Sensors and Actuators
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Lecture – 55
System Demonstration for Physical Vapor Deposition

Hello. Welcome to this particular module. This module is really interesting; because if recall the last lab component. We were discussing each and every or most of the parts within the PVD system. And when we k about PVD we were king about thermal and E beam evaporation,

So this particular lab now we will show it to how to operate the system and coat a. We will use aluminum as an example it is easy to lt. And we will show it to that if you want to actually work in the lab. And want to coat a slide or a substrate with what is a procedure.

One with thermal evaporation and the second one with the E beam evaporation, please focus on this module this is one of my favorite modules. Because actually will be able to see how the system is in an operating mode and will see how the substrate is loaded where is the E beam.

And I cannot see E beam actually, but here is crucible and there are 4 crucibles and then there is a boat. how the chamber looks like. whatever we learn in theories one thing when we look something in the lab or we experienced that in the lab is a very different thing. I hope that like this particular module.

And any questions again are free to ask in a forum. I will request a few of my students to show it to along with we have called the engineer from indirect Mr. Rajanna. And he will show us how the system operates, but we can also operate independently. This is a very simple and easy system provided to understand the concept, ok. I will see you in so other class till then take care, bye.

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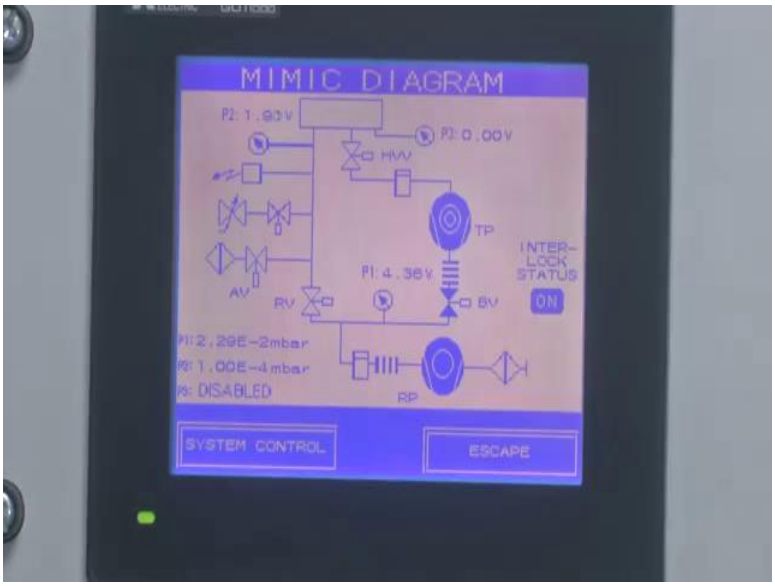
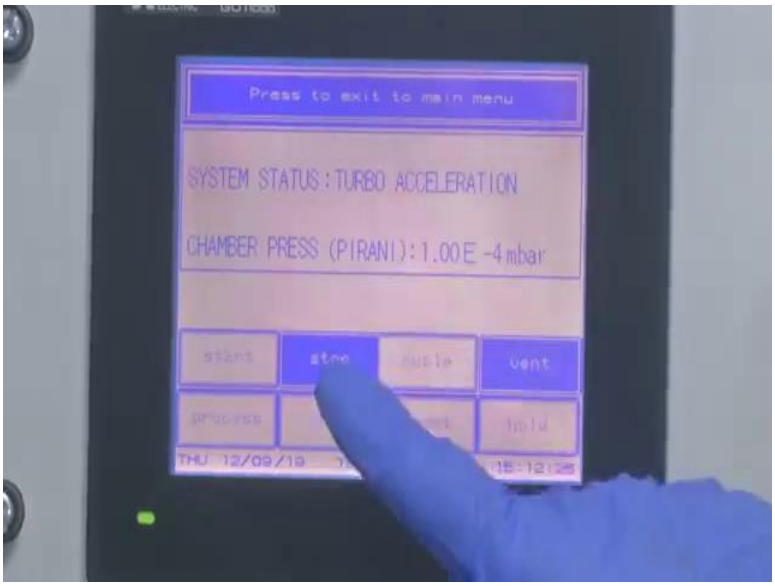
(Refer Slide Ti: 02:45)



This is the rotating pump indication. Now the rotating pump is in the blue condition it is there. Now it is on and this is for the baking valve. Now, baking also valves also open and this one is a turbopump. Then turbopump is also on. Now, the pump is acceleration; it will start now just wait for minutes to complex field achieving to a complex field. Now, know to wait 5 minutes.

Yes, 5 minutes (Refer Ti: 03:23).

(Refer Slide Ti: 03:24)



Now, we are going to mimic diagram. press to exit to the main nu.

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(Refer Slide Ti: 03:35)

Then press to system view, then press to mimic diagram. Now, what are the process we are going to on; it will show now, rotary pump baking valve and turbopump. when the turbopump full speed will achieve after that it will go to open the high vacuum. This is the automatic I an, once; only once put a start press the start that is all.

(Refer Slide Ti: 04:07)

So; now, turbopump is ready connection this now it is at full speed. now, press the cycle.

(Refer Slide Ti: 04:22)

Now, then it will go to now system status is cycle sequence by pumping, by pumping.

(Refer Ti: 04:31).

It will, it is in a high vacuum this chamber is in high vacuum condition now, it is in minus 5 levels. Now, it is in minus 5 level vacuum is there in process chamber r-process chamber. Now, the system is in a high vacuum level which is in minus 6. now, we are going to deposit the deposition and this is thermal first we have to go to do the thermal deposition. before that thermal deposition, is going to the IMO government.

IMO government and though are (Refer Ti: 05:05) substrate-level substrate. Substrate and the atmospheric moisture content or any gases deposited on r substrate know that is cleaning when are doing the IMO government. we are going to doing the IMO government before that press that process know went to IMO government press the process then press the seek.

Now, seek it is a vacuum is in minus 4 levels then admit that gas to the chamber. admit the gas in the to chamber through this needle valve slowly open the needle valve and observe the vacuum level where it shows, the vacuum level is kept minus 4 levels minus 4 level milli bar.

(Refer Ti: 06:11).

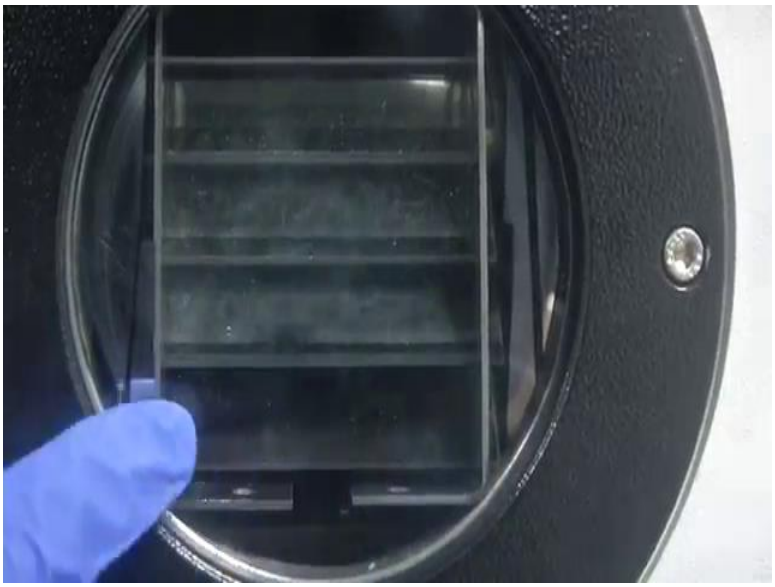
(Refer Ti: 06:21).

(Refer Ti: 06:28). Once switch on the h d, switch then switch on the circuit breaker.

Now, we are going to doing the IMO government, before that switch on the h d switch then switch on the circuit breaker. Then observe the current level, what we update current here that much of current display here. Slowly increase the HTLP control quad too and apply the current.

(Refer Ti: 07:02) pattern.

(Refer Slide Ti: 07:46)



h u that vacuum level is in minus 4 levels minus 4 millibar. observe the process inside the process chamber, it is in the violet plasma will show have seen that violet color plasma. it will up to 3 minutes to 5 minutes, it is an upper IMO governnt cleaning r sulfate will cleaning, then. After the IMO governnt this cleaning is over, then switch off the circuit breaker switch off the h d on the switch, then slowly decrease the current level.

And before that decrease, the current level first then switch off the circuit breaker and switch off the switch, yes correct know.

(Refer Ti: 08:43).

Now, the chamber is in a high vacuum condition, it is at minus 6 level. now, we are going to deposit thermal deposition [FL]. Thermal deposition, we are already we have loaded inside the substrate and we have loaded the s; source aluminum material is there inside the source. we are going to do the before that thermal deposition switch on the thickness monitor.

After switch on the thickness monitor, we have to whatever level thickness needs please set the thickness using t n 1 or t n 2, already it is in 600 nanometers reasserted like this. Whatever need please set the thickness then switch on the l t switch, switch on the circuit breaker; switch on the circuit breaker. Here help control have to give them or apply the current here slowly reach the current.

This current depends upon r material. Now we are kept in aluminum material. the aluminum is taking less current, [FL]. observe the inside the chamber the is glowing and the material is going to lt. before that open the shutter and rotate a switch on the rotator attrition, before doing the deposition printing is required.

printing applies low current 1 or 2 minutes, then pressing after that has to increase the current for want to do the thick coating.

(Refer Ti: 12:07).

What did start

See observe the, [FL]. Now, the rate of deposition is increases and coating also increases. Now, the coating is going on depend upon materials, depend upon whatever r data deposition decrease. have to set the current or what is; what way r deposition rate it requires. (Refer Ti: 13:53). [FL] full finish. (Refer Ti: 14:14).

(Refer Ti: 14:15).

Full [FL].

(Refer Ti: 14:19) finished.

once a coating is completed. We have to first minimize the current or decrease the current; however, and switch off the circuit breaker, switch off the thermal switches. The

thermally thermal deposition is completed, now we are going to electron beam one deposition, sir.

(Refer Ti: 15:09).

(Refer Slide Ti: 15:10)

we are going to bake the electron beam one deposition. We first switch on the power supply here in the immediacy source control.

(Refer Slide Ti: 15:34)

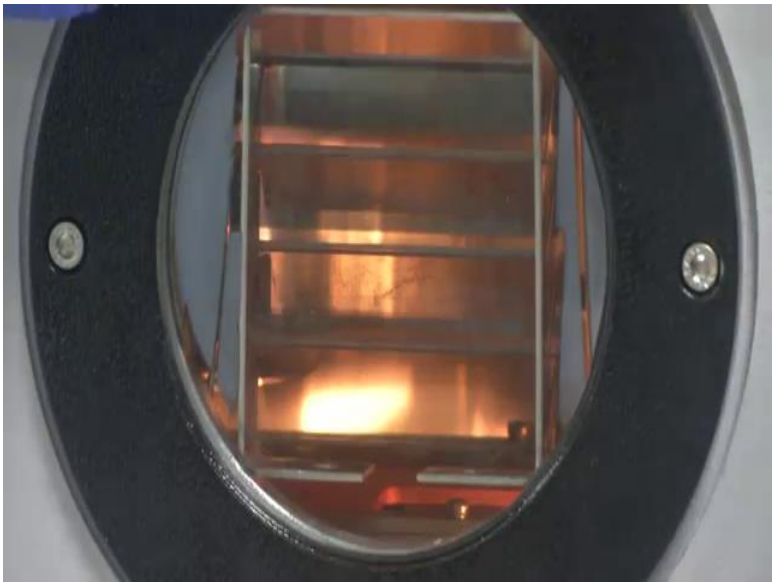
Switch on the power on press the power on switch. Before we power on switch, we will ensure this control navigation 0 conditions. Now, switch on the gun. Slow (Refer Ti: 16:37).

(Refer Ti: 16:40).

Now, storage is the operate the current. sorry.

(Refer Ti: 16:59).

(Refer Slide Ti: 17:03)



Now, inside will observe the bake is on. The current increase the storage increase the current; now it is under precondition just wait 2 minutes after that we will increase the power. Before that have set the thickness, I set at 400 nanometers for thickness; depending upon having to increase the current.

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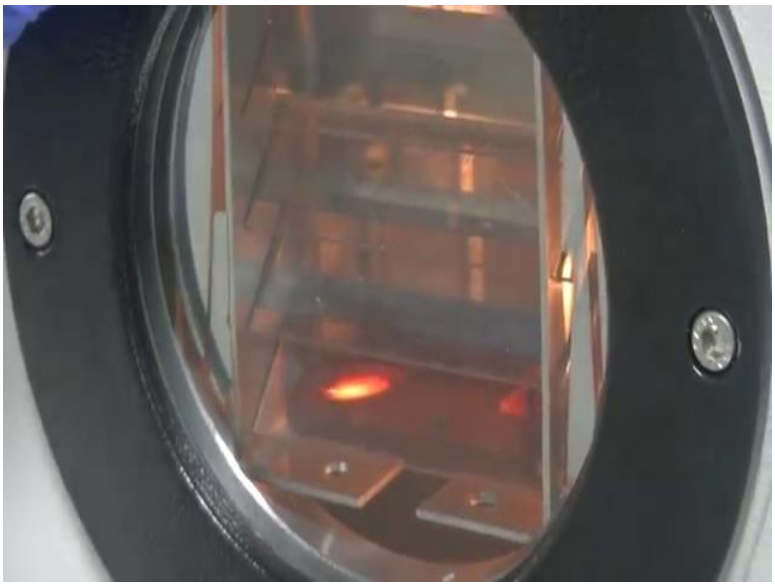

Now, observe the beam place around the crucible. Now, is.

Beam falling on the crucible.

Beam falling on the crucible. now, it is going on and slowly a little bit increase the current, (Refer Ti: 19:17). Now, observe; now what is going on; say, data deposition and check. This data deposition also increases then coating thickness also now we are going to increase. Suppose are going to increase the data deposition, have to increase the current otherwise keep as it is.

(Refer Ti: 21:35).

Here set at 150 thickness. that is shutter will off, the shutter will off. once are finished r coating trial, slowly decrease the current to 0 levels then switch off the gun. Then switch off the power controller power and switch power switch. Now deposition substrate key as it is in slots so 50 to 30 minutes; because the chamber is at so temperature.

we are unloading this ti; this, this temperature is putting timing effect or so moisture content and suddenly it will increase the moisture content know moistures. it will affect r deposition substrate. keep as it is (Refer Ti: 23:23).

(Refer Ti: 23:25) keep the (Refer Ti: 23:27).

A system in high vacuum condition.

High vacuum condition.

At this condition (Refer Ti: 23:33) went.

(Refer Ti: 23:35).

As a filament is spoiled. (Refer Ti: 23:37) basically happens now. that is providing it associates the 5 to 10 minutes.

15 to 10 minutes (Refer Ti: 23:45).

Pull it.

Keep as it is, should not open chamber after finishing r deposition process.

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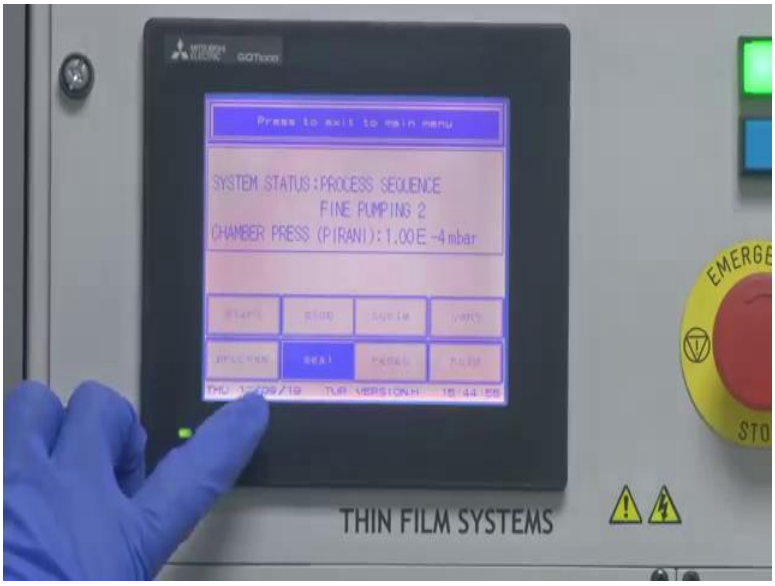
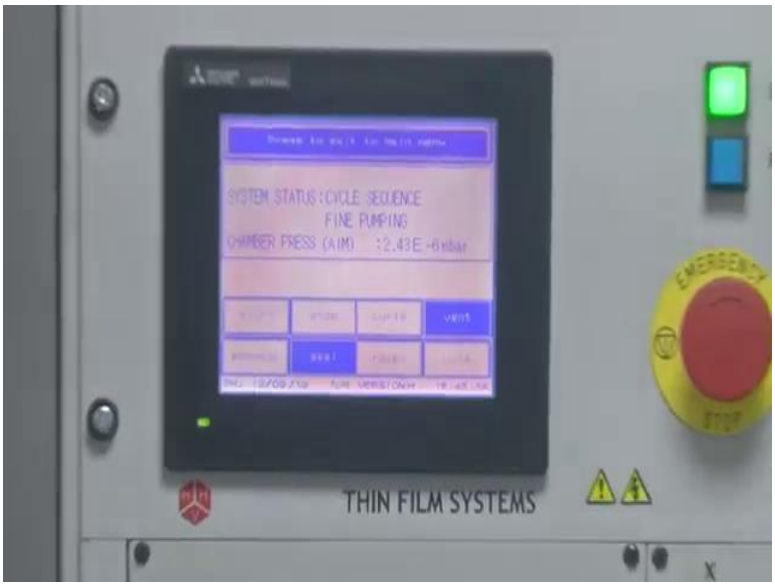


Once the r-process will over press the process.

(Refer Slide Ti: 24:00)

Then move to cycle.

(Refer Slide Ti: 24:07)



Now, today maximum (Refer Ti: 24:52) for electronic beam and this (Refer Ti: 24:26).

Sir, today maximum (Refer Ti: 24:27), this is 600 milliamps depend on.

Up to what can (Refer Ti: 24:35)

Up to depend upon r material have to give up to 600 milliamps.

Ok, I will ask the temperature rate mentioned,.

Where (Refer Ti: 24:43).

What is the maximum rate; that, that has to go with.

(Refer Ti: 24:47).

Later the version goes better.

(Refer Ti: 24:55), what is the maximum that it can system can.

This one. For the aluminum it goes to 35, 40.

40 angstroms per second specifically.

It will go to.

And for this one thermal maximum current.

This one Nah, this is for the process 400 amps, but it should not go 400.

(Refer Ti: 25:18).

What is the 30 (Refer Ti: 25:19), 30 for LBM 20 (Refer Ti: 25:21).

30 to 50 sorry, 30 to 50; initially it will test both currents for once it will lt yeah it will co down, it will not co down, have to.

Decrease the current.

Decrease the current otherwise, it will r rate of temperature will faster.

Whatever, all the material will be going to faster operation (Refer Ti: 25:45). r is going somewhere that is if the slowly we can deposit.

25 amps is a max.

25 to 30 is (Refer Ti: 25:57).

For aluminum, Kerolin is 400.

400.

Whenever think (Refer Ti: 26:01).

But.

Baskets.

r material knows, that I think that much power material is not (Refer Ti: 26:11).

(Refer Ti: 26:13).

More than 100 and (Refer Ti: 26:15).

More than 100 times. Yeah, 150 or (Refer Ti: 26:23) 170.

Once the r-process will complete, here switch off the sweep also and switch off their volt rate.

Sweep.

Sweep, the x-axis and y-axis r beam in moves; x-axis and y-axis, we (Refer Ti: 26:39) here r crucible.

The beam is falling 270 degrees. This is going somewhere. adjusting it can use the sweep pendulum.

But, how did we know it is like by visual or (Refer Ti: 26:57).

More visually, we can see in tube mode then (Refer Ti: 27:01).

(Refer Ti: 27:03).

Ok.

Increase the width. That is for the center initiative is 0 it will center. have to that fully r material wants to evaporate. it will have to increase.

Oh, beam (Refer Ti: 27:17).

Beam yeah.

Beam (Refer Ti: 27:19), oh that can also be possible.

Yeah.

How

have to increase this one.

Oh, (Refer Ti: 27:25).

have linearly seen then increase, otherwise, the beam will another.

(Refer Ti: 27:31).

This is a (Refer Ti: 27:35) pump positions a sine wave (Refer Ti: 27:39).

Sine wave (Refer Ti: 27:41).

Anyone wave (Refer Ti: 27:45) and nothing will happen automatically.

(Refer Slide Ti: 27:47)

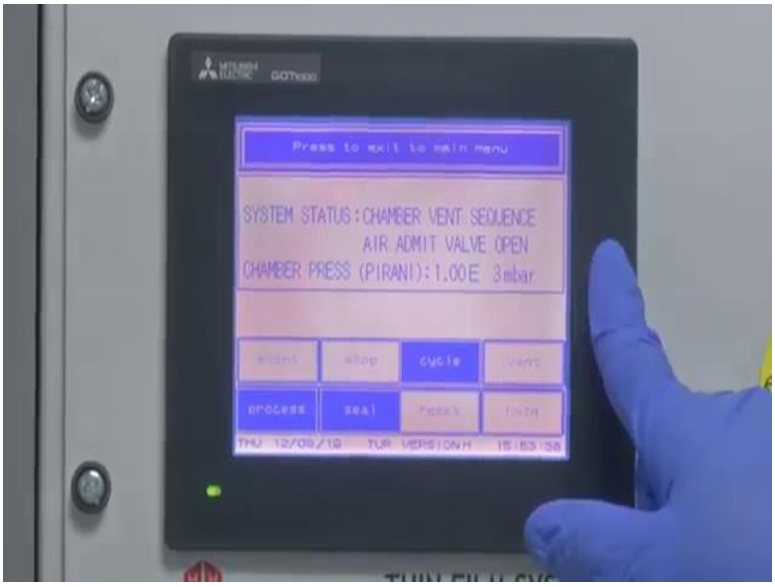
(Refer Ti: 27:49) is fine.

Now, we are going to unload the samples. Before that switch on the electron beam concept (Refer Ti: 28:03) and press the seal.

(Refer Slide Ti: 28:16)

Press the seal the high vacuum valve isolates, it will close isolates the chamber press the seal.

(Refer Slide Ti: 28:23)



And vent, press the vent; now it shows air admit valve open on the screen.

(Refer Ti: 28:41).

(Refer Ti: 28:55).

For venting the chamber use nitrogen gas.

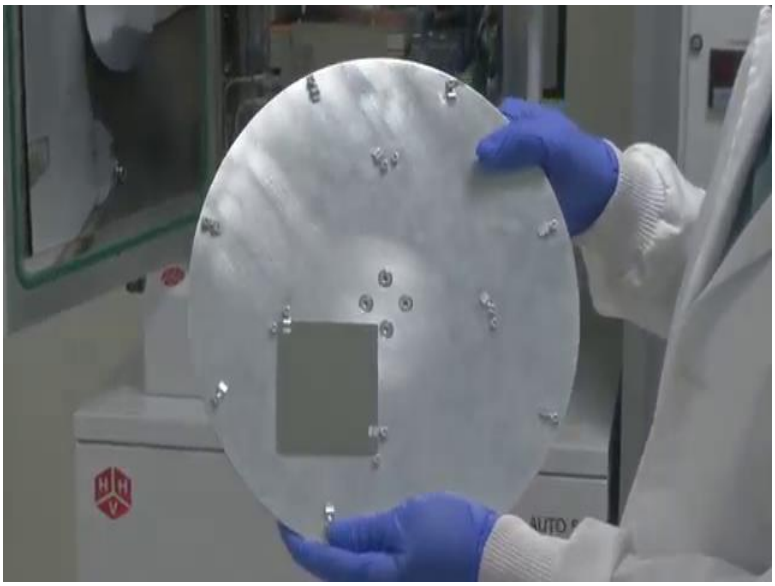
(Refer Ti: 29:15).

Now, observe safety interlocks using knob conditions. air connected in the vacuum internal also vacuum the internal stage. now, the chamber is in an atmospheric condition. it will open. result safe and touch will off.

(Refer Slide Ti: 29:37)

Off, open the chamber door.

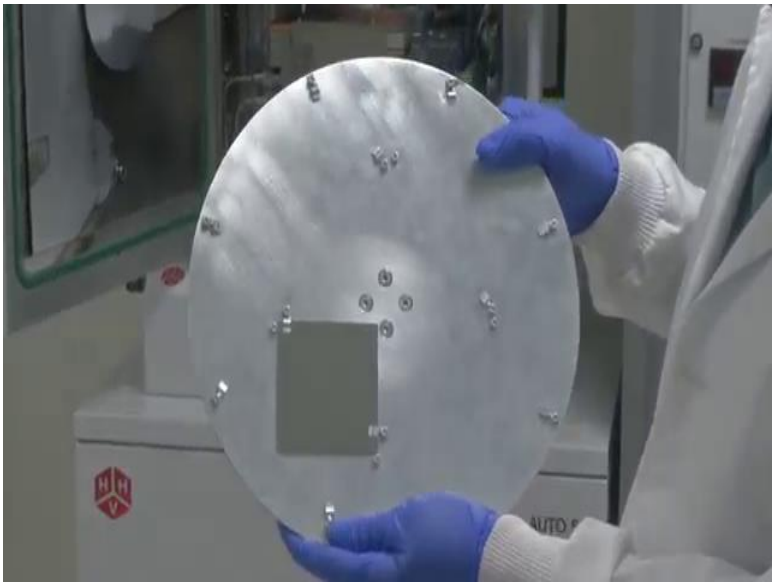
(Refer Slide Ti: 29:51)



And to remover substrate holder, observer central will be coded here. Here do not keep the chamber open in a long ti, please after removing r substrate please close the door. And do not keep as it is, do so vacuum level. press the cycle.

(Refer Ti: 30:35).

(Refer Slide Ti: 30:37)



(Refer Slide Ti: 30:48)

Now, I am going to load the samples take a clean glass. Fix only a (Refer Ti: 30:53) like this whatever requires. Place the glass here, (Refer Ti: 31:03) not remove just slightly open. Then tighten the screws, using align keys. Now, r substrate is; now r substrate fixed on the substrate roller; now molding even substrate roller.

This is 8 (Refer Ti: 31:45).

Now, we are going to load the substrate roller, the chamber will be now vacuum conditioned. once again press vent press the chamber.

(Refer Ti: 31:59), it is a gas. (Refer Ti: 32:05).

(Refer Slide Ti: 32:53)

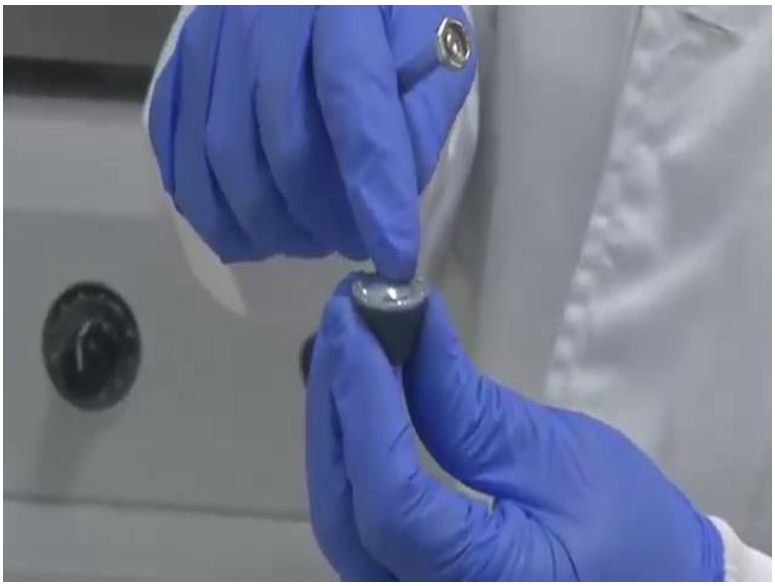
Now, this substrate roller as it is, just coming to (Refer Ti: 33:03) direction. Now it is fixing, once the substrate roller is fixing our substrate roller fixing. to load the material by which whatever whichever r material going to coat, please load the material using a thermal or electron beam drum.

(Refer Slide Ti: 33:31)

(Refer Ti: 33:31).

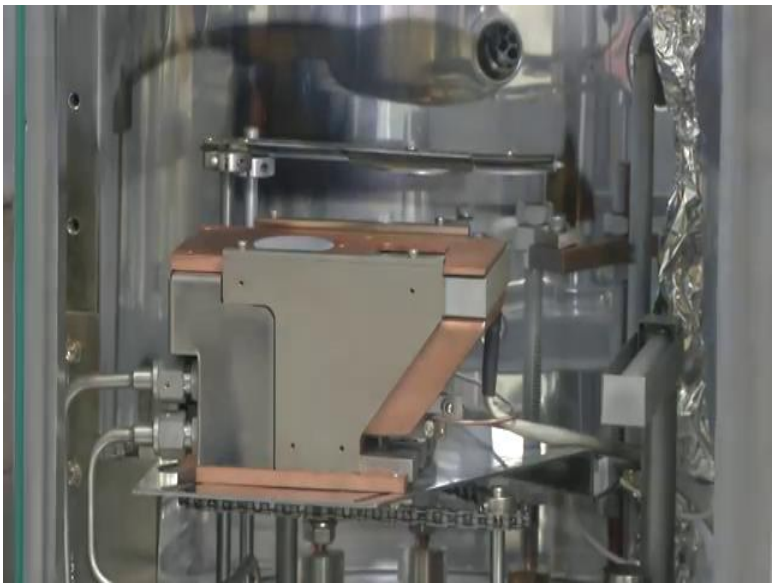
I am going to explain this, how to load them in (Refer Ti: 33:41), close clips to remove crucibles.

(Refer Slide Ti: 33:54)



This is for a crucible. whichever material is going to coat, please keep inside this crucible now we see this we have already kept aluminum in the crucible. once kept the crucible material in the crucible.

(Refer Slide Ti: 34:16)

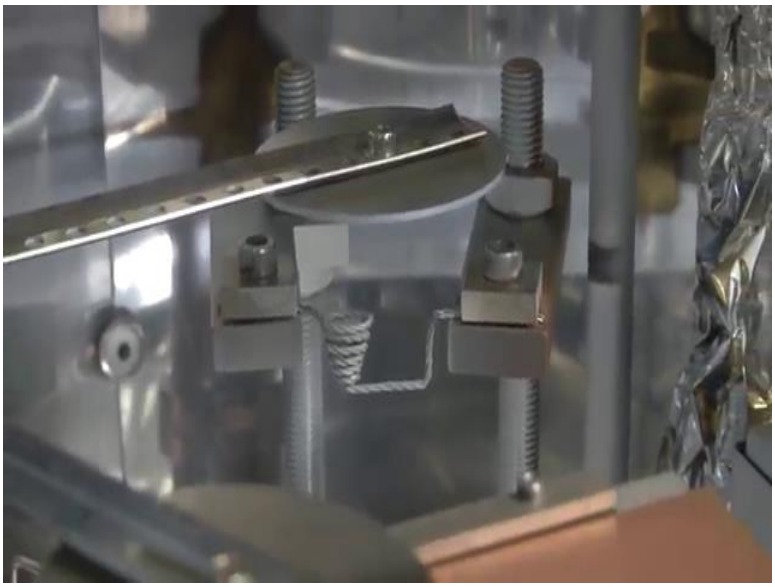


keep as it is please, this carry 4 packets a number of crucibles are 4. have to; this is for current controller packet selection; crucible selection, switch on the mains power. Now that crucible is in the condition is in second crucible material whatever oxygen is kept in the second crucible.

are going to change the crucible, which has to rotate this current (Refer Ti: 35:05) whichever wants 3 or 4. Just run just in 3, see r crucible is rotated. See, if more temperature is on it will indicate green, otherwise, that green does not co r motor is not rotating. have to not rotating; see that crucible now we are selected the fourth one.

Suppose are going to first one has to turn the now anticlockwise kept it as 1. Now, (Refer Ti: 35:45) is running. Now, the rotate 4 to now cos the first one. This is part one to this ti we are going to do the crucible selection and keep the material in the crucible. Now I am going to show how to keep the material in thermal.

(Refer Slide Ti: 36:12)



Now, I am going to show how to play the basket or filament or boat in the thermal source. We have to take the align key 5 mm just lose loosening in the screws like this, remove basket; once, the basket is basket or boat or filament once having the applying current it will brittle. remove carefully.

And now, I am going to assemble this basket to back. Now, the basket is assembled. And put whatever r want to go to do the coating inside this kept inside this material. I am going to put aluminum material on it. This is an aluminum plate, I am going to keep them inside the tungsten basket like this.

are going to do material kept in the source thermal source and slightly have to tighten the screw and close the shutter. Now, material loading and unloading samples and

unloading that substrate holder I have to explain. Once samples loaded and it is materials loaded close the chamber and keep as in a vacuum condition.

(Refer Slide Ti: 39:11)

Now, press the cycle; now, that chamber is pirated in the chamber. Now, the lighting is going on inside the chamber. previously the safety interlock in knob condition, now the lighting switch is enabled. r safety interlocks on. Safety interlocks on are going to do the process otherwise without safety interlocks on are not going to not able to do the process any process extend or thermal or typical.

(Refer Ti: 40:05) not getting on.

Not getting on.

80 percent is satisfied with any safety.

Safety international only safety after that r-process will on otherwise it will not get on. Once the r-process is over, I am going to explain how to shut down this closing procedure. Previously, I am going to open the I am explained open procedure; now a closing procedure.

This is a response to the system shutdown.

shutdown finally, end up with a shut down the system, how to shut down the system it is in under vacuum condition, once when are going to do the shut down just press the

seal, seal see chamber it shows the chamber seal after that press the stop; and when are going to switch on the system psd press stop; now press stop.

whenever press the stop, it shows the turbo deaccelerating; it, it will down the speed will down. Wait for a few minutes, the pump will deaccelerating. Always do not keep the chamber in the atmospheric condition of open conditions. Please, so keep in so vacuum condition, now after that, the turbopump is off.

Yes.

now.

(Refer Ti: 42:19).

have to switch off all the things safe now it is in safety.

(Refer Slide Ti: 42:24)

switch off the IO switch. Now everything switches off, then switch off the mains supply.

Main power supply and we will leave it.

And switch off all regulators that ti work chiller or air compressor and gas. Please close all the things.

Thank you.