Advanced Neural Science for Engineers
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Lecture 23
Lab 08
Sputtering Demonstration - II

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So, we are here after the break. So, as you can see here already. So, I mean pressure inside the chamber is around 2.7 e to the power minus 6, as shown here. As we have the zoomed in view earlier here. So, from there you know that pressure gauge will show what is the pressure

inside the chamber and that will be measured by the penning gauge, what is installed back side of this.

So, here after the, so, this is now we are good to go and we can start our process because standard thing is like we usually wait till 3 to the power minus 6. So, it is actually done. So, after this we can directly go to process step.

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But before going to process step, we will first switch on the argon supply because you know that for sputtering argon plays a very important role that you already know from the theory classes, or we will, I mean it will be covered in theory classes. So, argon supply will help to generate the plasma and argon being a little heavier than other gases and being one of the inert gases, it will not create any issue or it will not react with the either the target or with the substrate.

So, that is why we are using argon here. So, let me switch on that argon supply first, which one is there that we have shown in the introductory module. So, we will just switch it on and come. So, it is already on. But always because of the safety reasons, it is always recommended that whenever you leave the lab or you stop, you are done with the process, you should stop the gas flow everywhere. Because otherwise, it can, it may lead to some other accident.

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So here after the argon, we are pressing here process. So, in process mode, first throttle pumping will start. So in that way, I mean the pump down step or the suction by the vacuum pumps, it will not be in full, it will be like almost like half open type or the partially open type.

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So coming to the next part, we will go to source control now. So here, here it will be like all the menus available. So here if you can see here, like the first one, we have provision for RF power as well as DC power. And we have provision for MFC like Mass Flow Controller, argon, oxygen. So, whatever we can, we want to choose, we will choose in that way.

So here, we do not want to deposit any oxide layer yet deeper, I mean, in DC supply, like using our DC supply, we are first depositing tungsten. So, that is a metal. So we do not need any oxide in the environment. So we will do it with argon only.

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So before that the first thing, we will just switch on the DTM. So, as it is not completely optimized. So, we can just check whether some material is getting deposited or not, that will be actually good enough. So that we can understand what is happening there in the chamber. There is the first thing.

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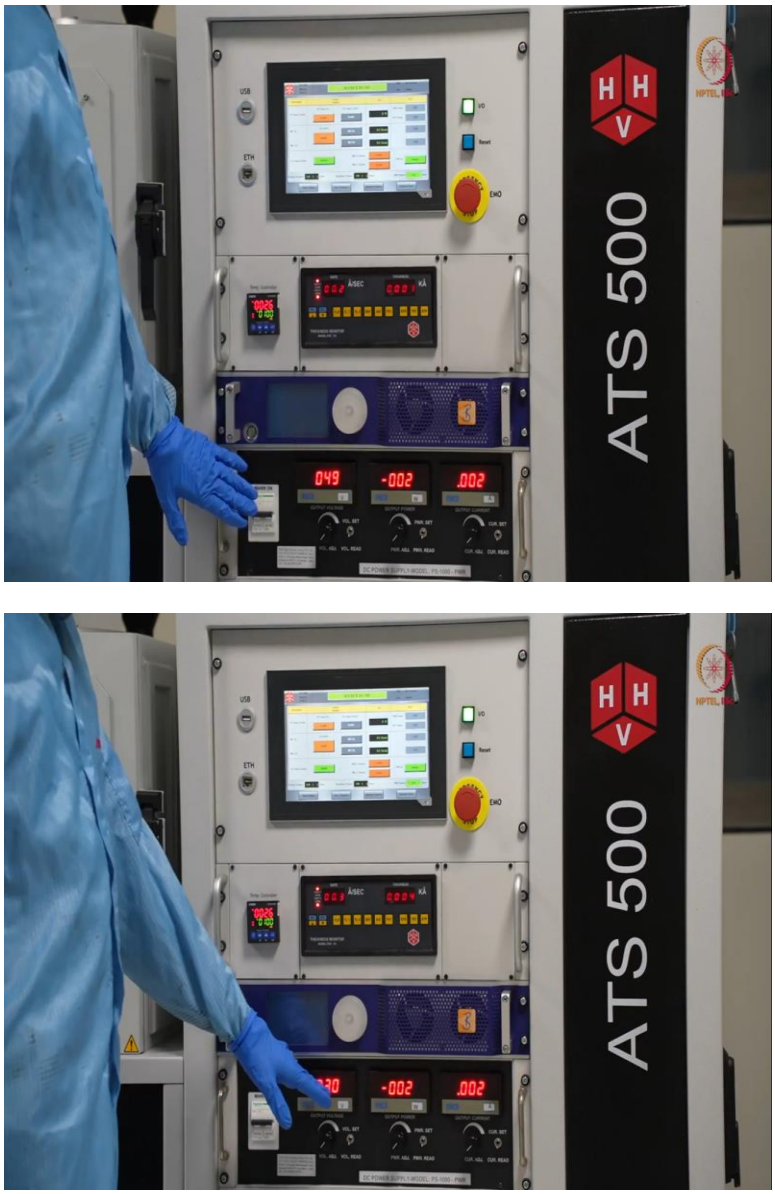

So here we have both options RF and DC, we will enable the DC supply. So just after enabling, you can see that here, this was on. So now you can see here, it will I mean, we will change it in such a way, so that plasma will be generated, we will go to that step. But before that. So, here we will switch on the MFC and for argon.

So, if we switch it on, then we have to give how much flow we want. So how much SCCM. So, usually 20 to 30 can trigger a plasma.

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So we will just try with that first, let us say we will go with 20. So, actually speaking, you can play around the figures like, if plasma is not there you can just increase the flow a little bit or like it depends on your chamber conditioning and what type of material you are using, you can just change the parameters accordingly.

So, here as you know that it is in magnetron two. So, that will come to that part later. So magnetron two that is the right side one that we have discussed already. So we will open this for this deposition. And here, if we can see ACC control.

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So, from here, we can start the rotation and we are going to do that. So rotation will be at 5 rpm, let us say. So here this is done. Now we may enable heater also but we are not showing it now. Because if this type of deposition, like metal deposition on glass that does not require any type of extra heating. But in case of an insulation deposition, usually we may prefer to deposit at some higher temperature. In that case, it is always better to use, I mean use this heater and deposit the material. So, we will go back to source control.

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Now, let us start the things. So, here now we will mostly see here and we will check whatever reflection is showing there and here.

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So, here at the first step, we will increase the output voltage. So, it just makes sure other things are all off. So, first thing is we have to set this power, how much power you want to deliver finally. So, let us say we will set it around 200 or 250.So, let us say we set it at 200, at 250 and put it as power, read power.

So, read power means actually how much is getting delivered at set power is the maximum how much it will be delivered. So, let us say, if we maintain it in such a way that V and I is so high that it will cross 250 then it will be like on cut-off. So, after 250 will not allow to deliver.

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So, here for that we will increase it first. Let us say around 300 to 400 we can go till that much. So, we are setting it at 400. So, as of now we cannot see any plasma. So, gas supplies on already.

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So, here first, we will start increase the current level. So, with that plasma is supposed to be generated. So, actually here we can see that plasma power is not allowing it to increase. So, it requires more gas supply. So, these things you have to take care when operating the tool. So, till now we have delivered enough power here. So, that much is enough for generating plasma and plasma is generated here also. So, you can just, we will just focus in the chamber, and we will show that plasma is generated. We can show it from here.

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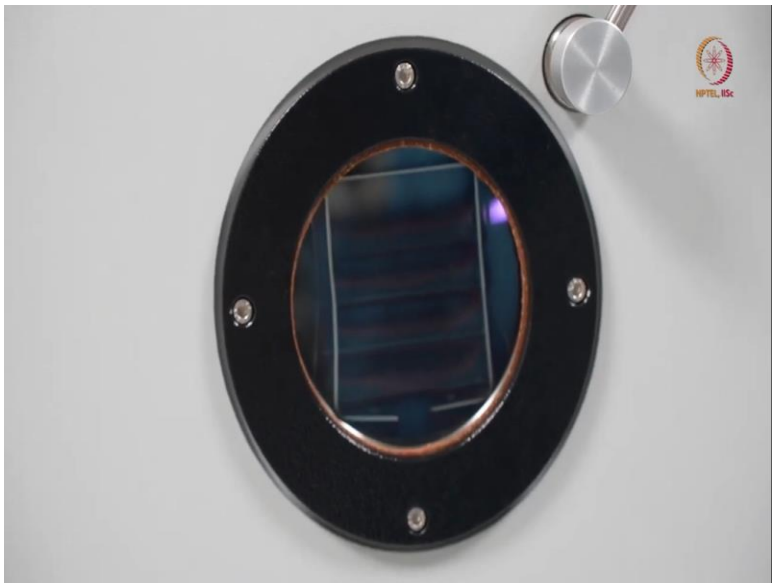

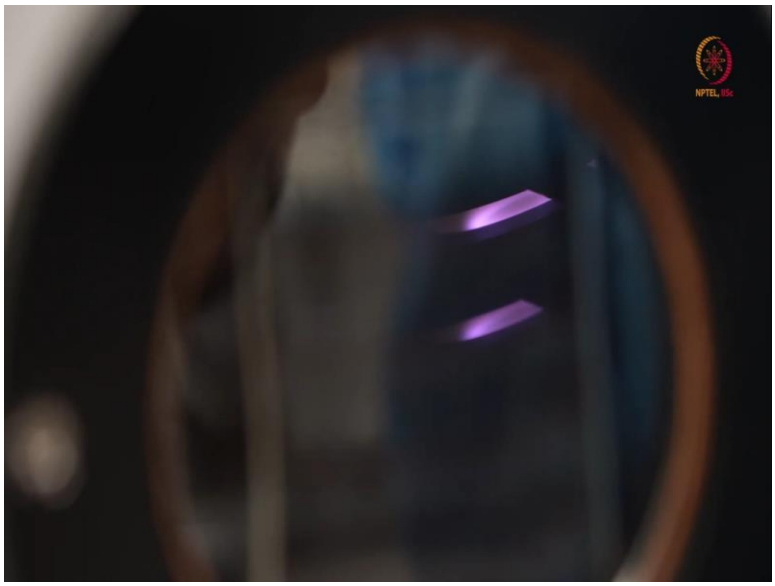

So, here through the viewport you can see, if you can go a little closer. So, see the plasma is visible, but you can also see that it is actually stopped by the cover there. So, that is our shutter. So, that shattered is basically to, I mean the shatter will be there. And it is depositing in the backside of the shutter as long as the flow is kind of stable.

So, it is depositing for some time. So, now we are going to open the shutter. So, you can see how it is. See now, now if you can, if you can see, now it is like a beam. You can see the plasma is from the target to the substrate like that much now it is flowing or that much is glowing that you can see from here. So this is DC sputtering, I mean that plasma.

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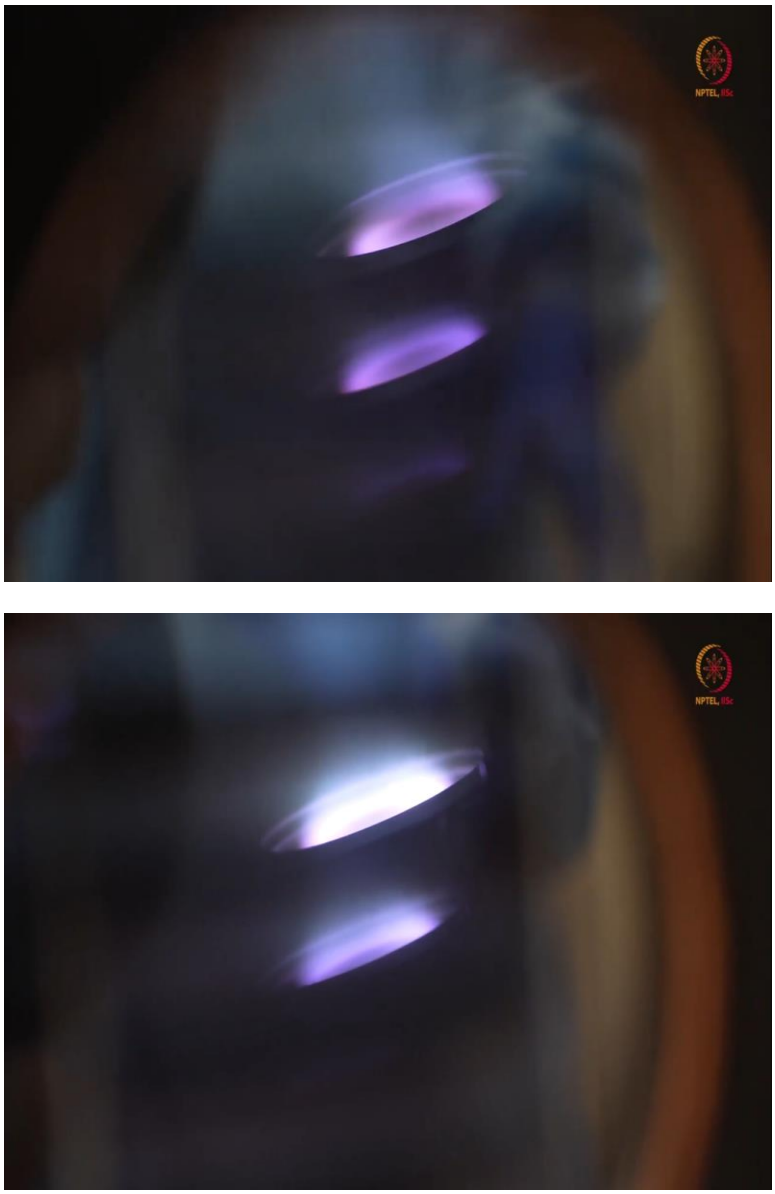

So, here if you see now, so, when you will just show you that whole panel that time you will understand. See, whatever the intensity was, now, this time, I have increased that supply voltage. So, with increment in supply voltage, obviously, I mean, whatever plasma power was there, that increased.

So, that means, you can control either the supply voltage or the supply current or the maximum power. So, any of these you can just control and you can control the power. So, now I set it, so that it will be around 150 watt. So, this is the colour. So, with power, colour of plasma will change.

So, that is something we were supposed to show you. So, here, we are to try it actually is in our case, we usually use these type of parameters only more than 150 watts. So, that colour will be like this. And whatever it is deposited, that we will show you in some time, like whenever it will be our deposition will be over. We can show you the things.

So, now, still you should see some increment there. Because, we have been, I mean, I have increased the current little bit. So, now, in this way, we can further increase the things. So, now, this is kind of the, I mean, I will request to show it from the front panel now, then we will discuss the remaining things.

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So, here as we mentioned, I change this to identify now. So, when you, I mean when we first focus inside, it was 400, now it is 525. Second, this one, these also have increased. So, that that effective power, I mean power delivered. So, we can we put it to power read. So, this is actual power delivered, this also increased to 170 and that is why that was the like, that was the plasma colour and that much of glow intensity that you saw there.

Now, the second thing is, after this deposition will show RF power, I mean deposition using RF power using the on the same sample only. Because this is something that we are not using for any any device purpose, this is just like for demonstration. So, we are using the same sample for both the things. So, we will stop this deposition and then go to that.

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So, for that the first thing you have to do is close the shutter. So, just like same as electron beam evaporation technique, first close the shutter. So, the deposition will be stopped, after that decrease the current. So, with decrease in current, you can see that here output power will keep on decreasing. So, if current supply is has currently stopped, this is also zero.

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So, now decrease this voltage. So, this is zero, this is also zero. Here, you can keep this set or it is recommended to just minimize the power also and set it each and every time. Here after all this, you can actually switch off this DC power. It was enabled. So I just disabled it. So then this part is off.

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So here, gas flow actually, we can just reduce it a little bit or we will just reduce it to 20 where it was. So, after that, we can switch off this argon supply also, disable and disable. So, this will switch off that MFC part. So, this is something like everything comes under one deposition of DC sputtering. So, after this on the same sample, we will show you the RF sputtering as well.

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So, for that, we just came to that ACC control again and we change this rotary drive to 10 rpm, it was set at 5 rpm. So now we just set it to 10 rpm. So, this will, I mean uniformity can be governed by this. So, you have to change this 5 rpm, 10 rpm everything that you can, actually, you can like optimize the parameters as per your tool.

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Now, let us go to source control. This time we will try with RF power. So, whenever, it will take some time because it is kind of auto. So, it will take some time to switch on. So another thing is, this steps are kind of similar, like we have to switch on this gas valve first, then MFC argon. Then again, let us start with Just 25 SCCM.

So, here just to tell you like DC sputtering usually can deposit only the, used for deposit the metals. But RF sputtering can be used for both metals as well as insulators. As we do not have an insulator target as of now, so, we showed here deposition of another metal. So, for that we like loaded aluminium target here for the deposition. So, we will show that only.

So, as this is a metal, so, it may require little or, and second thing is this is aluminium. So, that is kind of little softer metal and low weight metal, not that heavy molecular weight version. So, it will be requiring some less amount of power. So, we will set power accordingly and we will show the things.

So, again, if we see for, but this time DC power will be off. So, disabled and this time, we will switch on this magnetron one. That is the basic. Now, let us start. So, first as this is done, we have to set this RF, this power we will just set it. Let us say we will set like 30 watt. So, we will start with a minimum one, and as this is aluminium 30 watts should be kind of enough.

So, it will take some time and we will wait till it generates any plasma or we will just increase it little bit. 50 maybe. So, you can see here, what is the power it is actually delivering. So, for that we have set the power at 50 watt and MFC is set at 25 SCCM. So, with that we should have some plasma generated here.

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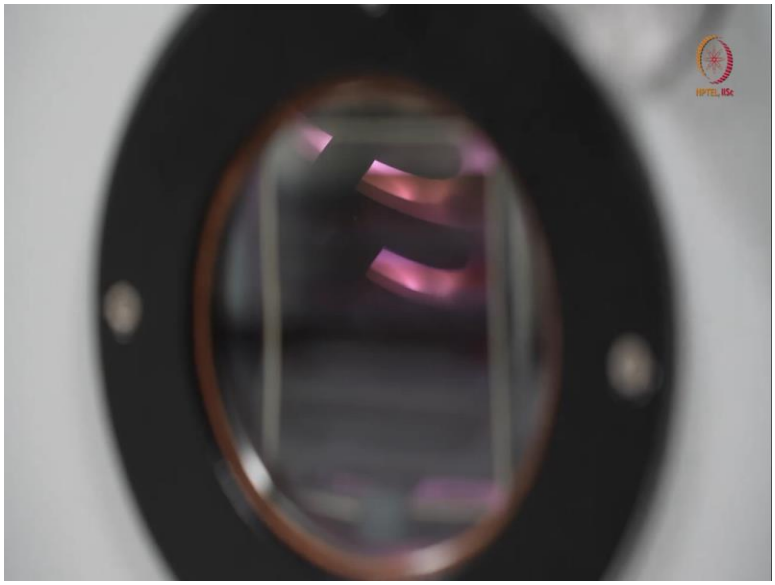

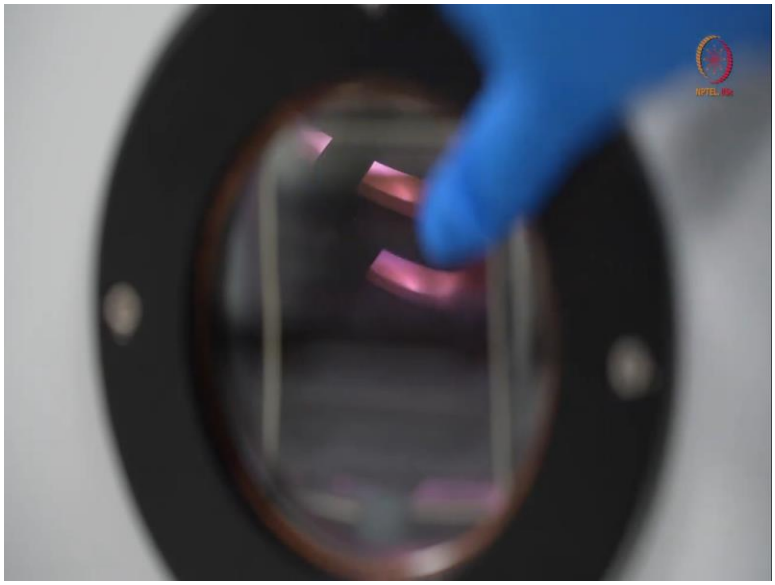

So, let us focus here in the chamber, if we can focus. So here at a closure view, we can see that I mean through the viewport what you can check here, see, if we can just opening the viewport again for a better look. So here, this is the plasma generated and here this is the shutter. So now this is to the magnetron one. So, magnetron two was that side, magnetron one is here. So this is generally, I mean powered by RF power, RF frequency as you can say. So, here, I will just open the shutter to show you.

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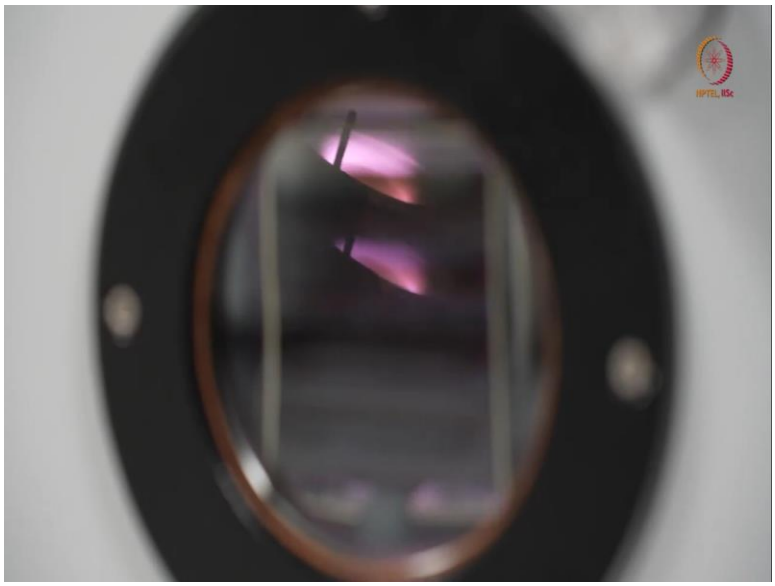

See. So, this is a plasma generated here. So depending on power, what type of material you are using, what is the SCCM all these things like how much gas you are flowing, all these things will matter when you come for any deposition. So these things you have to optimize by your own. So now for a better understanding, please, follow the, I mean theory classes once again. So in the PVD section sputtering, you will get some better idea.

So this is just the demonstration part. So now we will stop the deposition. We will take the sample out from the chamber and we will show you how that deposition happened. Actually speaking, we should deposit for more than like at least 15 minutes, 20 minutes deposition is required. But here as you can see, just 3 to 4 minutes are there. So, it will be just a very very thin layer, but still will show you that only.

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So, as you can see that we set it at zero watt. So, now it is zero. Now we can switch it up. So this part is done. Now here, if we consider this mass flow controller, this also have to switch it off. So first zero. So, flow will be stopped. Then disable that MFC argon and then close the gas valve. So this part is done.

So before shutting down or before opening, or better to say before leaving this window, we should stop this DTM also, because we cannot do that from outside. So from this window, we either off or stopped everything. Now, we will go back to system control.

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So, as the deposition is done, and here we are whatever this is at throttle pumping state. So as you can see, now we can actually, I mean, you no need to focus on the other things because you already know that these are switched off. So, we will focus more on the system control part now. And after that, we will just go to the chamber to see inside, whatever is happening or what happened already, these things. So here, let us say, we will just take from here. Now, still it is in throttle pumping stage, we have to close this first. So, we will press seal.

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This step is almost similar, whatever you have seen in case of electron beam evaporation. So, both are from like similar make. So, options are also kind of similar. When a chamber is sealed, so, we have to go for venting to open the chamber.

So, as we have deposited just now, we I mean, after devotion is over, we should wait for at least 10 to 15 minutes to cool down the things. So, we will I mean still that much time, we will wait. So by that time, we will just keep the cycle on. So, that vacuum cycle will keep on going. But we can even wait with the chamber sealed condition also.

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So, we already waited for almost 10 minutes and you can see that continuous pumping was on. So, pressure reduced drastically like it is now almost 2 to the power minus 6, which is actually even like very good for one tool or it is actually showing the tool health is also good. So, for venting the chamber, first will seal the chamber. So, that it will be detached from the pump, otherwise, automatically it should be done. But instead of relying on the internal tool things better you do it by yourself, then you go for venting.

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So, as I pressed vent, so, it is showing chamber vent sequence and then air admit valve open. So, currently we are getting the sound also like air admit valve is open.

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And through here. So, as we know air admit valve is here. So, through this venting is happening. So, air is going in, we will just open the chamber and see what is actually, how much was the deposition.

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So it will show something here also like how much pressure is there inside the chamber, that will come to know. As we can still get the sound that means that the air is still going in. When it will be stopped, we will understand that air inlet is stoped. So, we can open these and check how the deposition was.

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So, it is almost done and you can see sound is also not there, or it is very less. Now, let us try to open the chamber.

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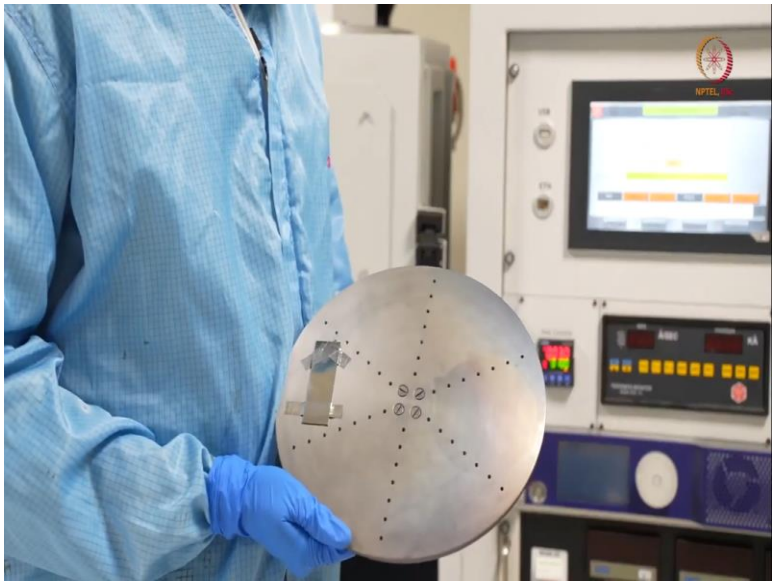

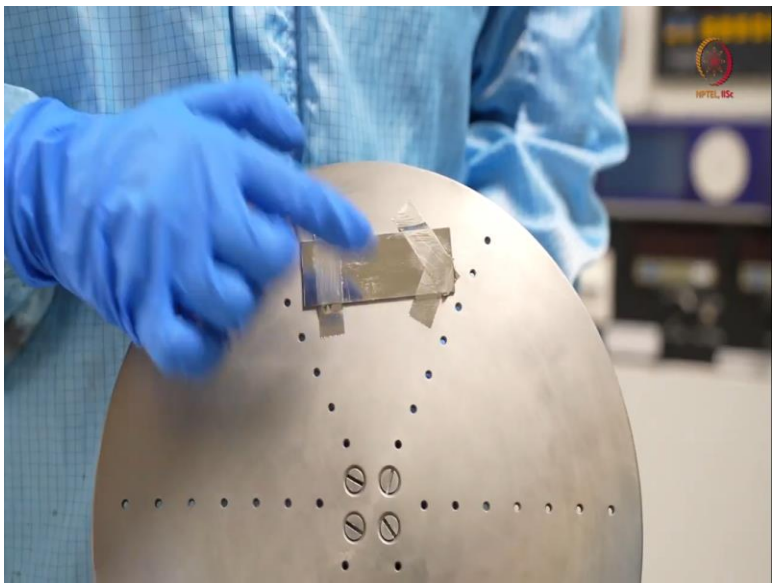

So, this is the chamber after the deposition. Now, let me just take this out and show you on camera. So, see, this is the chuck. So good amount of deposition already happened, because you can see this. So, we will just take these things out. And we will show you how much deposition has been happened. So, let us go to workbench for that.

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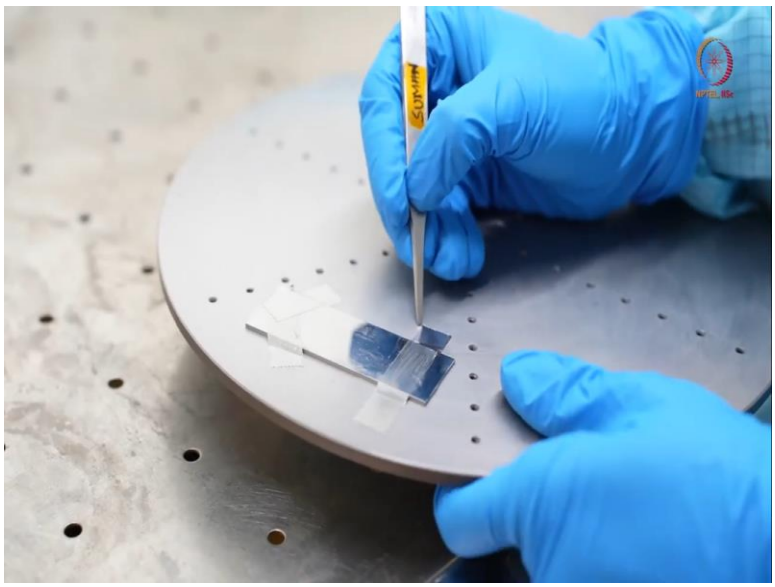

We are at the workbench now. So we will just take these kapton tapes from here. This take it little carefully, so that your sample will not break. So, this is the thick glass. So, there is like very less chance of breaking it. But if this is any silicon wafers or some other sample then there is a fair chance.

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So, here you see, this is this our sample work like a mask. So wherever it was. So, there is no deposition and otherwise there is some deposition on top.

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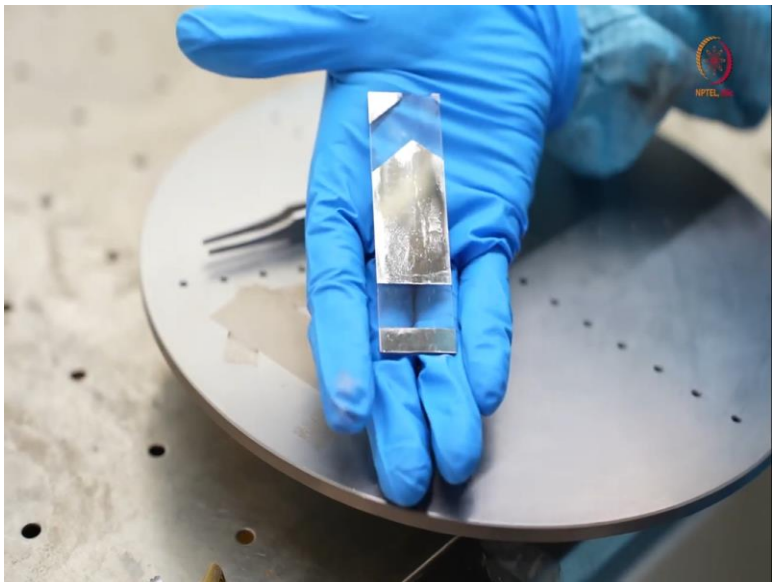

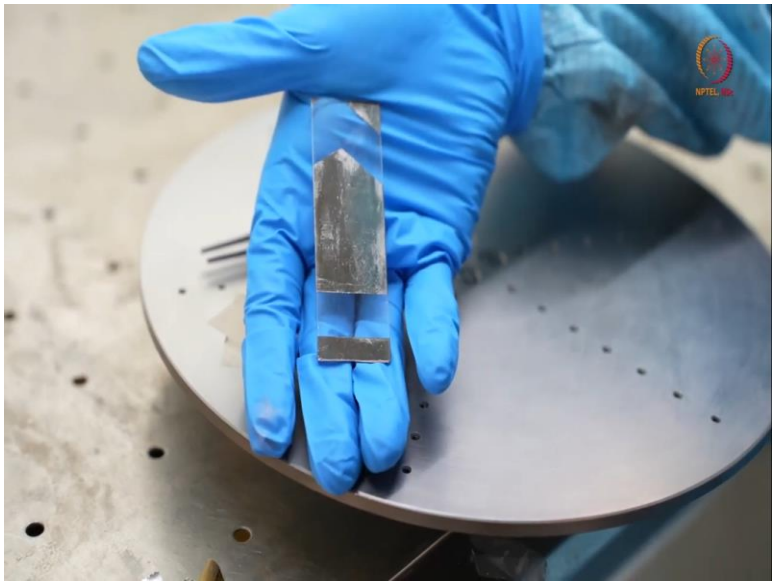

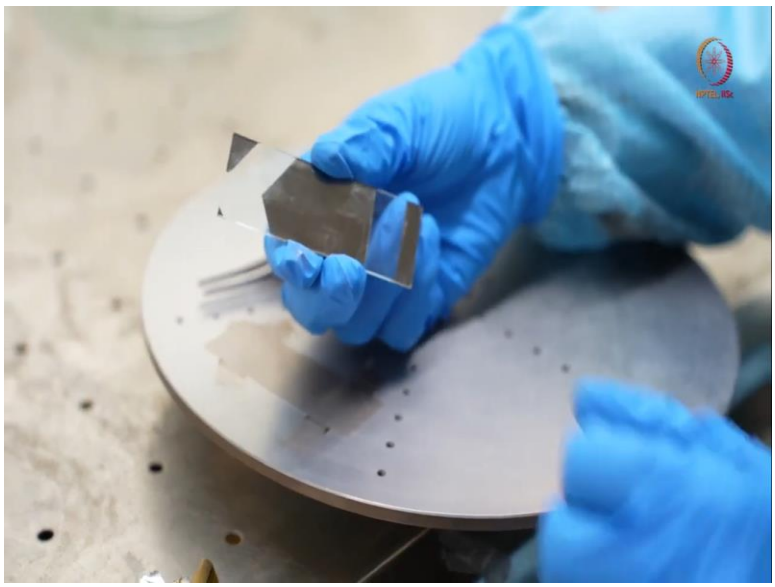

See this. This I just put it on my gloves, so that you can see the colour contrast. From here and from here also you can see. This is from the backside, as this is a transparent substrate, so, you can see from the both sides. So, this type of deposition you can do and you can see as the Kapton tape was pasted, based on that, we have some pattern on that.

So, this is all about the deposition. So, now, I mean switching off the tool that also will show after this. So, before that we have to put this chuck inside the chamber, then we should, then we will discuss the other things. Let us keep it here only on the workbench and let us go back to the tool again.

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So, here we will, so, whenever we leave the tool, it is actually kind of mandatory that you close the chamber always. So, that will help you to manage with minimum contamination level of the chamber. So, we will just keep it in as we have already shown how to place it back or take it out side. We are not again showing the things. So, now, this is already inside.

So chamber was actually clean. So, when you see that after a couple of depositions, chamber does not clean or liners needs to be cleaned or the chuck needs to be clean, that you can do after like couple of depositions, like after 5, 10 depositions, you can just clean the things. So, we will close the chamber, after as we have already placed it inside, placed the chuck inside.

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So, as you have closed the chamber, actually, we cannot leave the tool like this, because this is a vacuum tool that has a vacuum chamber here. So, if you leave the vacuum chamber at atmospheric pressure or under atmospheric pressure, so, actually efficiency of the tool will be lost or it will be compromised in long term. So, always we should keep it under vacuum.

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So for that, we will start cycle again. So, we are not pressing start this time, because already it was, I mean as we have shown when we started the tool, we have shown that we, I mean had to start the tool, so that pumps will be on after that we will go for a cycle. So, this is not the case this time. So, this is here.

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And another thing is we are about to off the tool. So we know that we are not going for further deposition. So, mandatorily, we have to switch off the gas supply. So, that we will do first. So, by the time it is creating some vacuum, by the time our gas flow is off already, though valve was off. So, gas flow was not there inside the chamber, but still it is better to be off.

So, here we can see the roughing pressure is around 1.7 e to the power minus e to the power 2. So, it started evacuating the chamber, but we should keep at least e to the power minus 3 or e to the power minus 4 pressure, that will take some time, maybe 10 to 15 minutes or 20 minutes it will take. So, till that much we will wait, because after that something else is also there to discuss after this.

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So, as you can see here, we left it for quite a long time and it is already minus 5 range. So, you can see here it is almost, e to the power minus 7.5 or e to the power minus 5, and it is still decreasing. So at this stage we can actually switch it off or turn off the tool. So, we have to wait till this much, otherwise, enough vacuum will not be here.

So, efficiency will be lost day by day, it will take long time but it is kind of deterioration process. So, here as it is you can see, it is almost 5 to the power minus 5 now. It is good to switch off. So, we will seal it first. So, I pressed seal. So, you wait as long as sealing process is done. We can see here system status as chamber seal. So, sealing is done.

After that we will stop, we will press stop. So, stop means you can see immediately, it is turbo pump decelerating. So, turbo von decelerating means turbo pump will be decelerated and when this will be stopped after that the other pump that is the rotary pump that will also be stopped.

So, but for rotary pump to be stopped, it requires that turbo speed or its rpm will be below some certain level, till that rotor day will be on as a backup. So, actually speaking, it will show standby, but for better health of your tool or for better longevity, you can actually, like after pressing stop, you can wait for 15 to 20 minutes.

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After that, you should like to turn off the tool by pressing this on a zero, this button. But till that time, we can just wait for some time, we will just show you that it will be standby mode. So we will be back like we will wait like around 10 to 15 minutes off camera, then we will come on camera and show you the things. So, we have waited for almost 20 minutes.

So that like after 7 to 8 minutes only, it will be on standby. So, you can see status as stand by. But we have to wait for some more time, so that speed or the rpm of the like blades in our pump should be completely like stopped or almost towards stopping. So that it will not, I mean the sudden switching off will not affect the supply or it should not affect the blades.

So, basically after switching off, it will just get a jerk. So, just to revise that at higher speed. So that damage will be less or damage will not be there. So, that is why we have waited for that long time. So, you can see this is like the state when we used to be at the first.

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So, after this we can switch off the tool. So just press this. So, after this tool is shut down from this part, still we have to switch off the main power first, then chiller and compressor, these two have to switch off. So that should be in our mind, okay.

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So, this is like demonstration of the sputtering tool. So far we have discussed, first we have discussed the parts here, the different parts, different gauges, pumps, whatever is here and where it is actually. So, based on which model you get or which model you use, basically, there will be a little bit variation of the placemats, but basic things will be same.

And then we have shown how to control the things and then RF sputtering, DC sputtering, so basically, using RF source and using DC source, DTM again. So, what are all, I mean how

these can be used and how was the deposition and how to do that part, like how to deposit the material, what type of materials can be deposited using which type was sputtering, all these things we have discussed today. So till next module, just stay safe. Keep learning. Thank you.