

Standard Operating Manual

AST Peva-450I E-Beam Evaporation System

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1. Picture and Location

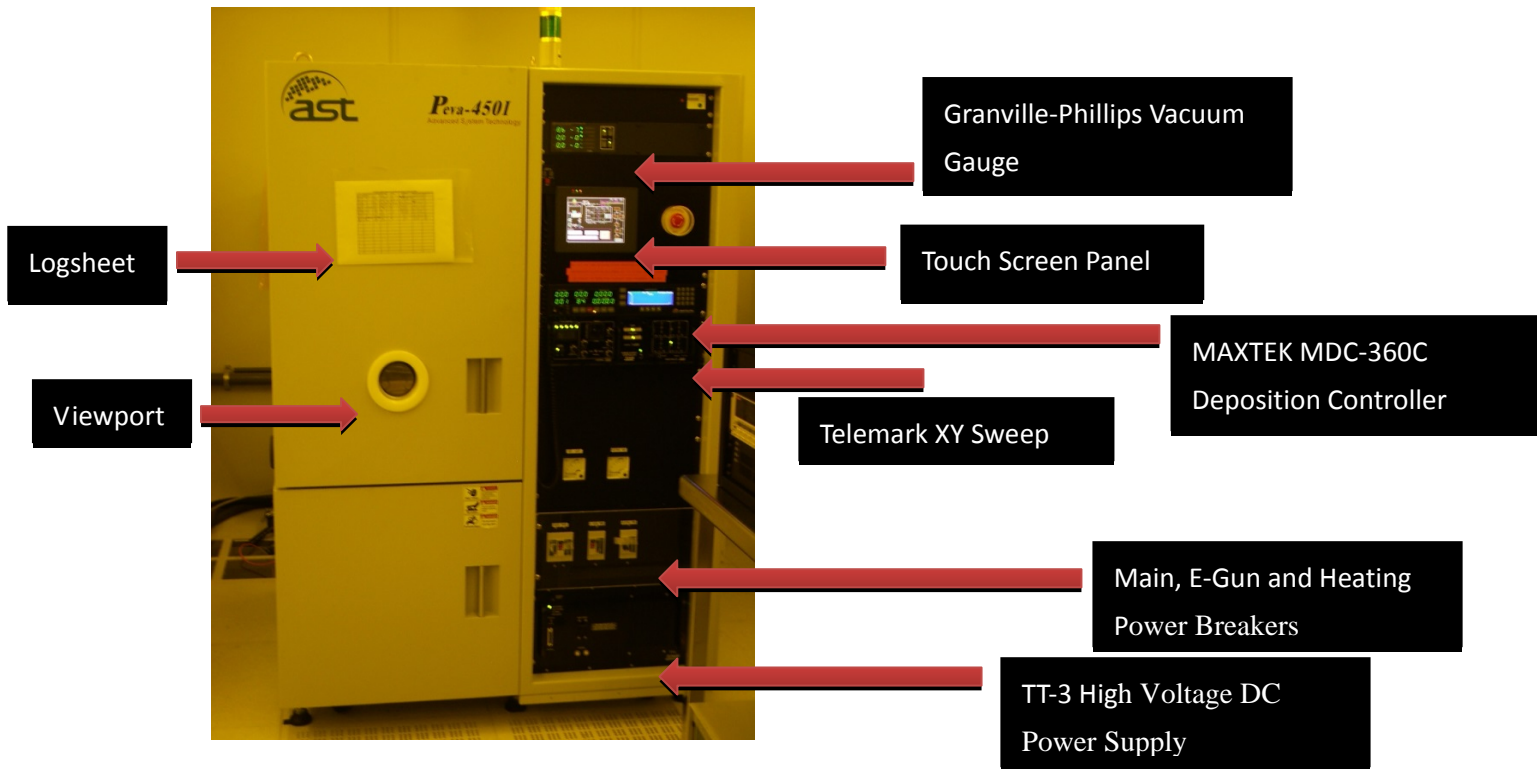


Fig 1: AST Peva-450I E-Beam Evaporation System

This tool is located at NFF Enterprise Center Cleanroom Room 4162

2. Process Capabilities

2.1 Cleanliness Standard

AST Peva-450I E-Beam Evaporation System is “Non-Standard” equipment for metal evaporation process use.

2.2 Available Deposition Materials

The following sources are available in AST Peva-450I E-Beam Evaporation System.

AST Peva-450I: Al, Ti, Ni and Au

NOTE: Consult a NFF EC staff member prior to do new materials other than above listed materials.

Hazardous or **Radioactive** materials are not allowed to be deposited in AST Peva-450I.

2.3 Performance of the AST Peva-450I E-Beam Evaporation System

What the AST Peva-450I CAN do

- It can provide thin films (**≤3000Å thick**) of various metal and semi-conductors with precision measurement of film thickness via crystal monitoring.
- It provides very directional evaporation particularly useful for lift-off metal patterning.
- It has a single vacuum chamber for **METAL** evaporation processes.
- Deposition on up to 2” and 4” wafers at once.
- Deposition on pieces, which are fixed to a 2” or 4” dummy via HB 836 Anti-static polyimide film silicone adhesive tape.
- Deposition rate is fixed on 1Å/s.

What the AST Peva-450I CANNOT do

- Thick film deposition is not allowed because of too long processing time, wear on the system, expense of materials, and adhesion issues with your sample.
- Evaporation of dielectrics is not allowed.

3. Contact List and How to Become a User

3.1 Emergency Responses and Communications

- Security Control Center: 2358-8999 (24hr) & 2358-6565 (24hr)
- Safety Officer: Mr. Wing Leong CHUNG 2358-7211 & 64406238
- Deputy Safety Officer: Mr. Man Wai LEE 2358-7900 & 9621-7708
- NFF EC Technician: Mr. Peter Yiu Cheong PUN 2358-7225 & 2358-7218
- NFF Phase 2 Technician: Mr. Wilson Pui Keung YIP 2358-7894

3.2 Training to Become a Qualified AST Peva-450I User

Please follow the procedure below to become a qualified user of the AST Peva-450I.

1. Read all materials on the NFF website concerning the AST Peva-450I.
2. Send an e-mail to NFF requesting AST Peva-450I safety operation training.
Scheduling can take up to several weeks due to the many requests coming in for this tool.

4. Operating Procedures

4.1 System Description

AST Peva-450I is consisted of a single vacuum chamber for METAL evaporation processes that use an electron beam to heat the metal sources. There are 4-pocket E-Beam evaporator used for depositing Ti, Al, Au and Ni. The materials are put into crucible liners for better heat uniformity throughout the source material and to allow

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for easy removal and refilling. Wafers are loaded on a rotating planetary and pumped to below $1.0\text{e-}7$ Torr using a cryopump. Pump down time is typically 30 minutes for base pressure $3.0\text{e-}6$ Torr. Deposition thickness is controlled via a crystal monitor. The evaporator has three distinct sub-systems: the vacuum system, the deposition thickness control & monitoring, and electron-gun control. AST Peva-450I has three control consoles:

1. Master console, Touch Screen Panel – AST Peva-450I Touch Screen Panel on the front side.
2. MAXTEK MDC-360C Deposition Controller - in the middle side, with a backlit LCD screen.
3. TELEMAR TT-3 control - power supply (below the “MAIN PWR”, “E-GUN PWR” and “HEATING PWR” breakers).



Fig 2: Touch Screen Panel – Menu

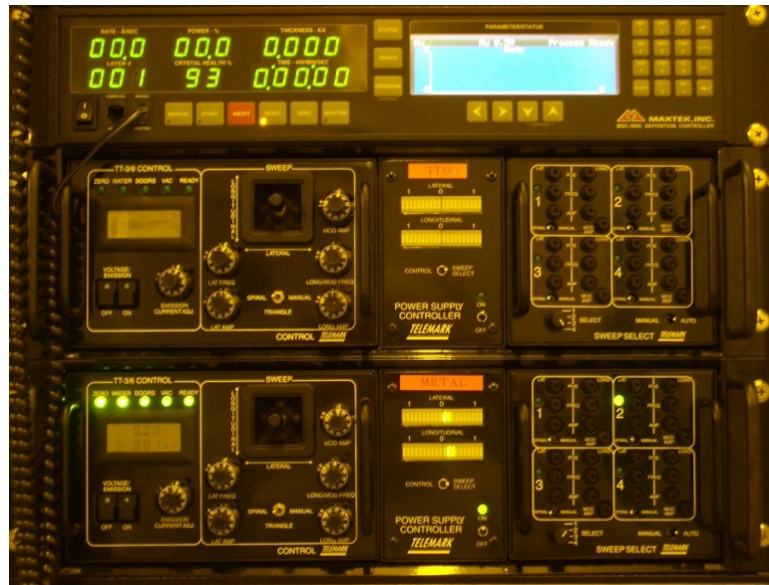


Fig 3: MAXTEK MDC-360C Deposition Controller



Fig 4: TELEMARK TT-3 High Voltage DC Power Supply

4.2 Safety Warnings

This equipment can cause injury if not used in a cautious manner.

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1. The operator can inhale particles while handling the chamber and is advised to cover the mouth or wear a protective respirator mask with fine filter.
2. The system can also be easily damaged if the electron beam is misplaced or is allowed to drift out of position.
3. Hot targets can cause burns.
4. While the amount of X-ray escaping the machine should be safe, we do not have current measurements of the level of exposure. Do not operate this machine if you could be pregnant.
5. Intense light will be emitted from the evaporation materials. Always use dark safety goggles when you look in the chamber.

4.3 Operation Rules

1. If an equipment failure while being used, never try to fix the problem by yourself. Please contact NFF staff.
2. Do not operate equipment unless you are properly trained and approved by NFF staff.
3. Do not leave an on-going experiment unattended.
4. Do not do the evaporation process over ten minutes per run.
5. Should be at least ten minutes for target cooling after evaporation process.
6. Do not change the e-beam focus of the system.

4.4 Initial system checks

1. Touch screen panel will show the equipment is under high vacuum mode due to “high vacuum valve, HV” and “cryopump, CP” are ON.
2. Chamber ion gauge pressure reads less than $1.0e-7$ Torr on the vacuum gauge

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controller, unless the system was recently used. (Chamber ion gauge reading is found on the Vacuum Gauge Controller.)

3. The cryopump temperature is 12K or less.
4. The chamber temperature is 20°C or less (reading is found on touch screen panel)
5. The crystal health is greater than 80%. (Readout on MAKTEK controller.)

4.5 Status checks

1. Check the NFF website for reservations, problems and to see if it is already enabled by another user.
2. Check for an EMPTY sign attached to the machine. Do not use if an IN USE sign or MAINTENANCE sign is there. Check for problem notes.
3. The system is available if the initial system and status checks are normal. Check-in the equipment and enable the system on NFF Machine Reservation System. Place sign “IN USE” on the machine.

4.6 Venting the chamber (before loading wafers)

1. Make sure TELEMAR TT-3 power supply main power is turned off.
2. Wait 10 minutes for cooling after evaporation process.
3. Press the “VENT” button on the touch screen panel.
4. Wait until the 307 Granville-Phillips Vacuum Gauge Controller is displayed $7.6e+2$ Torr (about 4 minutes).
5. Verify the main chamber door seal has decompressed.
6. The chamber door can be opened.

4.7 Inspecting the chamber before use

1. Inspect the planetary for any “real” wafers belonging to other users. If any are found, keep them in a labeled box.
2. Press “SH1” button on touch screen panel for shutter open.
3. Press “POCKET” button to entry E-Gun Pocket Control page and toggle yellow button “OFF/ON” for crucible select and verify each source is sufficient for process.
4. During toggle “OFF/ON” button to rotate the crucible to each position and inspect for splattering, contamination, cracking or other problems. Be sure the crucible assembly rotates freely. Don’t use crucibles in poor condition. Report any problems to NFF staff.
5. Inspect the chamber for peeling, particles, and material splatters. Vacuum and wipe if necessary. Thorough cleaning of the equipment every time will aid in reproducible results long term.
6. Make sure the view port is clear, if not; please clean it firstly before close the chamber door.
7. Load source into the correct crucible position posted on the front of the control panel. NOTE: some materials are allowed in multiple crucibles. Making sure they are clean and fit with the correct height and shape (snug not tight). Correct height would be 60% to 100% of the crucibles original Height or original weight.
8. If more pellets are needed, be careful not to overfill. Pellets must not protrude above crucible or Hearth may get stuck or jam.
9. Return the shutter to the closed position.
10. If a new crystal monitor is needed (80% or less), change it now.

11. Press “ABORT” button and replace a new crystal
12. Press “RESET” for verify crystal health is achieved to 98-99%

Single Vacuum Chamber	
Source Material	Correct Crucible
Al	C1
Ti	C2
Ni	C3
Au	C4

4.8 Load wafers

1. Load samples on to wafer holders or wafers face down on the planetary. The outer circle of planetary is recommended for better uniformity.
2. To verify thickness load a bare Si wafer with a mask partially covering it for a step height thickness monitor. The mask can be a partial wafer or Anti-static polyimide film silicone adhesive tape.
3. Last chance to check you put inside samples and change crystal.

4.9 Pump down

1. When finish your samples load, close the chamber door and it will automatically start to pump down.
2. **DON'T GO AWAY YET!**
3. Monitor the pump down to be sure the chamber door was correctly closed:
 - a. Verify that the roughing pump and roughing valve turn on within

10-20 seconds.

- b. Wait for the pressure to drop to the crossover pressure, i.e. for the cryopump to take over at about 150 mTorr. This will take 5 minutes
4. Typically around one hour for the chamber to pump down to about $9.0e-7$ Torr or below.

4.10 Deposition

On the MAXTEK MDC-360C Deposition Controller console:

1. Power “ON” deposition controller.
2. Press “ABORT” and “RESET” for clear previous user’s process record.
3. Select “VIEW/EDIT PROCESS” and entry to make your process for E-Beam process.
4. The material library is located in “VIEW/EDIT MATERIAL”, we do not open to public for modify and with a password for protection.
5. Select correct process number (available process number 2 for Au, 3 for Ti, 4 for Al and 6 for Ni, 1, 5, 7-8 are empty).
6. Set deposition thickness (e.g. key 1.234 = 1234A)
7. Deposition Rate is fixed on 1A/s.
8. Check that the correct parameters (e.g. process number & name [=NOTE column], thickness and material) are displayed at the top of the screen.
9. Back to “MAIN MENU” by “<-“button in Arrow Keys.

On TELEMARK TT-3 control console:

10. Power “ON” the E-GUN PWR breaker for TT-3 supply.
11. Press TELEMARK TT-3 power supply, Main Power breaker “ON”.
12. Wait 5 minutes for (cut back) fans to spin up and stop flashing.

On TELEMARK sweep power supply:

13. Verify sweep controller power supply green light is on.
14. Make sure 5 interlocks green lights are on, e.g. Zero, Water, Doors, VAC and Ready.
15. Switch CONTROL/SWEEP SELECT switch to “SWEEP SELECT” and “AUTO” position.
16. Switch POWER SUPPLY CONTROLLER switch to “ON” position.
17. JOYSTICK/SWEEP CONTROL BOX: spiral/triangle/manual, switch to “spiral”.
18. Pre-center E-Beam position using the “fine tune” button for position adjustment and readouts from the LAT/LONG position.

On the master console touch screen panel:

19. Press “BACK” button to return “Menu” page.
20. Select “RECIPE” button.
21. Press “↑” or “↓” buttons for “RECIPE NUMBER” and “RECIPE NAME” columns selection.
22. Make sure “PROCESS” number column is equivalent to “RECIPE

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NUMBER” of MAXTEK MDC-360C Deposition Controller.

23. Press “LOAD” for recipe load.
 24. Press “BACK” button to return “Menu” page.
 25. Select “PROCESS” button to return “Process” page.
 26. Check that the base pressure is about 3.0×10^{-6} Torr or below. Record the pump down time, pressure and your deposition thickness in the logsheet.
 27. Press “START” button for E-Beam process start.
 28. Observe the electron beam each time the power is increased and adjust the position as necessary using the “LAT/LONG POS” in the SWEEP SELECT.
 29. Verify that the E-Beam is directed into the center of the crucible.
- IMPORTANT!**
30. Don't let the E-Beam go outside the source area and ruin the crucible!
 31. Check that the rate of deposition is normal for the power applied (In general, deposition power is not over 40%). If not, Press “STOP” button to stop running process immediately, please contact to NFF staff.

On the MAXTEK MDC-360C Deposition Controller console:

32. When process is started, be sure that the DC amps gauge does not exceed 0.4A.
33. Check that the Kilovolts meter reads at -6.82kV, not exceed -7kV.
34. If so, press “STOP” button in “Touch Screen Panel”
35. Report these problems to NFF staff.

On the master console touch screen panel:

36. To deposit another type of material let the crucible cool for 5-10 minutes.

37. Rotate to the new crucible. Follow instructions starting at Step 1 in the “Deposition” section.
38. Selected correct crucible, it may take a moment to rotate. See position/material list posted on E-Gun Pocket Control page.
39. If finish the process, make sure wait at least 10 minutes for all materials firstly, this cools the targets before venting, which prevents oxidizing them.
40. Press TELEMARк TT-3 power supply, **Main Power** breaker “OFF”.
41. **DO NOT VENT UNTIL COOLED FOR 10 MINUTES.**

4.11 Venting and unloading

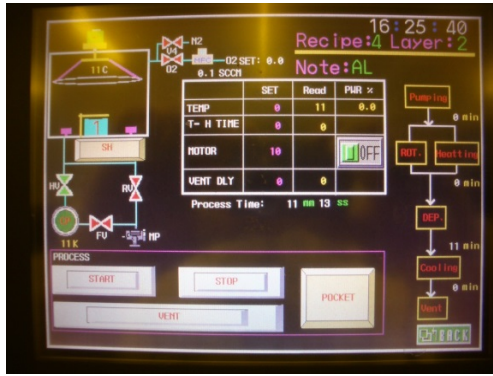

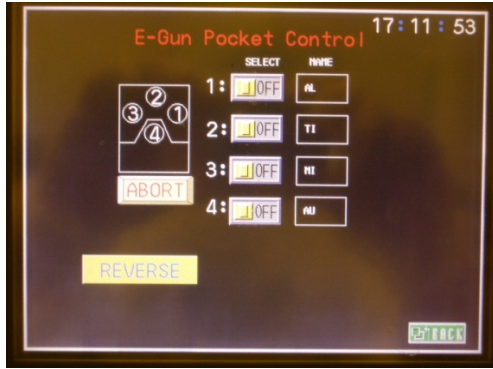

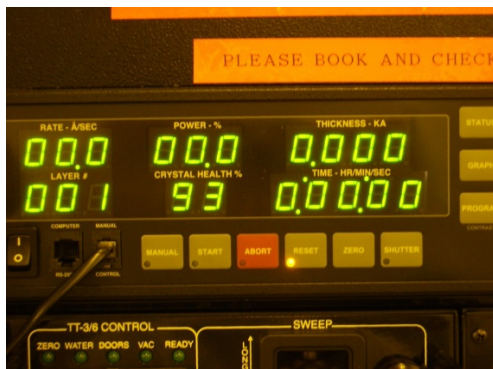

1. Make sure TELEMARк TT-3 power supply main power is turned off.
2. Wait 10 minutes for cooling after evaporation process.
3. Press the “VENT” button on the touch screen panel.
4. Wait until the 307 Granville-Phillips Vacuum Gauge Controller is displayed $7.6e+2$ Torr (about 10 minutes).
5. Verify the main chamber door seal has decompressed.
6. The chamber door can be opened.
7. Remove wafers and inspect visually. You’ll be responsible if damage has occurred and you didn’t report it.
8. Put the Al dummy back to substrate holder.
9. Perform the required crucible, shutter, and chamber inspections and clean as per previous instructions.
10. If process finish, please check-out the equipment and disable the system on

NFF Machine Reservation System. Place sign “EMPTY” on the machine.







4.12 Pump down and shutdown

1. When finish samples unloading, close the chamber door and it will automatically start to pump down.
2. **DON'T GO AWAY YET!**
3. Monitor the pump down to be sure the chamber door was correctly closed:
 - a. Verify that the roughing pump and roughing valve turn on within 10-20 seconds.
 - b. Wait for the pressure to drop to the crossover pressure, i.e. for the cryopump to take over at about 150 mTorr. This will take 5 minutes.
4. **RECORD RESULTS** in the logbook.
5. Be sure the crossover pressure is met and that the cryopump valve opened.
6. Clean up the area and return items to their proper locations.
7. Place an **EMPTY** sign on the machine.
8. Write down any problems or comments in the logbook.

Appendix

 <p>The image shows a touch screen interface for a process. At the top, it displays '16:25:40' and 'Recipe: 4 Layer: 2'. Below this is a 'Note: AL'. A central table shows parameters: TEMP (SET: 0, Read: 11, PAR: 0.0), T-H TIME (0, 0), ROTOR (10), and VENT DLY (0, 0). A 'Process Time' of '11 min 19 ss' is shown. At the bottom, there are 'START', 'STOP', and 'POCKET' buttons, along with a 'VENT' button.</p>	 <p>The image shows a touch screen interface for process number selection. It displays '2' and 'NOTE:'. Below is a table with columns for 'BASE' and 'Layer1' through 'Layer9'. The 'BASE' column has values: 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0. The 'Pre-Rotary' row has a '0'. The 'Rotary' row has '0' in all layer columns. The 'TEMP' row has '20'. The 'T-H TIME' row has '0'. The 'AUTO VENT' row has '0'. The 'VENT DLY' row has '0'. The 'Process' row has '1'. The 'Process TEMP' row has '0'.</p>
<p>Touch Screen Panel – Start, Stop and Vent buttons</p>	<p>Touch Screen Panel – Process Number Selection</p>
 <p>The image shows a touch screen interface for 'E-Gun Pocket Control'. It displays '17:11:53'. There are four 'SELECT' buttons labeled 1, 2, 3, and 4, each with a 'T1' or 'T2' label and a 'T1' or 'T2' label. There are also 'ABORT' and 'REVERSE' buttons. A 'SELECT' button is also present.</p>	 <p>The image shows three electrical breaker panels. The left panel is labeled 'MAIN PWR', the middle panel is labeled 'E-GUN PWR', and the right panel is labeled 'HEATING PWR'. Each panel has a yellow cover and a red emergency stop button.</p>
<p>Touch Screen Panel – E-GUN Pocket Control</p>	<p>MAIN PWR, E-GUN PWR and HEATING PWR Breakers</p>
 <p>The image shows a control panel for the MDC360C. It features several digital displays: 'RATE - Å/SEC' (000), 'POWER - %' (000), 'THICKNESS - Å' (0.000), 'LAYER #' (001), 'CRYSTAL HEALTH %' (93), and 'TIME - HR:MIN:SEC' (00:00:00). There are buttons for 'START', 'ABORT', 'RESET', 'ZERO', and 'SHUTTER'. A 'TT-3/6 CONTROL' section has 'ZERO', 'WATER', 'DOORS', 'VAC', and 'READY' indicators.</p>	 <p>The image shows a control panel for the MDC-360C. It features a digital display showing 'Au 0.5Å Rate' and 'Process Ready'. Below the display is a keypad with numbers 1-9, 0, and function keys. The text 'THIS MACHINE' is displayed at the top. The 'MAXTEK, INC. MDC-360C DEPOSITION CONTROLLER' logo is visible at the bottom.</p>
<p>MDC360C – Deposition Rate, Power, Thickness and Process Time Parameters</p>	<p>MDC-360C – Alpha and Number Keypad</p>

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<p>TT-3 Control – Interlocks</p>	<p>TT-3 Control – XY Sweep (Long and Lat)</p>																																
																																	
<p>MDC-360C – Main Menu</p>	<p>MDC-360C – Select Process</p>																																
 <table border="1"> <thead> <tr> <th>Process Name</th> <th>Layer#</th> <th>Thick</th> <th>Material</th> </tr> </thead> <tbody> <tr> <td>Au</td> <td>001</td> <td>0.060</td> <td>Au 0.5A</td> </tr> <tr> <td>View/run</td> <td>0000</td> <td>0.000</td> <td>end Layer</td> </tr> <tr> <td>Edit</td> <td>0000</td> <td>0.000</td> <td>end Layer</td> </tr> <tr> <td></td> <td>004</td> <td>0.000</td> <td>end Layer</td> </tr> <tr> <td></td> <td>005</td> <td>0.000</td> <td>end Layer</td> </tr> <tr> <td></td> <td>006</td> <td>0.000</td> <td>end Layer</td> </tr> <tr> <td></td> <td>007</td> <td>0.000</td> <td>end Layer</td> </tr> </tbody> </table>	Process Name	Layer#	Thick	Material	Au	001	0.060	Au 0.5A	View/run	0000	0.000	end Layer	Edit	0000	0.000	end Layer		004	0.000	end Layer		005	0.000	end Layer		006	0.000	end Layer		007	0.000	end Layer	
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<p>MDC-360C – Material and Thickness Input</p>	<p>MDC-360C – Display, e.g. Deposition Rate, Power, Thickness, etc...</p>																																