

國立臺灣大學奈米機電系統研究中心 Nano-Electro-Mechanical-Systems (NEMS) Research



E-Beam Evaporator User Manual



Manufacturer: Kao Duen Technology Instrument: E-Beam Evaporator Location: 2F Clean Room, PVD Bay, Complex for Research Excellence Contact: 02-3366-5064; <u>nemstech@mail.nems.ntu.edu.tw</u> Author: Yu-Ta Chen / Gou-Sheng Lyu Version: 1.0 (Nov 2023)



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- 1 Usage Restrictions
 - Only trained and certified users are permitted to operate this equipment.
 - Please bring your own target material and crucible. Crucible dimensions: Top diameter 3.7 cm, bottom diameter 2.8 cm, height 1.75 cm, wall thickness 0.35 cm, bottom thickness 1 cm.
 - For coatings exceeding 7500Å, please bring your own quartz oscillator.
- 1.1 Material Restrictions
 - The center has two e-beam evaporators for reservation, one dedicated to metals and the other for oxides. Please reserve the tool accordingly.
- 2 Pre-Use Checklist

□Process cooling water pressure> 2 kg/cm²

Compressor pressure at 1.5~2 Mpa

Ensure electron gun power is in the off state (refer to 3.4)

After Check-In,

□Ensure all status indicators are green

Check the health status of the film thickness monitor>65%

Tilt angle at 17 degrees (refer to 3.5.1)



Figure 1 Operation Interface





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- 3 Equipment Operation Procedures
- 3.1 Venting Chamber
 - Turn off MV
 - Open VV, introduce nitrogen, vent vacuum, countdown for 10 seconds
 - The vacuum gauge next to the chamber goes from -100 and starts counting to 0.
 - When the count-up ends, the chamber door can be opened.
 - After opening the door, use the vacuum cleaner to clean the interior of the chamber and the surrounding rubber strips to ensure no particles that might affect the vacuum level.



Figure 2 Venting Procedure

- 3.2 Loading Target Material Crucible and Samples
 - Click on Pocket/Sweep to select the appropriate target position (refer to 3.5.2), place the crucible filled up to 80%, ensure no debris in the groove before insertion to avoid affecting the rotation and cooling of the crucible.
 - When loading samples, if they are pieces, securely attach them to the dummy wafer with PI tape.
 - After loading the sample, please open Angle Adjust (refer to 3.5.1), set the rotational speed and angle, and test it to ensure the sample does not fall off.
 - Confirm the reflection of the target mirror is clear and visible.



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Figure 3 Schematic of Chamber Internal

- 3.3 Evacuating Vacuum
 - First, ensure there are no other unnecessary objects inside the chamber.
 - Door Puller → ON (Be careful not to get your hand caught; it's painful!!)
 - Auto Pumping \rightarrow ON
 - Vacuuming takes approximately 20 to 30 minutes. When the pressure reaches 5 x 10⁻² Torr, the RV closes, and the MV opens, achieving a minimum pressure of approximately~10⁻⁶ Torr
- 3.4 Turning On E-beam Control Power



Figure 4 Turning on TT Power Supply

3.



Figure 5 Turning on TT Controller Power

- Sequentially turn on TT POWER SUPPLY 1. CONTROL → 2. HIGH VOLTAGE
- Turn on TT CONTROLLER 3. CONTROLL POWER
- 3.5 Parameter Settings

3.5.1 Speed Setting



Figure 6 Speed Setting

- Set the speed according to process requirements. The center recommends a speed range of 5 to 15 rpm.
- Set the angle range from 0° ~30°, default to 17°.
- Remember to turn on Rotary before start





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3.5.2 Dep-Material Setting

Control Recipe Para- Record Annance Control Alarm Exit Message								
			nunce j setup j	Board				
Pocket/Sweep			Deposition Controller Load Film			Curve		
Pocket		Sweep	E Au		X beal	Curre		
Pocket1	Other	⊙ 1.Sweep1	⊐1.Al			E-Gun		
Pocket2	Ni	○ 2.Sweep2	-2.Ti 3.BB		KA	Pocket/ Sweep		
Pocket3	Cr	0 4.Sweep4	4.Cr 5.Au		sec	Heater		
Pocket4	Au		6.Cu		sec	Treater		
Pocket5	Ag		8.	~	70	Angle Adjust		
Pocket6	AL		Max PWR Dwell	1:00 MM:SS		Process		
			Crystal Fail Mode	1:Time Power				
			Xtal Stability	0	Dep-			
			Xtal Life Bounds	0.0		Controller		
		Sweep	Polt Vertical Scale			Den Film		
Auto Pumpir	ng	- 🝟 🔒	Polt Horizontal	100		Depainin		
		A MV	Date Plot Type	0:Rate	1	Load		
ON		T 1	SS-MAP	1		Dep-Film		
			Pocket	4				
		CP	Tooling1	65.0	%			
			Tooling2	100.0 %				
		TIK FV	* Sensor 1					
		Normal B						
		B: 3.8E-04 Torr						

Figure 7 Setting Target Material

Load Dep-Film →Select the target material from the drop-down menu
→Ensure the Pocket number matches the Pocket material

3.5.3 Deposition Parameter Setting

Depoition Controller Film Edit			Depoition Controller Film Edit					
Film: X					Film:			X
	Value	Unit	^	Π		Value	Unit	^
▶ Name	5.Au				Rate Ramp Tigger	0.000	KA	
Density	19.30	GM/CC			P	30		
Z-Factor	0.381				j l	1.0	sec	
Setpoint THK LIM	0.000	KA			D	0.0	sec	
Final Thickness	2.000	KA			Max PWR	40.0	%	
Setpoint Time LIM	0:00	MM:SS			Abort Max PWR SW	0:OFF		
Soak1 PWR Value	7.5	%			Max PWR Dwell	1:00	MM:SS	
PWR Ramp1 Time	0:30	MM:SS			Crystal Fail Mode	1:Time Power		
PWR Soak1 Time	1:00	MM:SS		4	Ctl Loop Qual	0		
Soak2 PWR Value	8.0	%	-		Xtal Stability	0		
PWR Ramp2 Time	0:30	MM:SS		I	Xtal Life Bounds	0.0		
PWR Soak2 Time	1:30	MM:SS			Polt Vertical Scale	1:5		
Soak3 PWR Value	0.0	%			Polt Horizontal Scale:	100		
PWR Ramp3 Time	0:10	MM:SS			Date Plot Type	0:Rate		
Rate	0.1	A/sec			SS-MAP	1		
Rate Ramp Mode	0:OFF				Pocket	4		
New Rate	0.0	A/sec			Tooling1	65.0	%	
Rate Ramp Time	0:00	MM:SS			Tooling2	100.0	%	
Rate Ramp Tigger	0.000	KA			* Sensor	1		

Figure 8 Coating Parameter Setting



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- Click Dep-film , enter Final Thickness (K Å), Rate(Å /sec), and ensure the pocket number matches the pocket material.
- When adjusting the deposition rate (Rate(Å/sec)), to maintain good film adhesion, the center recommends the initial rate of 0.1 Å/sec for the first 100 Å, gradually increasing for every 100 Å as needed, but not exceeding 1 Å/sec.

3.6 Deposition

🔀 Control 📰 Recipe	Para- meter 2 Record	d 🎢 Main- tenance	Setup Alarm Exit	Message Board		
Denoition Controller Film Edit						
Film		Curve				
FIUL	la esta de la composición de	_	CG: 7.9E-07 Torr E-GUN Interlock			
	Value	Unit		E-Gun		
Name	5 Au		E-Gun	D L M		
Density	19.30	GM/CC	X	Sweep		
Z-Hactor	0.381	-	HV Control Source Control			
Setnoint THK LM	0.000	KA	0 <u>.5 KV 34 mA</u>	Heater		
Final Thickness	2.000	KA				
Setpoint Time LIM	0:00	MM:SS	OFF ON OFF ON	Angle		
Soak1 PWR Value	1.5	%		Aajusi		
PWR Ramp1 Time	0:30	MM:SS		Process		
PWR Soak1 Time	1:00	MM:SS	Deposition Controller	Trocess		
Soak2 PWR Value	8.0	%	Pup Statuc Matorial X	Den-		
PWR Ramp2 Time	0:30	MM:SS	Manual 5.Au	Controller		
PWR Soak2 Time	1:30	MM:SS	p Bate Alege Bower % Thickness A			
Soak3 PWR Value	0.0	%	0.0 4.5 0	Dep-Film		
PWR Ramp3 Time	0.10	MMISS	Health-% Time-H:M:S			
Rate	0.1	A/sec	94 66:9	Load Den Film		
Rate Ramp Mode	0:OFF		Manual Chart Stop Zoro	Depirini		
New Rate	0.0	A/sec	Widhuan Statt Stop Zero			
Rate Ramp Time	0:00	MM:SS				
Rate Ramp Tigger	0.000	KA	v			
	11 K	1 1				
	Normal B					
	B: 3.8E-04	Forr				

Figure 9 Coating Control Window

- Before starting the coating, turn on Dep-Film, Dep-Controller, E-gun controller
- E-gun Sequentially turn on 1. HV Control $\mathbb{P} \rightarrow ON$, 2. Source Control $\rightarrow ON$
- Dep-Film Set the deposition rate and the final thickness
- Dep-Controller Press Start ; the process starts and switches to Idle mode when the final thickness is reached.
- Sequentially turn off E-gun [→] 1. Source Control → OFF [→] 2. HV Control → OFF
- For subsequent layers, repeat steps 3.5.2 to 3.5.4, load the pre-coating material, set parameters, and turn on the E-gun.



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• Upon completing the coating, lower the temperature appropriately, close MV, open VV to break the chamber.

Note: If the QCM health is less than 65%, please inform the staff.

- 3.7 Unloading samples and chamber pump down
 - Vent the chamber vent (refer to 3.1) →Unload the samples, crucible (refer to 3.2) →Use a vacuum cleaner to clean the chamber, target holder, and rubber seals.
 - Click Door Puller (be careful not to get your hand caught; it's painful!!) → Auto Pumping ON
- 4 Post-Use Check List

Check that all status indicators are green. If they haven't turned into MV after 30 minutes, please inform center personnel.

□Confirm E-beam control power is turned off as 3. CONTROLL POWER \rightarrow 2. HIGH VOLTAGE \rightarrow 1. CONTROL (refer to 3.4).

 \Box Ensure Angle Adjust is turned off and the angle is set back to 17° (refer to 3.5.1).

After all set, you can check out.

5 Version History

Version	Time	Author	Note
1.0	Nov, 2023	Yu-Ta Chen /	
		Gou-Sheng Lyu	