



# Center for Integrated Nano-Technologies

## Operating Procedure for Integration Lab E-beam System (EG1) (IL Ebeam OP, EG1)

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# 1. PURPOSE

This document provides the necessary information for the safe use of the E-beam Deposition system located in the CINT Integration Lab. Any questions beyond the scope of this document should be directed to the equipment owner.

# 2. ACRONYMS

Many pieces of equipment and procedures are known by their associated acronym.

CINT- Center for Integrated Nano-Technologies  
ES&H – Environmental Safety and Health  
Haz Mat- Hazardous Material  
MSDS- Material Safety Data Sheet  
PPE- Personal Protective Equipment  
PR- Photoresist  
QA- Quality Assurance  
S&S- Safeguards and Security  
SNL- Sandia National Laboratories  
SOP/OP- Standard Operating Procedure/Operating Procedure  
TGMS- Toxic Gas Monitoring System  
UV- Ultra Violet

# 3. DEFINITIONS

Authorized User- Personnel with the required training and subsequent approval of the Integration Lab manager to use said equipment.

CINT Key Operator- Designated Key Operators are qualified to perform tool specific training of Authorized Users, and are responsible for the maintenance of the equipment.

Visitor- Personnel trained in the cleanroom overall safety and gowning procedures, but not authorized to operate equipment.

ES&H Officer – Provides ES&H, S&S, and QA for CINT activities.

IL Staff – Integration Lab Staff who provide Equipment support and Safety training for users. IL Staff are typically Key Operators for multiple tools.

# 4. RESPONSIBILITIES

It is the responsibility of every employee, contractor, and visitor to ensure a safe and healthy working environment. There is no experiment or procedure at Sandia that is so urgent that it needs to be done in an unsafe manner, and it is everyone's obligation to refuse to do work that he or she believes to be unsafe. If there is an activity or situation that is of concern it is their immediate responsibility to contact a supervisor or ES&H representative.

# 5. TRAINING

Prior to using the Ebeam Deposition system (EG1) it is necessary to complete the Corporate, site, and tool specific training. The training required for the operation of EG1 is listed below.

## **5.1 Corporate training**

CINT personnel shall complete the following Corporate-required training prior to unsupervised operation of EG1.

- All Corporate training specified in the *IL General OP*
- RAD102- Radiological Training

## **5.2 Operations training**

Operations documents are available on the IL Training website.

- *IL Ebeam OP (EG1)* (this document)

- Chapter 10- Radiation-Generating Devices (RGDs)

### **5.3 Tool Specific training**

Hands-on training provided by a Key Operator.

## **6. APPROVAL, NOTIFICATIONS, SCHEDULING**

After reading and signing all applicable OP's, finishing all associated training, and receiving the express permission from the Integration Lab manager the Authorized User will be issued a new Integration Lab badge indicating that they are allowed to use the mask aligners. They will then be given access to schedule the tool in the on-line tool calendar.

## **7. SAFETY PRECAUTIONS AND LIMITATIONS**

General safety precautions are addressed in the *IL General OP*, which is a prerequisite for all other IL training. The major hazards for operations covered in the *Ebeam Dep EG1 OP* are listed below.

### **7.1 Mechanical pinch hazards**

Any equipment that has moving parts will have some sort of pinch hazard. EG1 has several moving pieces, some of which move independently of manual operation. It is important to be alert when working near moving parts.

### **7.2 Electrical Shock**

Almost all pieces of cleanroom equipment contain components that could pose an electrical shock hazard, however most are set up in a way that non-maintenance use does not carry much inherent threat of shock. Only the CINT Key Operator(s) may open the tool or perform maintenance. However when working with components that have a shock risk ALWAYS first verify the system is turned off and unplug the system from the wall. After power has been turned off the user should verify that the system will not power up and that physical control of the electrical plug is maintained to prevent the tool from being energized during maintenance.

### **7.3 UV Burn Hazard**

Prolonged exposure to diffused reflection from the output beam or a few seconds of direct output beam exposure can cause skin burns or burns to the outer layer of the eye. As with any UV light source always wear UV filtered glasses to protect eyes and limit exposure to UV radiation. During normal operation there should never be direct UV exposure.

## **8. SYSTEM OPERATING PROCEDURES**

### **8.1 Reserve EG1**

On the sign-up sheet at system, enter your reserved block(s) of time, along with your initials. If you work off-site, call Catherine or John to request a reservation.

### **8.2 Load/Unload Samples & Pump Down**

1. Verify green "EG2↑" status sign is displayed. The red "EG2 ↓" sign indicates equipment is down.
2. Verify the "In Use, Do Not Vent" sign is not posted on belljar.  
If "In Use" sign is posted, confirm a) the actual time, and b) your reservation time. If another user has samples loaded during your reservation time, you may unload them; however, if time permits attempt to contact the user before doing so.
3. Verify CV8 Power Supply (red toggle switch on yellow/orange PS unit) is off.
4. Verify Ion Gauge power is off.
5. Press "Stop" on front panel. **WAIT** for hi-vac valve to close, about 7 seconds; hi-vac valve will hiss for a few seconds, then "clunk" when it closes.
6. Press "Vent" button on front panel and wait for chamber to reach atmosphere, about 5 minutes. When at atmosphere, roughing gauge displays  $1 \times 10^3$  MBar.
7. While chamber is venting, affix samples to a sample stage.

To minimize contamination, do not use Kapton tape, carbon tape or photoresist directly on the stage. Instead, attach sample(s) to a glass slide or scrap wafer with Kapton tape, carbon tape or photoresist (bake resist before loading in chamber). Then use metal clips to secure slide/wafer to stage. Contact equipment owner for guidance.

8. When chamber is at atmosphere, press and hold "Hoist Up" switch until belljar reaches upper limit switch (approximately level with upper shield).
9. Set loaded sample stage in holder.
10. Check Source Materials log. If needed, exchange material in position 6 and/or 5 for desired material(s). Visually inspect desired deposition materials; notify equipment owner if material needs to be replenished. Enter changes on the Source Materials log
11. Rotate turret to material to be deposited first.
12. Check Xtal life. If greater than ~30%, replace Xtal (contact equipment owner for training).
13. Verify shutter is closed
14. Press and hold "Hoist Down" switch until belljar reaches lower limit switch. If needed, stop hoist just before it touches the base flange and realign belljar.
15. Press "Stop" on front panel.
16. Press "Vacuum Start" button on front panel.

### **This is EG-1 system IDLE MODE**

17. Post "In Use, Do Not Vent" sign on belljar.
18. Enter run in log book.
19. When roughing gauge displays  $2.5 \times 10^{-2}$  MBar, auto pumpdown controller opens Hi-Vac valve, and after a few seconds, roughing gauge will drop to  $0.0 \times 10^{-3}$  MBar.
20. When roughing gauge drops to  $0.0 \times 10^{-3}$  MBar, turn on Ion Gauge (lower half of equip rack).
21. While chamber is pumping, load your floppy disc into the IC/5 Deposition Controller and select/edit the desired Process.

### **8.3 Ebeam Deposition**

1. For standard depositions, pump chamber to  $1.0 \times 10^{-6}$  Torr or better; about 1 hour.  
For cleaner films, pump to the mid  $10^{-7}$  range; for quick-n-dirty films, pump to  $3.0 \times 10^{-6}$  Torr (not recommended for Aluminum).
2. Enter Time and Pressure in log book.
3. Confirm shutter is closed.
4. Remove "In Use, Do Not Vent" sign on belljar.
5. Turn on CV8 Power Supply (red toggle switch on yellow/orange PS unit); CV-8 control panel in equipment rack will light.
6. Turn on key (left side of equip rack).
7. Press red HV On button. Gauge will display ~10KEV. Do not adjust.
8. Press red Gun 1 Filament On button. Note that amperage on the analog gauge will not be apparent until the IC/5 Deposition Controller increases power to ~5%.
9. On the IC/5 Deposition Controller, press "Start".
10. Press F1 to Zero the thickness monitor.  
The IC/5 Soak settings need to be manually adjusted (steps ). When dep rate stabilizes in Deposit, IC/5 is returned to Auto (step ?). In Ramp/Soak modes, IC/5 controls power; in Deposit it controls deposition rate.
11. At the Soak 1 step, select F3 Manual (to right of IC/5 screen)
12. Use hand-held controller to adjust Emission current so that beam is visible in mirror, and deposition rate is 0.2 A/sec or less. If beam is not visible, increase Emission current; if deposition rate is greater than 0.2 A/sec, reduce Emission current.  
Check deposition rate every 10-15 seconds during steps 12-13. Rate often increased rapidly.
13. Adjust the Lat/Long settings for Beam Position, Beam Sweep (amplitude), and Frequency. For most materials, center beam and scan over the center 1/3 to 1/2 of the crucible. For Chrome or other chunks, sweep beam over 2-3 adjacent chunks.
14. When beam is aligned, manually increase power to nominal dep rate.
15. **Zero** thickness monitor.
16. **Immediately** press F3 to toggle back to Auto control. Deposition will begin; however shutter is still closed.
17. **Leave shutter closed** until deposition rate stabilizes. Watch the film thickness and re-zero if it approaches your target thickness, as IC/5 will turn the gun off when target is reached.
18. When rate has stabilized, simultaneously re-zero thickness and open shutter.  
To stop soaks or deposition, press Stop (upper right of IC/5), then either Start to restart that layer, or Reset to abort the process.

19. When target thickness is reached, close shutter.
20. Press white Gun 1 Filament Off button (some current flows even when IC/5 is set at 0% power).
21. If depositions are complete, go to step 23.
22. To deposit another film,
  - a. Wait for crucible to cool to a dull red.
  - b. Slowly (3-5 sec per pocket) rotate turret to desired material.
  - c. Go to step 8 of EBEAM DEPOSITION.
23. When depositions are complete, turn off white HV Off button.
24. Turn key to Off.
25. Allow chamber to cool for 10 minutes.
26. Turn off CV8 Power Supply (red toggle switch on yellow/orange PS unit); CV-8 equipment panel lights will go out.
27. Turn off Ion Gauge (lower half of equip rack).
28. Follow steps 3-16 of LOAD/UNLOAD SAMPLES & PUMPDOWN.





Equipment Rack

Hand-held controller

IC/5 Controller

Ebeam Lat/Long

IC/5 Controller

Ion Gauge

System Status Sign

Front Panel

EG2

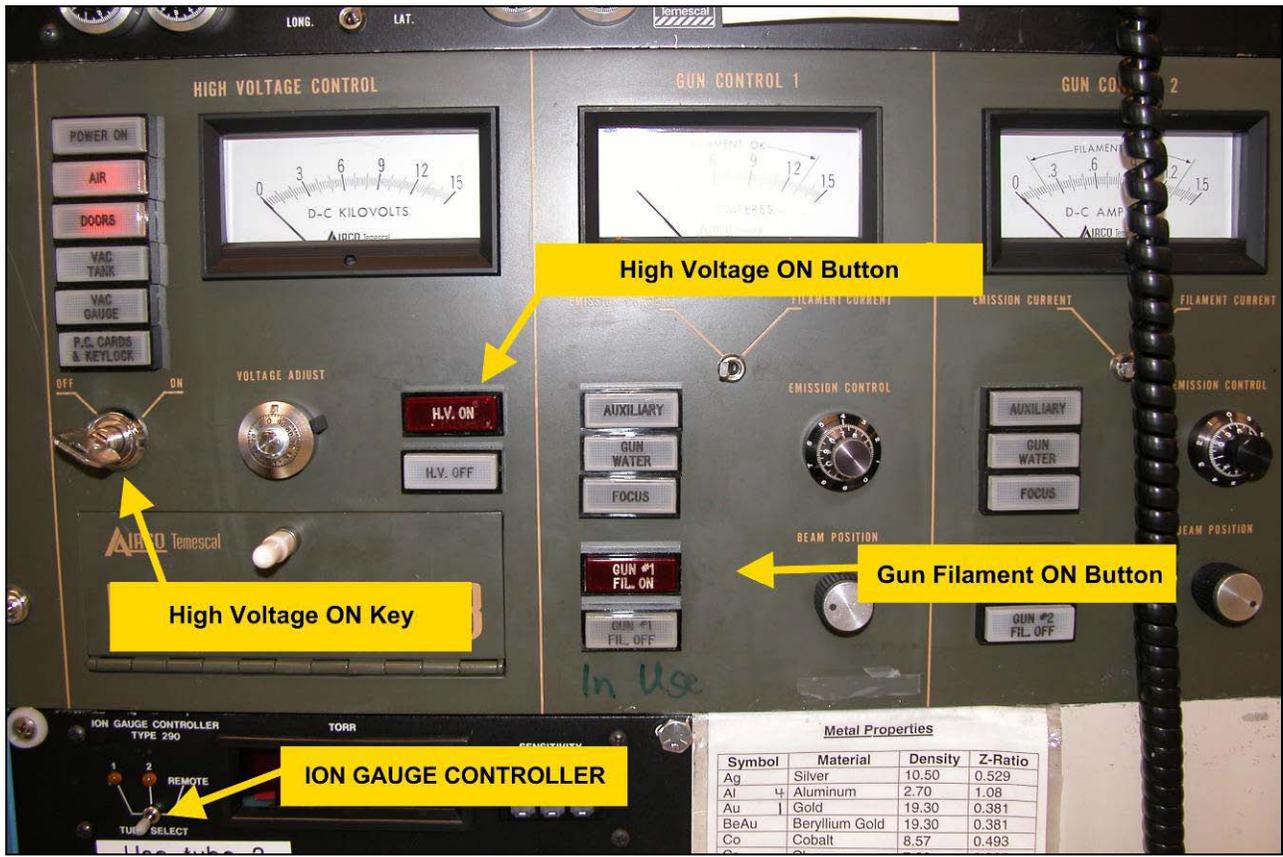
DANGER  
HIGH VOLTAGE

CAUTION  
HIGH VOLTAGE  
WILL DISCHARGE

MODEL CV-8

DANGER  
HIGH VOLTAGE

EVE



## 9. SYSTEM MAINTENANCE PROCEDURES

Most maintenance must be done by a Key Operator; however, Authorized Users who have received hands on training from a Key Operator may perform the following two procedures:

- Change or refill sources
- Crystal replacement

### 9.1 Change or Refill Sources

#### 9.1.1 Change Source Material

Source materials are stored in the top shelf of the yellow EG1 drybox. Some source materials are used with a crucible liner; always use liner if one is provided.

1. Vent and open chamber (section 8.2, steps 1-8, or steps 1-11 if loading a sample).
2. Check Source Materials log and note which materials need to be exchanged. When possible, exchange materials in positions 6 and/or 5.
3. Rotate turret to expose affected pocket.
4. Remove un-needed material/liner from the turret pocket and transfer to storage container.
5. Replace with desired material/liner.
6. Repeat steps 3-4 if additional material needs to be exchanged.
7. Update Source Materials log with new material(s).
8. Close chamber and pump down (section 8.2, steps 12-16)
9. Visually inspect desired deposition materials; notify equipment owner if material needs to be replenished. Enter changes on the Source Materials log
10. Rotate turret to material to be deposited first.

