Advanced Neural Science for Engineers

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Lab 07 Sputtering Demonstration - I

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In other modules, we have shown like complete fabrication procedure like from silicon wafer then cleaning, followed by coating of polyimide layer or polyamic acid layer and clearing it to make a polyimide film. After that lithography, then deposition of metal using electron beam evaporation system or by the process of evaporation. And after that lift-off. And after that we so basically that is like fabricating on electrode array, standard procedure of fabricating electrode array that we are doing here.

Now, as we have already studied the things like sputtering, thermal evaporation techniques like that other PVD or Physical Vaper Diversion Techniques. So, here in these modules, we will demonstrate how the sputtering tool works or how to do that sputtering system. So, here we will demonstrate this sputtering, RF sputtering both. And in consecutive modules will show you the thermal evaporation as well. So, here as we are, we do not have any particular device to fabricate, or using this sputtering tool.

So, we will just do some sample deposition just to show you or demonstrate the things. Here, from the, I mean, this is just like a recap. We have already studied how sputtering works or how sputtering tool or how is sputtering, as a system how it works in the theory modules. So, coming to this module, this is just a quick recap.

So, here, unlike any evaporation technique, this is, I mean here you do not have to melt the material and get the vapor or the evaporated thing to deposit the things. Here, what we are doing is, first we have a substrate. Here let us say, we load the substrate let us say here and a target here. So, target will be negatively charged.

So, as target is negatively charged, as you know that it will attract argon atoms. So here are not argon atoms, argon ions. So, here what we are doing, we will flow argon atoms here as an in gas phase. So, with a high electric field, it will break in ions and that are then and will fall or will be attracted to the target and heat that, so kind of scraping off the top layer of the materials will happen which will lead to evaporation on the substrate.

So, this is how this works basically. So, this can be with a DC source, the supply or the source can be RF also. So, here as we have discussed already, when we were discussing about EBM evaporation tool, we have mentioned that there is a limitation of the EBM tool that we cannot deposit very high melting point materials. So, for example, but crucibles we are using, those are of either molybdenum or we can use tungsten also or we can use graphite.

So, these are high melting point materials. So, these we are using as or was using as crucible because those cannot be evaporated by the electron beam that is why we were using as a container to keep the melt inside. So, here let us say, we have to deposit tungsten or maybe we have to deposit molybdenum or we have to deposit any other insulator like silicon dioxide, silicon nitride or any other insulators basically.

So, here is the tool, the sputtering tool we have to use because usually these oxides, nitrides and high melting point materials, these cannot be made with that electron beam. And here the scraping of the materials from top and evaporation, that is basically the sputtering of any material. That is the only way to deposit it, or we have to go with chemical vapor deposition techniques that we will cover later or we already covered the theory part.

So that you can just check it again, if you are not comfortable enough with this. But for PVD or physical vaporation techniques, this is the only way. So, here is the sputtering tool, we will show first in the same way that what are the things or the different parts of that and inside what are the main components available.

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After that will open the chamber, we will again demonstrate what are all components inside the chamber and then we load the sample and we will show how to deposit material using that.

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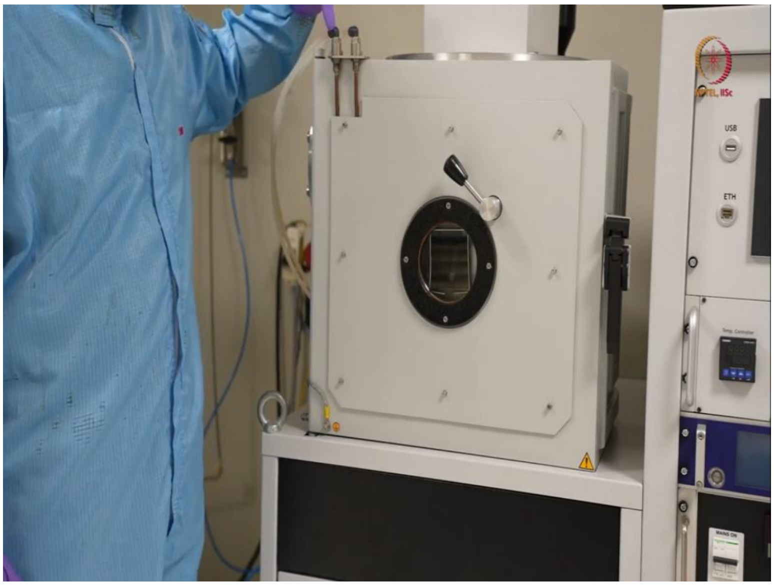

Starting with the components like this is the first one. So, this is the chamber. In operation tool also you have seen the similar chamber, but here you can see, I mean, here are the water flows that is required. So, inlet and outlet. Inlet water with, I mean from a chiller basically that is chiller outlet is inlet here.

So, that will be used for cooling down the magnetron. So, here there we had electron beam gun, here we have the magnetrons. So, this inlet water will pull it down and here is little hot water that is outlet from this, after cooling the magnetrons part. And here as you can see, we have one viewport.

So, during deposition, we can just open and see the things, but now as inside it is done. So, we cannot see anything but when plasma will be created that time we can show the things.

This is the first part, our chamber. We will load the things inside, I mean load the substrate inside and the target will be there and we can deposit.

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So, coming to this part. Here, first this is the display. So, whatever operations we are doing, like let us say creating vacuum, let us say triggering plasma, gas flow, switching on gas flow, switching off gas flow, heating, all these things, whatever we can do, we have to do it, I mean, we can give the instruction through this, this is a touch panel based. Here, this is that like one zero button like that, it was in EBM evaporator tools also.

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So, this is for switching ON the things and this reset button for resetting the hardware after each and every use. This is again one of the most important part. This is that emergency stop switch. So, if you are in any emergency or if something happens, you can just press it. It will like autocut the tool and you can just open it, before next use. There is nothing.

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So, here, we can see here, this is the temperature controller. It is as it is written already. So, when we will operate the tool, we will show you. So, the top part that will show the actual temperature. And bottom here it can show what is the set temperature. So, with this we can elevate the temperature and at an elevated temperature we can deposit materials.

So, as I already mentioned that insulators can be deposited, insulators, as well as the dielectrics. Basically dielectrics can be deposited using the sputtering tool. So we may need to deposit the material at some elevated temperature, such as let us say around 300 degrees C, or maybe 350 degrees C 200 degrees C, these are like the standard temperatures, usually, we used to deposit material sometimes.

But if it is a metal then usually we do not need any elevated temperature. However, if required, we have the provision here.

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Here, this is the DTM exactly the same thing that we have discussed in our electron beam evaporation demonstration module, this is the exactly the same thing.

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So here, these two are something different that you did not see or came across the things in our last modules.

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So here, this is basically the RF source. So as I already mentioned, so just to give a brief about this tool, we have two magnetrons, one magnetron is connected to the RF source and another magnetron is connected to the DC source. So here this is the RF source. So we can control this from this display only. So, we will just set the power and the forward power, reverse power, everything will be automatically taken care of by this module, this is the power source, power supply.

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And here this is the DC power supply. So, if we see, we can just, it is always switched on. And here you can see three displays. So here are three displays, three buttons to increase or decrease the values. And here set and read, like set and read. This change for each and every parameter. Here first, what do you usually do is, in this DC source, this can support up to 800 volt and 1.5 ampere current.

So, we do not need 1.5 ampere current in most of the cases. We usually do in milli ampere range only. So, less than 1000 milliampere. And here, this voltage, so how it works? So, basically, you can see there are two modes, either set mode or read mode. So, when we will switch it on, we will describe again in details. So, the read mode is basically to see how much voltage or how much power or how much current is actually being delivered.

So, that is in, that we can see from the read mode. And when we place this in set mode. So, basically, in set mode, if you increase this or decrease this, so by that you can actually set a higher voltage or higher power or higher current. So, usual procedure is, you can first set on voltage, on power here, invert, so whatever is expected for you, let us say, tungsten is loaded on the DC magnetron.

So, here you can just, what we have optimized, you can go till 200 to 300 Watts, so you can increase it. So, after switching on, obviously in set mode, you can increase it. Keep it there. Place it at read. So, you can see how much current, how much power is getting delivered yet. After that, you can increase this up to 300 to 400 volts. So, that is your initial and a steady voltage input.

So, after that, you can just take the read, how much is getting delivered actually, and then you can set the current as required to match this expected wattage. So, when that your set power will reach, it will be set. I mean it will saturate there only. So, after the set power, you cannot go beyond the set power, how much ever do you increase your current. So, this is basically a regulatory thing.

So, here, you can increase the set power and again use it at higher power, if required. So, usually, we usually keep everything at read mode. So that whenever we will switch on something, it should not be automatically ON and start giving some or start delivering some power. So, this should be switched off. And this is also switched off already. So, here we have checked these things.

So, here we have provision for like copying the recipes or in auto mode, we can just send on, Imean send some recipes also from here using the USB drives. So, this is the basic things that we have. And here already have discussed about this.

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Now, we will just check what are other ports and what is there in this. So, as we have seen, these components, whatever it is accessible from outside or whatever is visible from outside here. So after that, we will open this. We will get a brief introduction about this, just like the other components, then we move to the next part.

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So, let us open this up. Before opening, you can just see here, before opening the door, you can see here again the similar warning again like electrical hazard that isolate main supply before removing this. So isoate main supply is better, whenever it is switched off, you can open this.It is not like you cannot open this when it is in action or when it is running, because this is a mechanical key.

So you can open it anytime. But you should be aware that whenever supply is on, there is a fair chance that you can get electrical, I mean, you can get any hazard from here. So, now we are demonstrating it when we are, I mean when the system is OFF. So, I will go that side so that you can see this thing properly.

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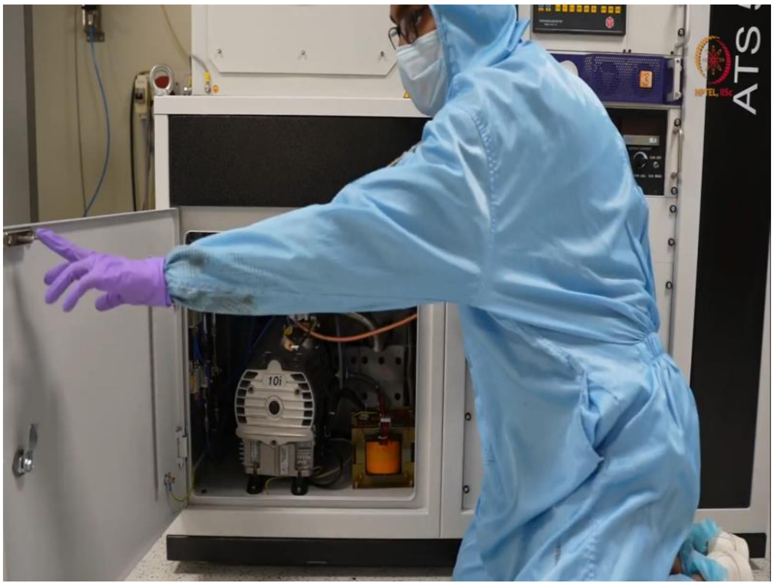

So, here you can see, this is almost similar things that you have checked. And obviously, just to mention, you mentioned it to you once again, this lock, means this and this, this lock is connected to the safety interlock. So, if this is ON by any chance, it will be sensed by the tool and you will get an warning sign and as long as this is ON, none of these supplies like RF supply or DC supply to the magnetron will not be ON. So, it is mandatory to close all the doors then only that high power systems you can, I mean high power components you can use. Otherwise basic pumps or basic transformers will work.

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So, here if you can see, this is the same pump, rotary pump that we checked, when we have demonstrated that EBM evaporator system. This is the similar pump. So, here, it can go up to 10 power minus 4 or better to say 10 power minus 3 to 10 power minus 4 milibar range, as we have discussed earlier. And here, we have one transformer at the right side, here if you can see. So, that is to facilitate power to the system.

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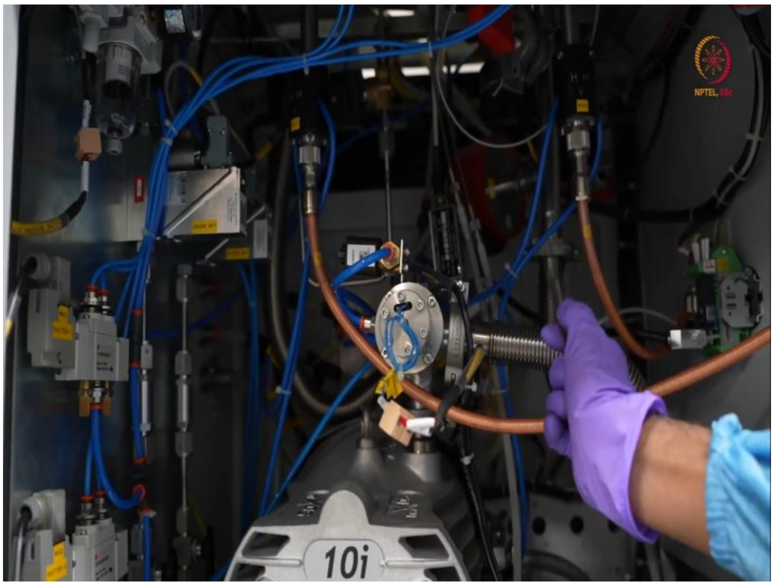

And if we can see through this area, so here as we have discussed about this, so here you can see the connections one from the side, another will be from that side, from backside basically, and both are with a tee it is connected here. So, one of these is the backing line, one of these is the roughing line. So, apart from this, we can see many things here.

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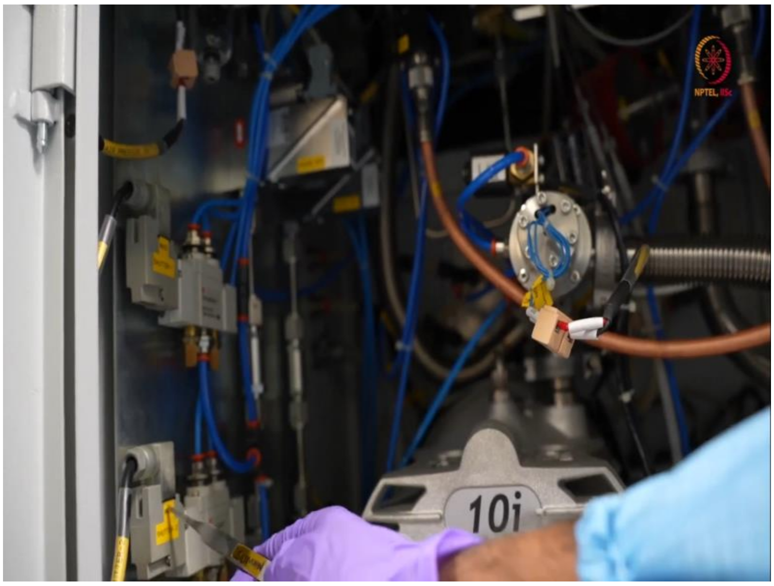

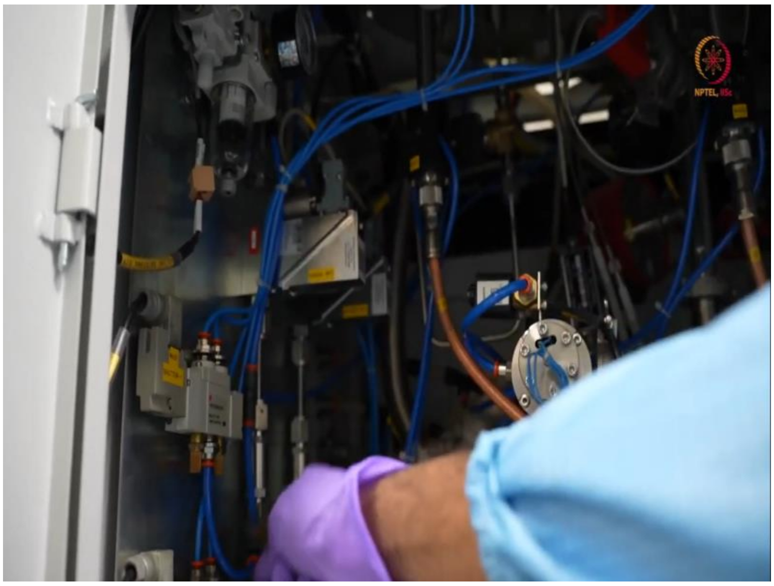

So, see here, this is the magnetron one for sputter one. So, this is one of the supplies. And here this is magnetron two, for the sputter two, this is another supply. These are the supplies for the water, whether water is going properly or not these are the cooling waters here, okay. This is the first thing.

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Then here you can see MFCs. So, argon MFC, you can see behind this, there is an oxygen MFC, MFC is Mass Flow Controller. So, what it does? So, we usually connect the gas pipelines to these and this will check as per the instructions given by you through the display or the interactive display basically.

So, whatever the SCCM or the amount or the volume of gas flow you want, this will allow only that much volume to be in the chamber through the pipes given. So, here this argon MFC and oxygen MFC, both are connected there and you can use. So, here argon is separate and in case of oxygen, if you want nitrogen somehow.

So, for your process, so you can instead of oxygen, you can put nitrogen also but MFC values will be different. That you have to calibrate it as your own.

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And here you can see, these are the lines, these are already on here and inside, because we have another regulator outside. We will operate from there leaving this area because this will be closed during the operation. And here when just like the EBM evaporator, we must say here that here we have all pneumatic bulbs.

So, as this is more automated than the evaporator that we had. So, here you can see, we have one, if we switch ON the chiller unit, we will get water flow, if we switch ON the compressor, we will get some pressure here and that pressure will act as the controller of all these pneumatic valves. So, some of the pneumatic works in here, some of the outside.

So, after this, we will move to the ports part like how we are, like how this exhaust is going out or from where we are supplying the oxygen rather than that part we will go to the backside basically. So, we will get a zoomed in view of that just after this. Before that will close and go.

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As you can see, we have closed the door. So, we are now here, the other side of the tool to show these things. So, here you can see, this is the air supply return. So, this is the pipe that is directly from the compressor. So, this compressor, I mean through the compressor will get some particular amount of basically you can say a rated pressure there. So that the rated pressure will be controlled by this compressor output.

So, we have that air supply. So that will be helpful to run all pneumatic valves, here is the vent. So, ideally we should vent with nitrogen, but as we are in a clean room, so we prefer to vent in cleanroom environment only. However, for better performance or for better or faster evacuation of the chamber, it is always recommended to use dry nitrogen, instead of air or instead of cleanroom air for venting the chamber.

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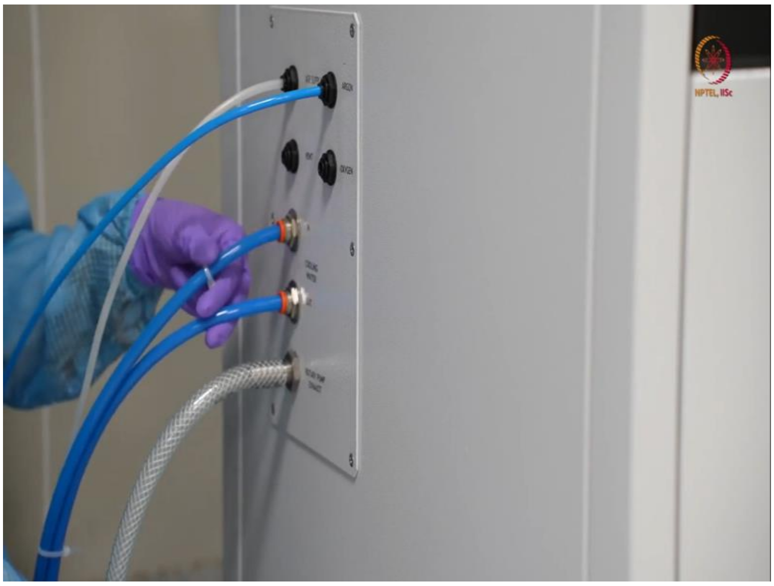

Here you can see the cooling water inlet and outlet both are here. So these are connected to the chillers. So through this in part or the inlet of that cooler, of the chiller unit like outlet of the chiller unit and the inlet of this unit, you can get water, within a range of 19 to 21 degrees C, as it was for the other tool and outlet is obviously little hot water after cooling the magnetron and the chamber. Because chamber outside has also the similar, like similar places to or similar channels to flow the cold water.

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Here as it is already written, it is a rotary pump exhaust. So, after the rotary pump exhaust, so all these are connected or from connected from the outside or to outside. Outside means, the utility place of our lab. So, that is a utility room we have one. So, that is just like a normal lab or normal place, not like a cleanroom environment. So, after all this, we have here argon and oxygen. So, inside we have already seen the argon MFC or mass flow controller or oxygen MFC or oxygen mass flow controller.

So, here inside we can, I mean outside also you can see, here argon is connected, because this is compulsory, because otherwise we cannot generate plasma for sputtering. The two reasons for argon, number one it is a little heavier atom first and second it is inert gas. So, if we use oxygen or nitrogen for creating plasma then that will react with the target itself, and we will get some different material deposited instead of that targeted material.

So, that is why we cannot use oxygen or nitrogen these type of active gases for creating plasma. So, argon is used here. And oxygen or nitrogen, it will be like, we will use same port for oxygen or nitrogen before, if we change the guest then we can flash out some amount of gas and then we can use it. However, this will be for creating the environment inside the chamber. Let us see, if we deposit any oxide, let us say SiO2.

Then we may have to have oxygen environment in the chamber based on the recipe or if you are depositing let us say silicon nitride, we may have to use or maybe we have to have nitrogen enhancement in the chamber. So, those things we can just make or maintain using this. So, here these are the inlets and outlets to the tool that we have shown, then we will come to the backside of the chamber.

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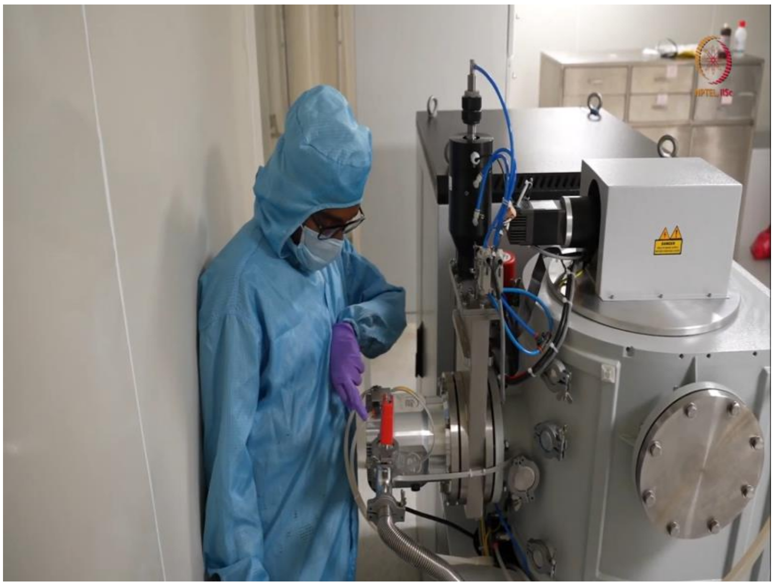

So, after those ports, now, we are at the backside of the chamber. So, here we can see this is the turbomolecular pump. So, this turbomolecular pump here you can see, one inlet water and outlet water. So, this also requires some chilling, some chilled water to get, I mean use it as a coolant. So, here is the turbomolecular pump, you can see, it is attached here like this with o-rings and all other connections.

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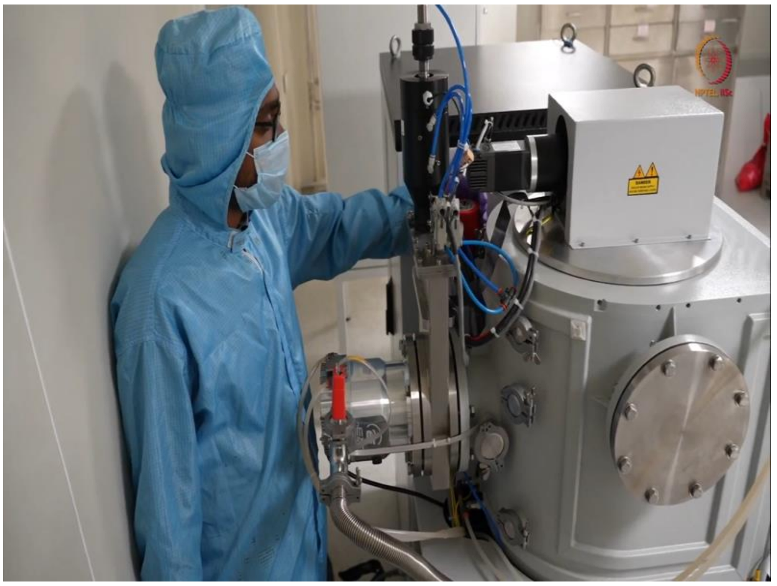

So, here you can see, I mean this is a penning gauge it works what we can show here, this is a penning gauge, Edwords, what can show here, this is a penning gauge that can show us the pressure less than 10 power minus 3 millibar range to 10 power minus 8, 9 millibar range. So, we have it here. So, we have checked our chamber can reach up to 10 power minus 1, 10 power minus 6 millibar approximately. So, that makes this chamber can reach, that can be easily covered by this penning gauge.

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Here is one more penning gauge and this can, I mean and you can see this connection is through that. So, this is one of the backing lines, here, that you can see through this pump and this gauge, this is the backing gauge. So, here you can, here if you can see there are many ports that is possible, we can just attach some new parts to this. Now we will check it. We can check these things.

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So, this is the main controller, the pneumatic valve that controls whether the chamber will be sealed, or based on the position of this, we can change the ceiling or the opening of the valves, everything will be changed here, that we can show during our demonstration.

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Here, if we come to this top part, so here, inside we have the rotary drive. So that rotary drive is to rotate the chuck during deposition. And here we have another port that we can open just like this we have another port. So here, we can use some load lock system, so that our chamber will be always under high vacuum and we can just load our sample here.

But as we are not doing that, precised works, so we are using the actual chamber, I mean, we are loading in actual chamber and run the tool for deposition. So this is basically outline about the tool. And here you can see inlet outlet that we have shown from the front side and here you can see these are the channels for water coolant. So this is basic outline.

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So we just take the basic components of the tool before starting So, now, we are about to start, before that the last thing I want to just tell you. That you can see the backside, there is an gas connection the regulator. So, the regulator will come to the point when will deposit, will show it in like in a closer view, because gas flow and all these things are actually important for the sputtering tool.

So, from there we are, next cylinders are kept outside in a utility room. We took the connection here and from there as I have shown that, that side like other side of the tool, we have that argon inlet. So, that is basically our organ connection. We will come in details, but one thing you may see it is always in closed condition other than the time of deposition, because gas safety is also very important.

I mean whatever the gas is there outside maybe inert gas, but it should not be leaking, it should not get any leakage part in the lab itself, because that can be a hazard for the person who are working in the lab. So, always it will be in close condition. So, during deposition we will show it, we will open that in front of you and we will demonstrate the thing again.

So just to start the tool, it is the same procedure as we describe for the EBM evaporator system. So here also we will switch on the chiller and compressor first, because cooling water is important and the compressor is also important for the valves. So we will switch on that and we will switch on the main power.

And I will be back soon like within a moment, you just hold on for a moment. So, here if you can see that to power is ON, see compressor, all these are ON. Now we are about to switch ON the tool. So, as described earlier, this is the similar procedure and as you can already I think you have noticed. This from the same company same make, so procedures will be almost similar. So, let us switch it on.

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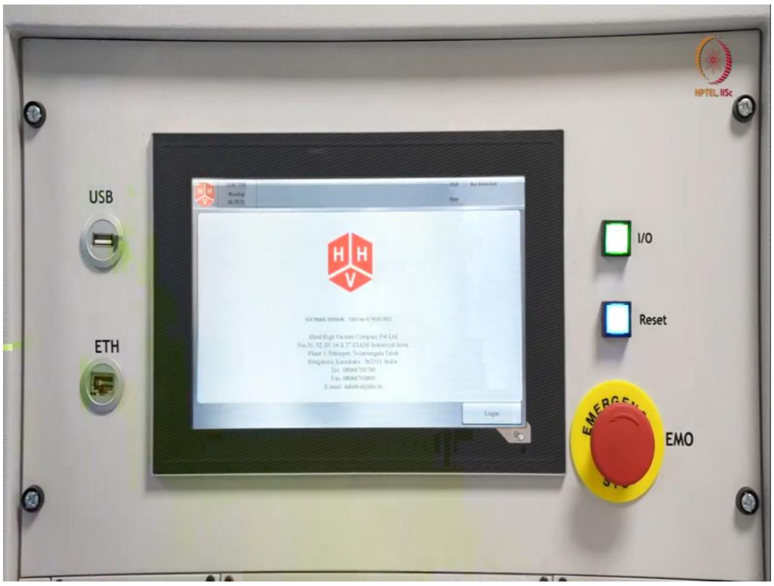
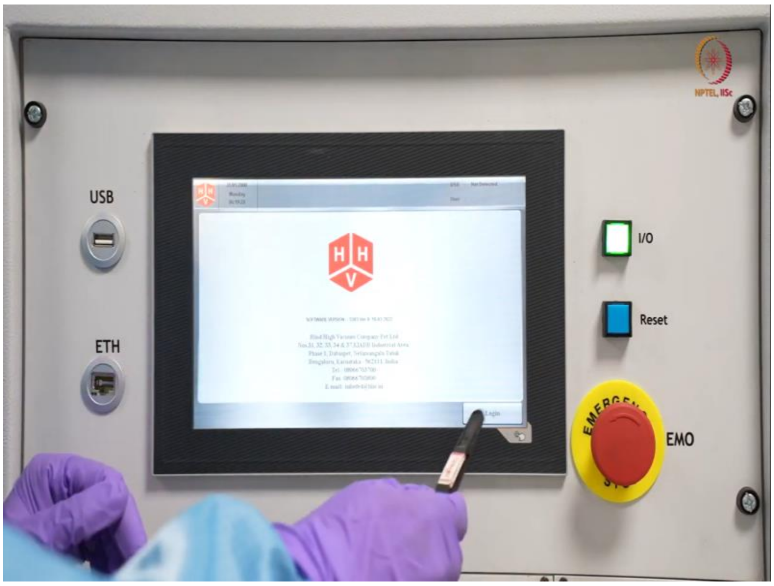



USB
I/O
Reset
EMO


USB
ETH
I/O
Reset
EMO


USB
ETH
I/O
Reset
EMO

So here you can see the screen. And here as earlier also I told after that reset can be one of the things you may have to reset the headers. So we press reset. So, after that, here you can see there is some extra option for login because this supports supervisor mode or the user mode, engineer's mode, there are many things.

We usually prefer to use these in admin mode, so that we can go for any type of values, anything. So we will just, so this is to stop us from unwanted intervention, but in lab we are only using the thing. So, it is I mean clear, what are the passwords and all this is already shared among us. So, here we are also showing the things now, if you see that.

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So, here if you see, anyway do not go with the date and time, this is not set properly. So, here if we see, this is a manual mode. So, if we want to run the tool in manual mode, we can go with that. But this is semi automated tool, where only deposition is manual, other things can be, can run automatically. So, here even deposition can be automated.

However, there is a problem. So, if any human intervention is required that time it will create a problem, we have to stop the process, terminat it and we have to start again. That is why we do not prefer deposition in automated mode. But that provision is here, unlike the EBM tool that we have shown. So, here this is a manual mode, all manual if you want to do.

Here is the system control is a source control. So, system control is for like basic operations like venting, then loading the, I mean during loading the sample whether we want to vent, then the cycle mode or if we do other things like seal the chamber and all those options are here in system control. Then there comes a source control.

So in source control, we have all magnetron related information like argon flow, oxygen flow, nitrogen flow, or maybe how much I mean whether we can switch ON the DTM or whether we can switch ON the power supplies, all these options are here in source control. The supervisory menu, usually we do not use it as long as we actually need any changes or something diagnostics, diagnostics are the similar thing.

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And these things are all comes under supervisory menu only. Because these are more like calibrating the tool, as a tool with unit or time or all these things that we do not want to demonstrate also. So what we will do? We will show like not in manual obviously, we will do it either in system control or source control, these two we will be demonstrating to you. So first let us go to system control.

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See, here it already sensed because during demonstration I pressed that emergency stop once and though I just released it, still it is showing that emergency stop placed. So, it is sensing that, that whatever happened to the tool. Here will just accept that error. So, whatever error will be there, that will be here, that will be shown here.

So, here we can see that, I mean, if somehow pressured is not enough or compressor is not ON or water chiller is not ON, so because of that, if pressure is not enough or water supply is not enough, then those like issues also will appear here.

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So, here as I just clicked on that, you can see what are the alarms it came that is here or you can even see the history, when it happened, what type of problems it occurred, all these things you can see. We can just go back as you do not actually need to check all these things now.

Since, there is a standby mode when you just start, system will be in standby mode. So, we have to start to get the pumps ON. So, before that we prefer to vent. Because it is well known that whenever you are using any vaccum tool, always you have to keep the chamber in vaccum condition or you have to evacuate the chamber before switching off the tool. So, definitely our system is in vaccum. So, we will vent the chamber, we will open, we will load some sample.

This is just, it will be a glass slide that is regularly available in like laboratory or not in stationary basically, in laboratory purpose or glass slides that you are well aware of that once you will see you will understand. So, we will load that, then we will start the position or the processes. So, here first let us vent the chamber.

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So, as I pressed vent, so vent is in green color that you have seen there only when it was a closed view. And it was showing an admit valve open. So it will be open until and unless we have enough air inside to open the chamber. That means releasing that vacuum and take this to the atmospheric pressure, then only we will be able to open the door. So we will wait till that time, we are waiting now also.

So here only option available is seal. So, by mistake, if you start venting it, you can immediately seal it. So that I mean you will not lose the vaccum. So, that is one part of that. As it is almost done, and we understand these things, if you are experienced enough, we will understand by the sound only when it is done or when or how much time it may require.

As the sound stops, so air inlet is almost stopped, so we can understand that it is already done. We will open this, and with that, we will just seal the add admit valve. So, now it is showing standby. Now, to save our time, we can switch on the pump before loading the things, loading the sample also. So, just to save our time, we can start it, but we want to demonstrate each and everything, so first we will focus inside this chamber, we will show the things then we will start the process there.

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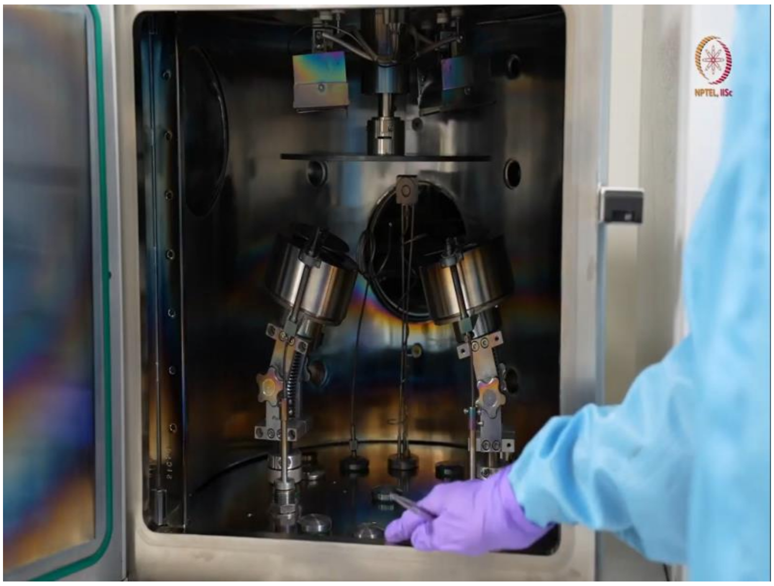

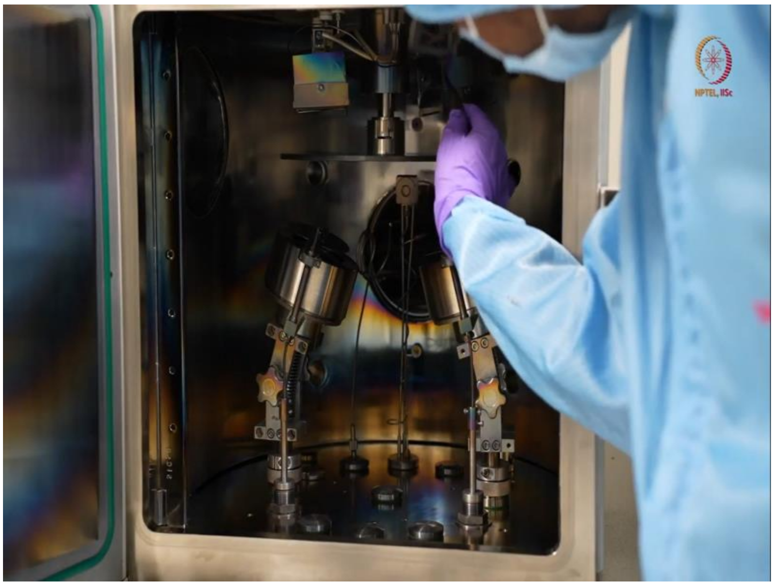

So, this is inside. Let us have a closer look, what is there in the chamber. So, this is inside the chamber as I have told already, that we have a provision for deposition at higher temperature. You can see here this and this here are the heaters. So these are the heaters that can directly heat our chuck. So the chuck is loaded here over the shaft. We will show how to remove and how to load the things. But still here are the heaters at the two ends.

Now, if it is in rotation, then it will definitely hit almost uniformly everywhere. So, these can go up to 400 degree. Now, if you can see here, one more small wire is coming out, if it is not visible, then also it is fine, no problem. Because I hope you know the basics of temperature sensing. So that wire is used for sensing the temperature. So here are the things.

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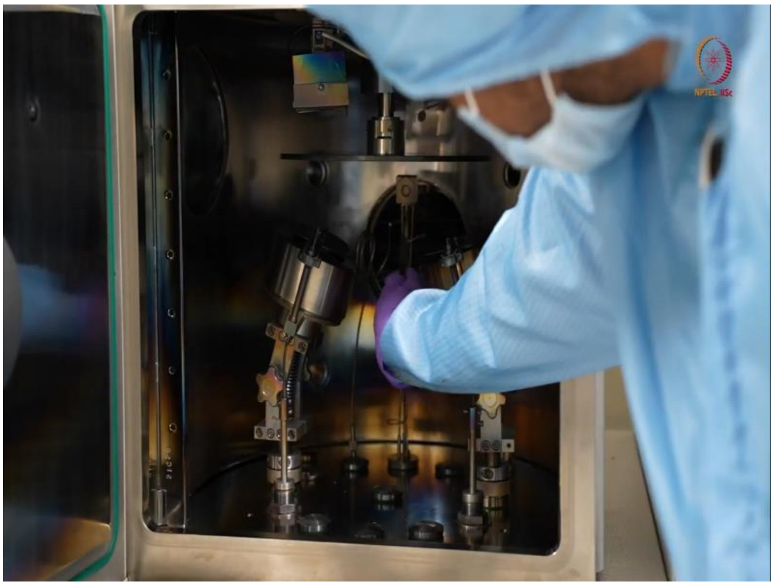

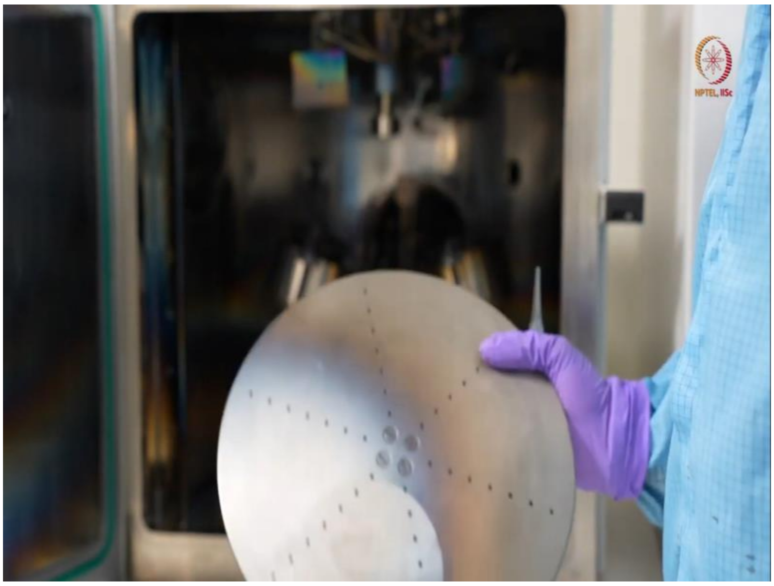

So here now, coming to this part. Here you can see the similar or before that I will just unload this so that you will get a clearer view. So this in the same way it can unload the chuck. So this is a little smaller chuck than that. This is eight-inch diameter. Whereas that I mean in case of EBM evaporation tool that we have that has 12 inch chuck, this is 8 inch only. That depends on your requirement, you procure it as you want.

So here now, you may get a clearer view. You can see one pipe here. So, this is the argon, argon pipe. So, argon flow is connected I mean argon purging will happen through this. And here are the two magnetrons. We will come to show the details about the magnetron before that I want to show this. So, here argon.

So, here you can see it is almost at the same distance, so that during deposition, we do not have to open or before deposition, we do not have to open and align it properly, it is almost at the center. So, argon purging will be all over and whichever we want to use, we can use any of the magnetrons as per our wish. So, when we open that down, when you open, so we have seen the connections to magnetrons. So, these are here and here.

So, those are from the RF source or DC source. So, here in this tool, this right side one, here, DC source is connected, and here in the left side one, RF source is connected. So, we can use or we could use these for any installation, deposition of any insulation layer. And here is DC can be used for metals.

So, here as we know that RF can deposit metals as well as insulator. So, this is more versatile, but as you know already from the theory part that half cycle will be used for deposition and half cycle will be like an relaxation things. So, for faster deposition, we always preferred DC for the metals, because we have that option and not the RF.

But we can use both as presently do not have any insulator, I mean insulator in lab to insulate a target in lab to demonstrate the things. So, we placed, both the places we placed metals only. We will just show how to generate the plasma and how to deposit it. So, this is insight about this chamber. So, here already you just, let us get a quick recap, what we have seen already. Here, this is magnetron.

This is the first magnetron, second magnetron and here is the argon flow will be through this and here is the QCM. This is the QCM or Quartz Crystal Monitor, that we have actually shown in the EBM evaporator. It is the same thing. So, here is that crystal actually, and this will give the value and we can check that to the DTM. So that much is here. So then we just open on off the magnetron. Let us open this only, we will just open one of these magnetron and show different components of that.

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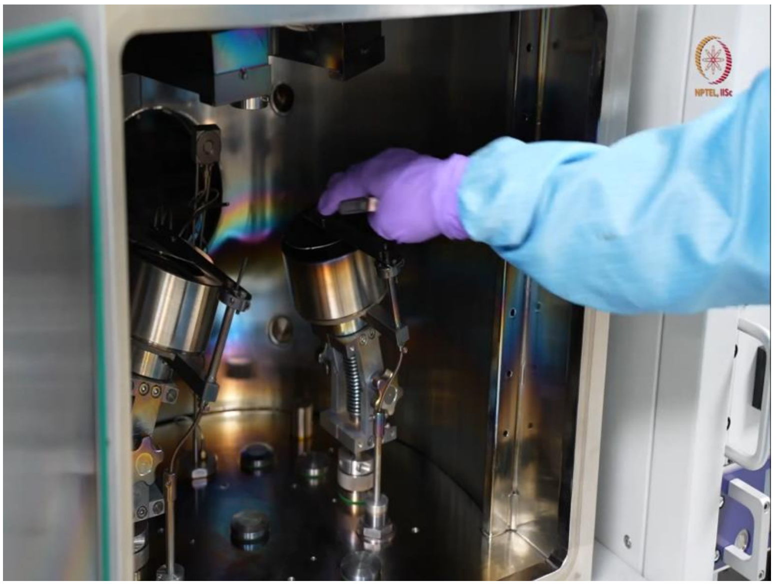

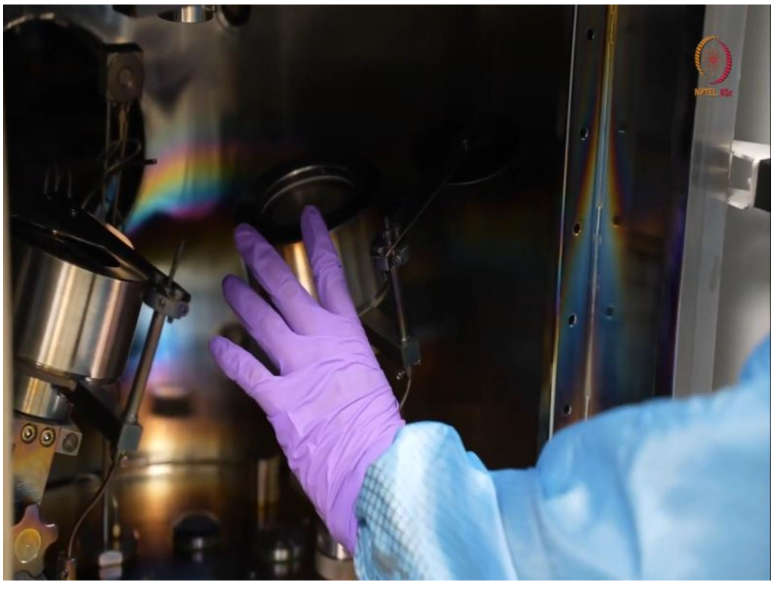

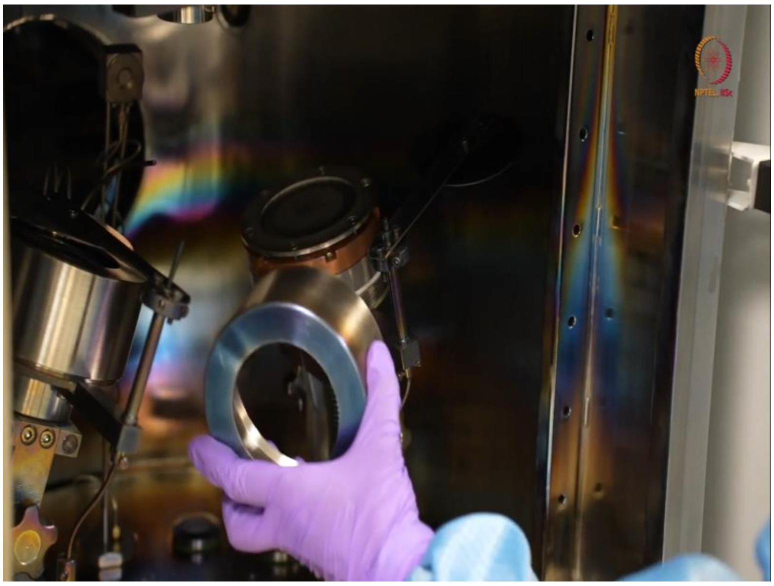

Here, you can see the closer look of on magnetron. So, how we are giving the instructions through the tab or through the display, interactive display that will show during deposition, but for now, we want to show what is there inside. So, first we are just removing the shutter. So, you can see, we can remove the shutter that is also pneumatic.

So here you can see this is one of the plates and here is the target. So we will just take out this, this act as the ground supply. So, as I already mentioned that there will be on ground and on negative supply and negative will be through the magnetron to the target.

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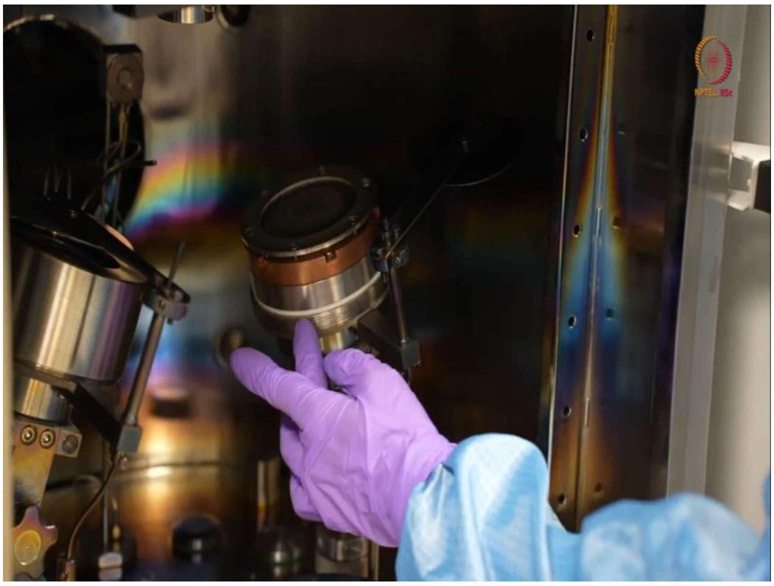

So, here the negative connection will be there and the other one is the ground supply that will be through this. So, while loading, this should not be in contact, like this ground and this magnetron should not be in contact. So now, we have one more guidelines. We will just remove this to show you how to load or unload the this target.

So, all these are like Allen key based. So, let us open this. Here is on point, when we are removing it it is fine, but when we will be placing it back, we should be careful that this plate of on top of the target to hold the things, should not be like tilted or something, then there is a fair chance that it will touch the other that ground connection, that we just now removed. So, those things we have to be cautious. Before that let us remove it and show you the things like how to unload this.

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So, here you can see, here is on groove. So, this is basically here to fix the things, so that it will, so the target cannot move here and there. So, this is the target.

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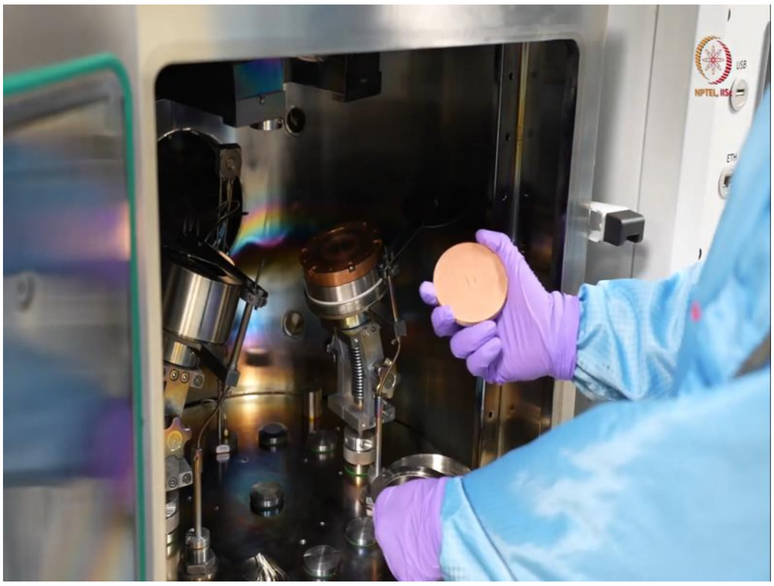

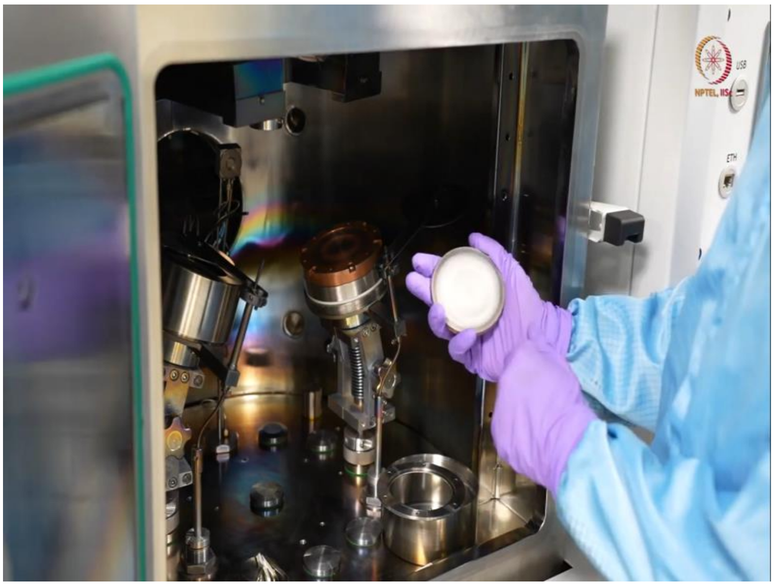

So, here actually you can see, this is the backplate is copper and here is the target. As we have used this earlier, so you can see that outside area that is still shiny and inside it is a little rough, because materials from here is already scraped out and it was deposited. So, with time there will be grooves. So, that will be visible. This is a new target. So, we cannot see that now only. But here you can see this is the magnetron so here we will get the negative connection.

So, this here is the electrode. So, it will come from here and with this you can manage the tilt. So, whether you can keep it like this or you can exactly make it straight, those things you can change as per your wish. So, here, if you have this copper backplate, then like transferring of the voltage or transferring of energy from the magnetron to this target will be easier. Because copper is a very good conductor.

So, if you do not have these copper back, I mean do not have target with copper backplate then it is better to use some graphite sheet or something on top of the magnetron before loading this target. So we are now placing it back. So we could even open after this and to show the things, but showing magnetron is not part of this course.

So, we will just stop here only after showing you how to load and unload the target. Because we do not want to show the repairing of the tool or somethong. So, here if we keep it here with their small groove, it may not be in, I mean it may not be properly held. So, this top layer is required just for that.

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So, first we will show how to place it back. Just make sure that grooving and all things are perfect and it is properly aligned, otherwise you cannot. So, otherwise, you cannot place it back properly. So, it will take some time, with time or with practice you will get more efficiency, how to do this.

So, when loading, do not close it to its extreme first and always try to like close the LN keys off or close the screws as a diagonal or the opposite area, just to make sure that it will not be tilted. So, almost similar things you can do. So, both the things you can see. And see this has a magnet, how do you understand. See this, you can see that there is a proof that magnet is there.

So, magnetron will work in that way, you can just place it like that. So we will just quickly place all the screws because two are there. So we have the references now. So, we can go with it quickly. So, here you can see, we just fixed this top plate with grooves to hold the target at a particular place.

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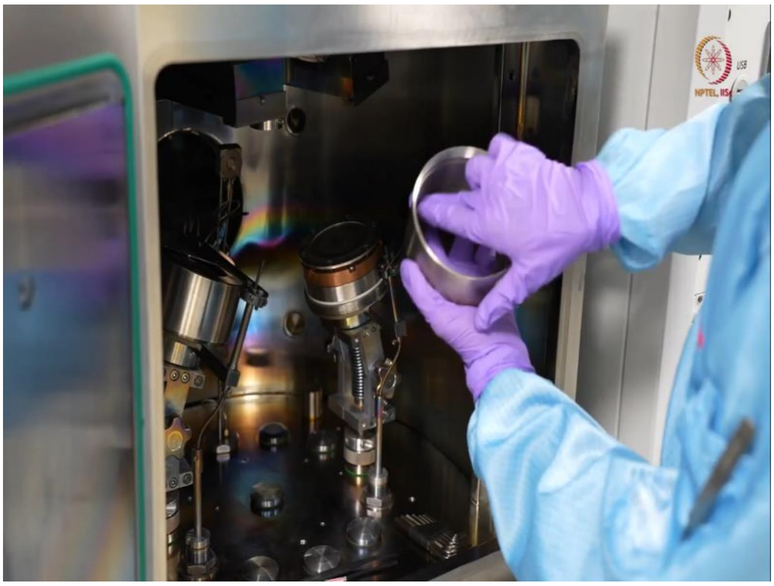

And now, this is the ground connection, this will just keep it, so you have to make sure that this part is clean, otherwise, this can be seen as a short connection. So before that, let us just press it. This is just like closing a container. And one thing just make sure after you load it, there should be a gap of 2 to 3 mm millimeter, 2 to 3 millimeter. So, this match gap and whatever voltage you will apply divided by this much gap.

So, that much potential difference will be there that will start breaking the gas supply or the argon atoms in ion and electrons. So, those ions will be bombarding on this target. And after this bombardment these atoms will come and fall on the substrate that will be loaded in the chuck. Here similarly, like, if you see here, we have kept that merge gap, that much gap. So, once it will start being in or disintegrating in ion and electron, it will create a plasma within that range. So, here, we will just now, let us close this, we already closed these things.

And we will check the same for the other one. And as we know that we do not have any insulator, so for that RF supply, we will deposit at some lower RF supply or lower power supply and here, as this is tungsten, so it is hard material and it is high melting point material, so it requires some higher power, DC power. So, we will see all these, before that we will load the sample, load on sample on chuck, and we will load it here. And then we will close the chamber. So, let us go to our solvent bench where we will be loading the sample.

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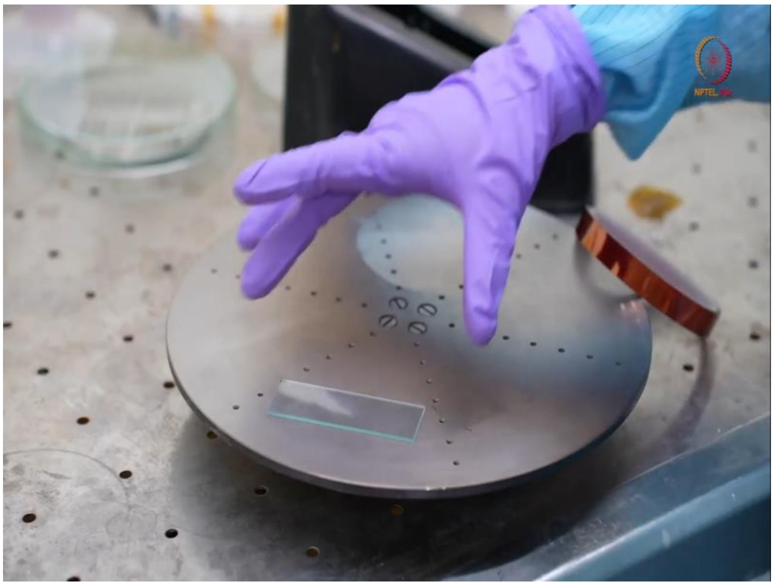

So, I have placed, so this is the chuck I have placed it here. So there is actually no particular, I mean, reason of a placing it here, if you want to, I mean based on your application you can keep.

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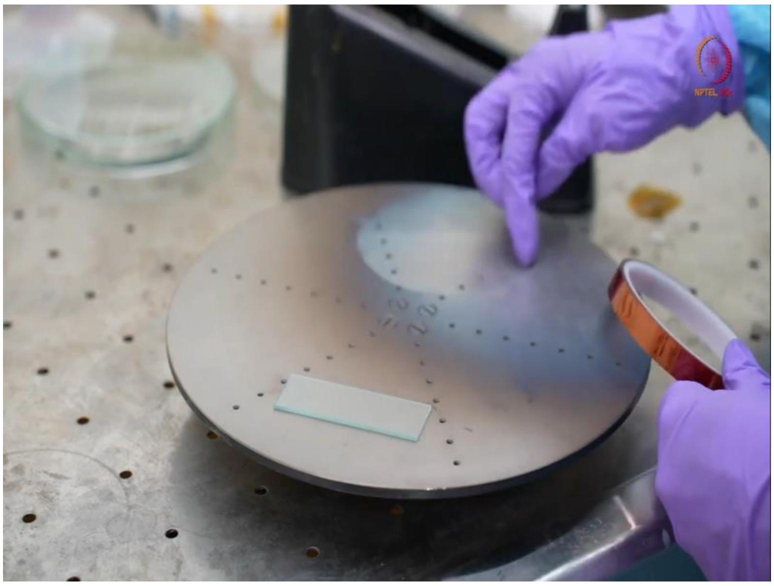

So, here you can see impression of one 4-inch of work. earlier we deposited, so that impression is still here. And after one deposition or two depositions, you have to clean the chuck.

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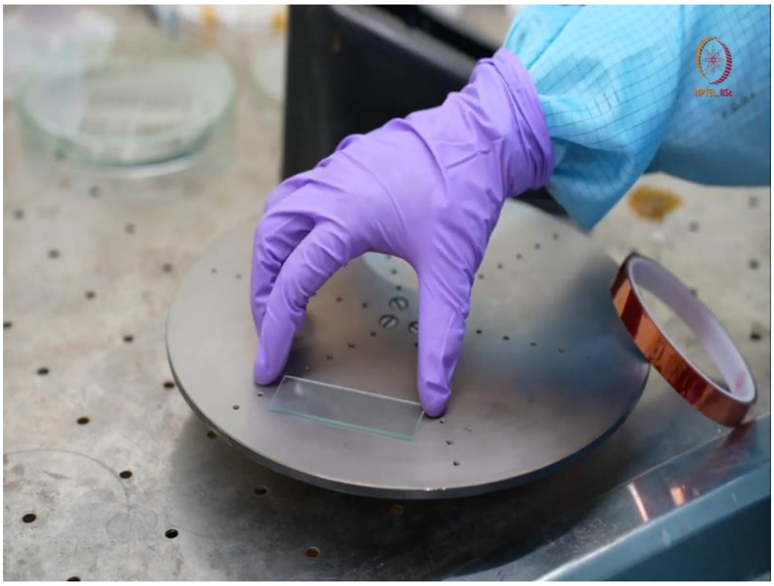

So here, you can see that normal blast slide I have just pasted one. So now, we will fix it with Kapton tape and in a single go we will deposit both the materials. Because here we are not actually targeting any particular device to fabricate. So, deposition is not, I mean deposition is important for demonstration purpose only.

So we will demonstrate DC, DC sputtering as well as RF sputtering both in same round. So let us just, we will just create some pattern type thing. So that it will be visible to you in a better way. Okay. So we are just sticking it. So, you can see on sharp edge, hopefully after the deposition that we want to show you. So before deposition, just make sure it is properly attached.

So that during deposition, when we will go for rotation like we always prefer to deposit under with the rotation. So when you go for a rotation, it should not fall on the target or it should not fall in the chamber. So for that you should make sure it is properly connected or properly attached. So let us go with that. So now we can see it is attached with some typical pattern that is that does not have any significance. But we just did it like that. We will show how this devotion happens.

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So we have the chuck here. We will just place it. This is the same process. So, closer view is not that important. So you have checked already during EBM evaporation. Similar loading process. So here when we are loading it, as we will be depositing in rotation, so it does not matter where we are actually loading the sample.

Otherwise, based on the magnetron, we had to load it properly, so that it can exactly come above one of the magnetrons that is a targeted magnetrons, like either this or that. But here as this is just like deposition and rotation and as this is just a demonstration, we will deposit both the materials on same sample. So we are just loading it.

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Here now, if we have any thing to see, whenever we want to see whatever is going on inside, we can always use this viewport. So we will show it here. So here you can just open the viewport and see what is going on inside, as magnetron is set properly, all the, both the covers I mean it is already covered by the shutter here. So, it will not deposit directly on this, the substrate on this. So, now it is good to close and we will start evacuation process. So, when the vaccum will reach, we will again start the deposition.

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USB
SYSTEM CONTROL
START BACKING PUMP
I/O
Reset
EMO


USB
SYSTEM CONTROL
TURBO PUMP READY
I/O
Reset
EMO


USB
ETH
SYSTEM CONTROL
BACKING VALVE CLOSE
I/O
Reset
EMO

So, let us come here. So, here we are in system control window, in this monitor you can see, either you can start or you can vent. There is no point of venting because already the chamber is in atmospheric pressure, as we just loaded. And we can see here backing pressure is still lesser than atmospheric pressure because we are not, I mean, we did not open those valves.

So, we just close a sealed chamber and opened it. So, that vacuum is still remain. Now, we will just start. So, that pump will be started after that we will come back to each of these points. Let us start the pump. So, it will take some time. As you can see already that backing pump is starting now.

So, when after some amount of backing, when there will be some safe pressure for the turbo to be ON that time turbo will start and it will be ON and it will show, see, it is already showing turbo pump ready. So, now, it will take some more time to get the cycle command. So, after that we can go for cycle.

So, now, you can see with turbo pump ready status, cycle is also glowing, so now we can go for creating vacuum. So, vacuum cycle is anyway it is automated. So, when you will start, we can discuss other things as well. So, it will start with laughing. So, backing valve will be closed, roughing valve will be opened and it will start roughing.

See, it already started roughing. So, in roughing step, it will first create or it will evacuate the chamber as well as the roughing line. So, after that it will be to the backing line because see backing pressure is always less and your turbo is ON, so that cannot be exposed to atmospheric or near to atmospheric pressures. So, it is duty of the turbo line to get that evacuation after that only backing will start.

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We can just get on better idea about this process from this system view. If you see this is the, I mean this is the chamber here, these are two magnetrons and here there are the connections like one MFC is dedicated to argon and the other MFC is dedicated to oxygen only, but you can use nitrogen as well, anything you can use here.

And here are the other gauges that are two Pirani gauges there and here one of the valves that is like for inlet. And here if you see this is like inlet means this is vent valve and if you see here one is this backing line, one is this roughing line, this is the roughing line that is ON now.

So, roughing valve is ON and through this rotary pump that is one, it is getting evacuated and again after some time, so high vaccum valve will be ON and backing valve will be ON and through these, through turbo, it will take over with time. So, when the backing pressure and these things are going on, we can just go back to check the status. This is the basic system view.

So, after this, this will be stopped. I mean or this will be or the roughing while will be closed, backing valve will be ON, then this part is already under vaccum, still it will just like a cross check, it will check through this with the Pirani gauge whether it is proper and then it will be exposed completely through this high vaccum valve. Let us go back.

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So, here when roughing is going on, we can just like extend the discussion a little bit. So here main menu, you can go back to that previous menu where system control, source control, everything will be there. Then you can come here, system view that you can that we already checked, checked just now. Now source control. Now the source control, you can access it from the main menu as well as from here.

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The source control as I already discussed, it will have all the information about this magnetron like RF power, DC power, these are two magnetrons, and this MFC or the mass flow controller, you can control how much gas will be flowing. And here magnetron shutter, whether to close or how to close, open, everything is here.

DTM is here and backing pressure, roughing pressure, all these things, all this information you can get here, we will come in detail discussion when will deposit the thing, I mean deposit the materials. So, here and here ACC control.

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So, from here this is basically accessories. So, here you can check or you can start a rotation of the chuck or you can use heater. So, these are the basic features that we can get here.

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Let us go back to system control here, so that after roughing we will see, till high vaccum valve is ON or it will start high vaccum like cycle. After that we will take a like, in offline, we just create the vaccum then we will come back for deposition again. But till the time just wait, hardly It will take few more minutes from roughing to back into this.

So, here you can see it will be almost equivalent pressure that time it will be shifted from roughing to backing or roughing line to backing line. So, before starting the process, you can just go back and check the theory classes for a better idea.

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So, here actually you can see this can, this is showing now the chamber condition. So, like see this is 24, whatever it is in red that is basically whatever it is the temperature sensed by the temperature sensor placed inside just on above the check. So, in the chamber, where our sample is loaded, that temperature is 24 now.

So, as of now, we this is the set temperature that in last depositions we have used that is 100 degrees C. So, this 100 degrees C you can increase, decrease still, till 400 degrees C you can go, that is up to the scope of this tool. So, here we are using or we used 100. But when we will deposit it or demonstrate it now today, so we will not increase the temperature because we are depositing metal only.

So, it is kind of useless to use this heater or heat the chamber inside. So, now this, before heating, we should think of what type of material is loaded there, if there is any polymer then we should check whether that polymer can sustain up to that level or not. That is one thing and then whatever, and the second thing obviously, what material you are about to deposit, that temperature is important or not.

Like let us say some material may need 200 degrees C for rearrangement or that is like some short aneealing you can tell, but if you cannot reach that temperature, then there is no point of doing it. So, these are the few things that you can get a better idea whenever we will just go to the theory part once again.

So, you can see still roughing is going on, we are waiting for that. So, here you can see now backing valve open just now. So, after that much of roughing, now it is pump down status and I think you can get the sound already. So, it is pneumatic valve. So, while changing from one state to another state, it will, I mean it will get that sound because of the pneumatic valve.

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See, now it switched to fine pumping. Fine pumping means through the backing line, now it is getting pumped or evacuated by the turbomolecular pump. Just for a confirmation, you can just check here, the system view. See now, this is closed, this roghing line is closed and high vaccum valve and backing valve is open. So, it is getting vaccum through this.

And if you go back you can see that now you can see the chamber, you can process, you can start process at this pressure or you can vent the chamber as usual. And we are not doing any venting thing here. So we will wait till this reach e power minus 6 pressure then we will show deposition of the materials using RF source as well as using DC source, Okay.

So, let us wait for some more time till it reaches e power minus 6. Usually, prefer 3 power minus 6 or 2 power minus 6. But thing is you can actually deposit any, at any pressure below 5 power minus 6 practically. But we as we have the capability of the tool, so we will just wait till 3 power minus 6.