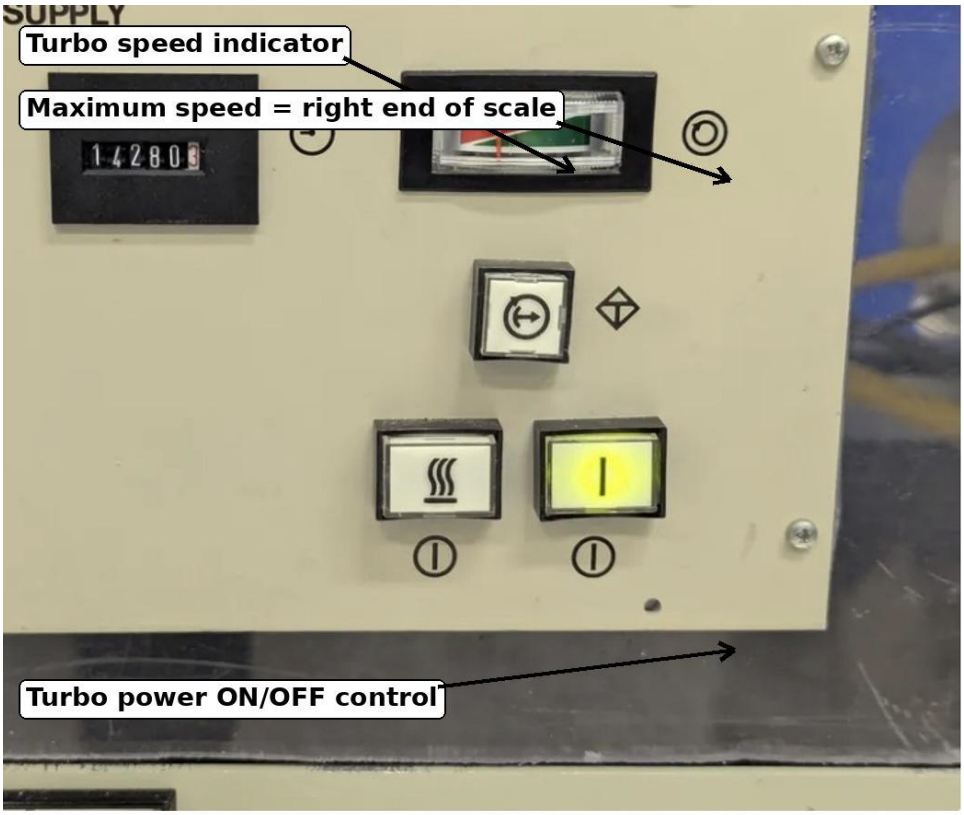
Convectron gauge

Continue rough pumping until display reads 50 mTorr.

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1.7 Start the Turbo Pump

The TCP 310 controls the turbomolecular pump, which creates the higher vacuum needed for deposition.



TCP 310 turbo-pump controller

Watch the speed indicator move toward the right as the turbo accelerates.

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1. Keep the vacuum selector on PUMPDOWN.
2. At 50 mTorr, turn ON the TCP 310 turbo-pump controller.
3. Watch the TCP 310 speed indicator as the turbo accelerates.
4. Wait until the speed indicator reaches the far-right/full-speed end of its scale.

1.8 Check High Vacuum

The Varian Ratiomatic 843 is the ion-gauge controller/display used to measure very low chamber pressure after the turbo pump is operating



Varian Ratiomatic 843 ion-gauge controller

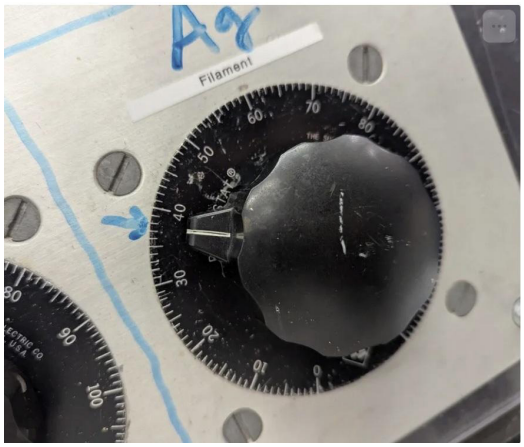
Left: pressure meter • Center: RANGE selector • Colored buttons: gauge controls

Use the LOG range as specified in the operating steps.

1. Turn ON the Varian 843 controller and read pressure from left-hand thermocouple (TC) gauge.
2. Once the turbo has reached maximum speed, keep the system pumping for the full 20 minutes before beginning deposition and make sure pressure is continuing to drop as read from the TC gauge.

1.9 Deposit the Metal

The right-hand rheostat controls electrical power to the silver evaporation source. Its number is power-control setting, not a temperature.



1. Make sure the right-hand rheostat is at 0.
2. Turn ON the power switch for the right-hand rheostat.
3. Slowly increase the rheostat from 0 to 20. The evaporation source should begin to glow orange.
4. Continue increasing the rheostat gradually from 20 toward approximately 40 while watching the source through the bell jar.
5. Allow the source to reach its operating temperature, then set the rheostat to 40.
6. Observe the source through the bell jar and keep the rheostat at 40 while metal remains visibly present in the basket.

1.10 Turn Off the Deposition Source

1. If no metal remains, slowly return the rheostat setting to 0.
2. Turn its power switch OFF.
3. Keep the chamber under vacuum until the evaporation source is no longer glowing.

1.11 Vent the Chamber

VENT means allowing room air back into the vacuum chamber so the bell jar can be opened.

WARNING: Never move the selector to VENT while the turbo is still spinning down.

1. Turn the ion gauge controller OFF.
2. Turn the turbo pump OFF.
3. Keep the selector on PUMPDOWN while the turbo spins down. Wait for the TCP 310 light to go out.
4. Once the light is off, move the selector from PUMPDOWN to VENT.
5. Wait until the chamber is at atmospheric pressure before lifting the bell jar.

1.12 Unload and Leave the Machine Ready

1. Carefully lift the steel-caged bell jar straight up.
2. Remove your sample from sample holder.
3. Check the gasket, lower the bell jar straight down onto the baseplate, and center it.
4. Move the PUMPDOWN / SEAL / VENT selector to SEAL.
5. Make sure the ion gauge is OFF, the TCP 310 turbo-pump controller is OFF, and the deposition-source rheostat is at 0 with its switch OFF.
6. Turn the rear power-strip switch OFF.

2. Step Explanations

2.1 What the Machine Does

Thermal evaporation is a Physical Vapor Deposition (PVD) process. The chamber is evacuated so there are very few gas molecules between the heated silver source and the sample. Silver is heated until it evaporates, travels upward through the low-pressure chamber, and deposits as a thin coating on the sample.

2.2 Why Rough Pumping Comes First

The roughing pump removes most of the air from the chamber first because the turbomolecular pump is designed to create high vacuum, not to evacuate a chamber starting at atmospheric pressure.

2.3 Why the Turbo Runs Before Deposition

The turbo pump creates a much deeper vacuum than the roughing pump. With fewer gas molecules in the chamber, evaporated Ag can travel from the source toward the sample with fewer collisions, helping the metal reach the sample and form a more controlled coating.

2.4 Why the Turbo Must Spin Down Before Venting

A turbomolecular pump rotates at very high speed. It must slow down before the chamber is exposed to room air because abruptly admitting air while the rotor is still spinning rapidly can place unnecessary mechanical stress on the pump.

2.5 Sample Compatibility

Only load samples that are clean, dry, free of loose particles, and compatible with vacuum. The sample must fit completely on the holder and remain clear of the evaporation source, bell jar, and surrounding chamber hardware. Use only mounting materials established for this tool. If a sample cannot be mounted securely with adequate clearance, do not run it.

2.6 Why the O-Ring and Bell-Jar Seal Matter

The O-ring creates the vacuum seal between the bell jar and baseplate. A shifted, pinched, dirty, or damaged seal can prevent the chamber from pumping down normally. Lower the bell jar straight down and do not force it against a misaligned seal.

2.7 Why the Sample Faces Down and Is Centered

Silver vapor travels upward from the evaporation source toward the sample. Mounting the coating surface downward and positioning it near the center above the source places that surface in the intended deposition path and helps reduce thickness variation.

2.8 Why Source Power Is Increased Gradually

The evaporation source is heated electrically. Increasing power gradually heats the source and Ag progressively rather than applying the full deposition setting immediately. Follow the documented 0 → 20 → approximately 35–40 → 40 sequence rather than jumping directly to 40.

3. Definitions

3.1 Machine Parts and Controls

Bell jar — The clear glass enclosure surrounded by the steel cage.

Steel cage / guard — The metal grid that protects the bell jar.

Chamber — The enclosed space inside the bell jar.

Baseplate — The flat metal surface on which the bell jar seals.

Gasket — The rubber-like ring that seals the bell jar to the baseplate.

Sample / substrate — The piece being coated.

Sample holder / heat sink — The metal holder above the evaporation source that supports the sample.

Evaporation source — The electrically heated assembly that vaporizes the Ag.

Basket — The wire-basket-shaped part of the evaporation source that holds the Ag.

Filament — The electrically heated wire/source assembly.

Rheostat — The adjustable knob that controls electrical power to the evaporation source.

Chamber-protection foil — Aluminum foil used inside the chamber to catch metal that does not deposit on the sample.

Power strip — The rear electrical strip containing the machine's main power switch.

PUMPdown / SEAL / VENT selector — The front control that changes the chamber's connection to the vacuum and vent paths.

TCP 310 — The turbomolecular-pump controller.

Varian 843 — The ion-gauge controller and display.

3.2 Vacuum Terms

SEAL — The selector position that isolates the chamber from venting.

PUMPdown — The selector position that connects the chamber to the vacuum-pumping path.

VENT — The selector position that admits room air into the chamber.

Pump down — Removing gas from the chamber to lower its pressure.

Roughing pump — The pump used for the first stage of evacuation.

Convectron gauge — The thermocouple (TC) pressure gauge used during rough pumping.

Turbomolecular (Turbo) pump — The pump used to create high vacuum after roughing.
Ion gauge — The gauge used to measure very low chamber pressure.

LOG range — The Varian 843 logarithmic pressure-display range.

Vacuum — Pressure below normal atmospheric pressure.

High vacuum — A low-pressure condition with very little gas remaining.

Torr — A unit of pressure used for vacuum measurements. mTorr — 0.001 (One-thousandth) Torr.

760 Torr is atmospheric pressure at standard temperature and pressure (sea level)

3.3 Deposition Terms and Units

Thermal evaporation — A PVD process in which a material is heated until it vaporizes and deposits on a surface.

PVD — Physical Vapor Deposition; deposition of material from a vapor onto a surface.

4. Troubleshooting

Bell jar will not lift: do not force it. Confirm the chamber has returned to room pressure.

O-ring moved or fell out: re-seat it correctly before pump-down.

Pressure does not reach 50 mTorr or stops decreasing: do not start the turbo. Stop the procedure and contact Nanofab staff; do not attempt vacuum-system repairs.

Turbo does not reach maximum speed: do not begin deposition. Keep the system in a safe pumping state and contact Nanofab staff.

Source does not heat or behave normally: slowly return the rheostat to 0, turn the source switch OFF, and contact Nanofab staff.

Bell jar is cracked, chipped, or visibly damaged: do not pump down the chamber. Leave the machine off and contact Nanofab staff.

Unsure whether Ag evaporation is complete: do not guess or increase beyond the documented rheostat setting. Return the rheostat slowly to 0, turn the source switch OFF, and contact Nanofab staff.