Advanced Neural Science for Engineers
Professor Hardik J. Pandya
Department of Electronic Systems Engineering, Division of EECS
Indian Institute of Science Bangalore
Lecture 4
Cleanroom and Gowning Protocol

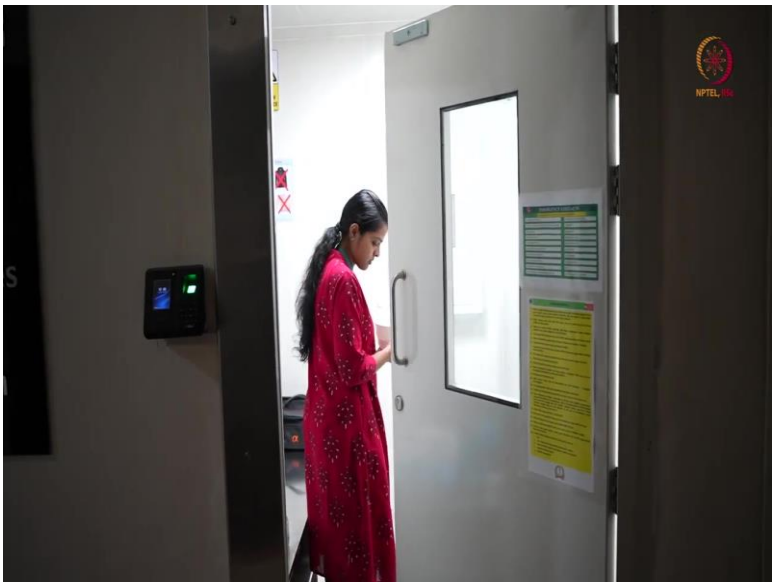
So till now, we have a very brief idea what we can do in cleanroom. So we have shown these devices that we have fabricated here itself. So now, the more interesting part, what is there in cleanroom?

So we will demonstrate so, for that Haripriya is there, my colleague that, so we both will go inside and we will show how to enter the cleanroom what are the protocols, what is what will be the do's and do nots, how to deal with the tools, what are all are the restricted materials inside cleanroom so we will discuss all these and we will go.

(Refer Slide Time: 0:49)

So she is already here, with our samples. So let us go inside. So as the as I told there are many restricted materials. So you cannot take your bags from outside to cleanroom inside. So we have a separate racks for that. So first thing whatever you have basically your sweatshirts, jackets, your bag, any outside material, you have to leave it in rack. Then as a next step, you have to remove your shoes, because outside shoes are not allowed inside so we have dedicated places for keeping the things in.

(Refer Slide Time: 1:38)



So here you can see there is an entry is restricted. So you have to give your biometric and you are allowed to go inside after that. So as you can see, she is going inside, so she cannot take the sample directly in. So she will place it in the pass box as we can see from here. So pass box is opened and now she is keeping it in. Now, she will close it from here and the other side we can see one more door, she will go inside and take it from there.

So now we have entered the cleanroom. So whenever you enter the cleanroom first you will enter a gowning area where you have to wear your like gown, your shoe cover, your mask all these things. So we will show that but before that, let us start with how to what is a cleanroom? Basically, a cleanroom is a dedicated area, dedicated lab where contamination, particle count, humidity, temperature, everything is controlled.

So here there are various types of cleanrooms or they can be classified as per the particle counts mainly. So if we see this is that cleanroom. Where we are standing now, this is plus 10,000 room. So what does it mean? So class in cleanroom means, in 1 foot by 1 feet by 1 feet volume, there can be maximum of, n number of particles with diameter 0.5 microns.

So basically in this definition, we are classifying cleanroom based on how many particles are there in unit volume and that should be with a particular diameter. So we are taking 0.5 microns as the standard diameter, this is the standard definition of a cleanroom. So class 10,000 cleanroom that you are standing here it means there will be at any point in the cleanroom there will be maximum 10,000 particles with diameter 0.5 micron or more in 1 feet by 1 feet by 1 feet volume.

So now, as I mentioned that this cleanroom is plus 1000 plus 10,000 that means the normal area is plus 10,000. And whenever we are using any bench like any weight benches lithograph area those parts are way cleaner, so that is plus 1000 range. So actually when we did the particle count here, we found that here in our normal area normal premises, the particle count is around 3000 to 3800 particles per cubic feet area that has a diameter of more than 0.5 micrometers and when we check inside the benches, so it turned out to be around 900.

So from there only we could classify that okay then this normal area is around 10,000 plus 10,000 and the benches are plus 1000. So that is about that is about our cleanroom specifications. So if you go for like standard fabrication procedures like standard device level fabrications in a standard device fabrications, so there you will find plus 1, plus 10 cleanrooms as well like by Intel or by other facilities.

But here as we are focusing more on biomedical, I mean, fabricating devices for biomedical applications and performing surgeries (rat surgeries) in house, here only we can fabricate the device, we can characterize and we can go for experimentation. So we decided that class 10,000 is pretty good and a standard one for these type of applications. So that is about the cleanroom, but it is not only the particle count that is controlled by this.

With particle count, we usually control the humidity, because humidity plays a very important role in few processes, for example, lithography. So whether it will be successful or not, that depends on temperature as well as humidity. So even humidity is controlled here and usually the relative humidity will be in between around 40 to 45 percent and the temperature will be always kept around 19 to 20 degrees Celsius, that is about general specification about the cleanroom.

Now, here, you may have a question how we are maintaining this particular count always or you can say how we are maintaining cleanliness in cleanroom. So that is done by air handling unit or AHU so that AHU usually that will be outside the cleanroom and ducts from there will come inside and through filters it will press or it will kind of you can say even it will flow the air with a higher pressure from top of the surface to the cleanroom.

So here you can see will show it on top. So there is one filter there, will show it in some time. So, whenever the air is flowing from that top, it is always a laminar flow, because if it is a

laminar flow, then whatever we are wearing, that may have some particles, so it can take particles out from there and put it on the floor.

In that way, this environment can be cleaner and the second reason is if the flow is turbulent, then it is difficult to recycle the same air again and again like recycling and filtering the air. To maintain all this easily streamline flow or laminar flow of air is maintained. Here you can control like from AHU you can control how much outside air or fresh air you allowed to inlet and how much you want to recycle that depends on like, how you want to maintain your cleanroom.

So here we will show you from the places from where you can provide the air flows and from where the air will get sucked that is one thing and as we told that, this is like artificial environment that we are making it something cleaner for our fabrication purposes as we are maintaining this environment for fabrication purposes. So there are many materials that are not allowed inside cleanroom.

Already we have I have mentioned a few like you cannot wear your sweatshirt or jacket because that contains a lot of dust particles usually you cannot wear shoes inside. Other than that there are many other restricted materials like if you have any marker pen from where you can get some VOCs or volatile compounds that you can smell at least. So by that you will understand whether VOCs are getting generated or not.

There is a very crude way of understanding. So for that any sketch pen or any ink pen, these things are not allowed inside cleanroom that is all. Then whatever the materials available in cleanroom that should be of non-shed materials. So let us say we are seeing this thing. So this is a metal wall. You cannot shed any material from here. So it will not leave or delete any material in the environment which can help in increasing particle count.

So all these materials will be not shared materials here as well as the float will be like that. That is the first thing. Second, you cannot wear any wet cloth inside, because any wet cloth will help to increase humidity inside cleanroom and that will like maintain environment inside. So you are not allowed to wear any oversized cloths inside.

Third, you cannot wear any oversized clothes because it should not come out of your hand or should not be used from any end because it can get caught in any of the tools. It will damage the tool first of all and it is a safety hazard for you as well. So these are the things and like only clean clothes are allowed.

Though we will gown and go inside, still we cannot gown also wearing any dirty cloth because that will first of all that will contaminate the gown and secondly, that contaminated gown will contaminate the inside environment. See as I am in gowning area, I can just wear like this and we are discussing now like this, but whenever we will go inside we have to gown properly and then only we will be allowed to get in. As just now we discussed.

(Refer Slide Time: 11:21)

So see here this is the inlet. So air will come there laminar flow. So that is one and after this it will go then there is the exit. So it will maintain a recirculation process. So ducts and everything is inside that one or above this.

(Refer Slide Time: 11:44)

And here there is a sticky mat that blue thing I think you can find it out pretty interesting stuff. So whenever we are going in, we will step on that. So whatever dust particles are there, below the cleanroom shoes, it will get stuck there then we can go inside. So that will keep our cleanroom little more cleaner. So that is the thing. So before going inside, we have to wear a few things like some PPE (Personal Protective Equipments). So from there, we will start that now.

(Refer Slide Time: 12:20)

So here, this is one of those, this is a shoe cover that you should wear on your issued wear, because that will keep the like whatever dust particles in your shoes that will be inside the shoe covered. So it will not contaminate the cleanroom environment.

(Refer Slide Time: 12:41)

Then here this is this is headband. So you can open it and wear it, so that your I mean dust particles from your head or the head itself will not fall on the fabric of the device, because I hope you know that the I mean our head can like contain a lot of dust particles first of all. And second one hair that that has a diameter of 7200 microns that itself can act as a contamination and that can fall on a device and many devices we will get damaged in a single book just by one hair. So this is one of the mandate things before entering the cleanroom.

(Refer Slide Time: 13:23)

Here is the mask. So we will wear the mask, because if we wear the mask, this will act in both ways. First of all, when you are exhaling, there will be a lot of humidity in your nasal breath. So that will be mostly absorbed by this. So you are not contributing in humidity of

this cleanroom that is first thing. And by any chance, if you spit or something like by mistake, so that will not fall on your device.

So that is more important from your device perspective, your device should not be contaminated. That is in one way. And second way. Let us say if you are working with some chemicals and let us say a fume is getting generated. So you should not sniff that fume. If this is there, so this will act as one layer of protection for you. So, it will not allow most of the vapor to go in that is this utility.

(Refer Slide Time: 14:34)

Then we have the gloves. So if you can see this blue color these are Nitrile gloves, powder free. So there are reasons for using these gloves. First of all, we should not wear any gloves that contains powder because that powder itself will be a contamination for your device. And if we can see the powders that means it is pretty big in size because most of the device of like 10 or 15 micrometers feature size we cannot even see that with our bare eyes other than using microscope.

So if we can see those particles that means that one particle is enough to damage one part of your device or completely maybe a few of the devices, if your device density on the wafer is more. So we need this powder free gloves first and materials should be nitrile not latex, because latex gloves has no chemical resistance.

So in one way if you wear this, so your sweat and all other things will not contaminate the wafer first and when we are wearing gloves, we should not hold it like that, then its basic purpose is not served whatever sweat and dust particles I have, I am transferring it to the

fingers of these gloves that should not be the case. So you just wear it minimum contact and wear this that is how you should wear gloves.

And now Nitrile, because it is a little bit chemical resistant not little bit basically thin Nitrile gloves, that we are using for day to day use, that can actually handle if it is a very low concentration acid or low concentration base, then your hands will not be affected. If it spills on your hand there also it will not be affected that is the first thing and secondly, these can withstand these Nitrile gloves can withstand acetone or IPA like this solvents, Ethanol, if any of the solvents that we use in daily basis.

However, not only this thin Nitrile gloves, we have many types of nitrile gloves, we have thin Nitrile gloves, thick Nitrile gloves, more than that we have MAPA gloves. After MAPA loves you have f-telon gloves. So MAPA gloves are good for little stronger acid that is basically acid protective gloves or separate acid gloves are available like that you should have when you are doing any chemical process like any etching or cleaning for using that or with these thin Nitrile gloves, you have to add a thick Nitrile gloves that is also available one gloves on top of the other one.

So it will be a protection against the chemicals like that you can safely handle acids or bases maybe with some higher concentration.

(Refer Slide Time: 17:39)

So these are the things basically we have. And we will show how to do because for gowing procedure, we have kind of process, kind of a flow. So we cannot wear one after another just randomly. There are reasons why we are wearing in that particular flow or why we are

maintaining the flow. So my colleague Haripriya is here she will gown and go inside and we will discuss that time why which of the PPE should be worn first and why it will be worn in that order.

(Refer Slide Time: 18:21)

As my colleague Haripriya already kept her desiccator in the pass-through chamber, we have shown earlier. So now she has to go in and collect the desiccator from inside because you cannot carry something directly and go like that. So inside there is some airflow, so that dust particle count will be minimized.

So now she will show how to wear all these PPEs like basically the gowning procedure and in the process we will discuss what to do and what not to do during gowning and while going inside cleanroom. So as I have already shown, so all these PPEs are here, mask, gloves, hairnet, and shoe cover. Now she will follow the particular order and complete her gowning procedure.

(Refer Slide Time: 19:19)

So, as a first step, she will start with mask. So usually these gowing procedure will be followed strictly in any of the windows. So these are like has to be followed strictly. So first, then it will be here and it is the second process. Now you can see here she has a long hair. So she should make sure that the hair should completely be inside that hairnet, she cannot keep it outside.

So from this way like from fore-head region or from neck region, it should not be visible or it should not come out of the hairnet, that is the first thing because we already mentioned that hair will contain lot of contaminants. So that is the first. There is our second procedure is over.

(Refer Slide Time: 20:14)

Now, she will wear shoe cover because already we have mentioned that your foot will contain a lot of dust particles. So she will put on here so cleanliness of this area and the other side that area is different. So we can wear I mean or we can move here with barefoot but we will not do that that. So she did that. So after that she will gown and put the suit.

So usually we keep it inside with airflow laminar airflow again from top so that whatever dust particles are there in the, or whatever dust particles are there on the suit that will fall. So it will be more cleaner than the normally kept suits. So, this is the standard way, first you have to put your legs and then like it is in that way.

So after that your hands will go like that normal very normal suits, we should make sure that on top of your hair net, one more cover will be there. So you should make sure about that then there should not be any exposed area except shoe cover covered foot and the hands after wearing this suit. So, that much you should make sure first.

(Refer Slide Time: 22:01)

So, after this, she will wear shoes and gloves will be at the last. So she is wearing cleanroom shoes. So if you can see this is a special type of shoes and it is a little bit chemical resistant also. So if it if some chemical spills, it will not affect her legs. So now she is completely gowned except the gloves. Why gloves at the last? Because just after this gowning, you will go inside and start your procedure.

So if you wear gloves first or in between any steps, so it will gather more dust particles on the gloves itself before starting the process. And that will affect the device fabrication. So wear the gloves as the last phase or at the last step of your gowning. And in that way, you can cover your hand and you can eliminate gathering dust particles on the gloves.

And there is a particular way of wearing the gloves that she is showing now, you can see that. So gloves should be on top of the gown or that cuff will go inside and gloves will come out of that. Why is it so? This is because so if any dust particle or if any contamination generated by your skin or by you basically so that should not fall in the cleanroom. So it will be contained in gloves in this way if you wear gloves in this way.

So it will come to the cuff and it will fall inside the gloves. So now she is ready to go inside because she is wearing all the PPE that is minimum requirement to enter the cleanroom. And I am still standing here at this site because I am not even wearing shoe cover not even wearing any of the PPEs. So for me to go in, I have to follow the same procedure that she followed.

(Refer Slide Time: 24:09)

So now she is entering the cleanroom so first, she just stepped on the sticky mat so that some dust particles whatever below the shoe that will get stuck to the mat and she can go in after this. So see she is going in and whatever dust particles are there that will be stucked to the mat itself.

So these sticky mats after some usage this sticky mat will be full of dust that time you just remove one layer put a new sticky mat that is how you can keep the environment a little more cleaner as she entered the cleanroom we can see that she directly went to the acid bench and switched ON the light and suction for that hood.

And then she will take the sample that she kept in the pass box. So here she is opening the pass box to get the sample, she is taking that whole desiccator from there, close it again.

(Refer Slide Time: 25:22)


ACIDS ONLY

So she will now open the desiccator and from there she is now taking the sample that she wants to process and with that then just close the desiccator. Ideally, we should keep the desiccator always under vacuum. So she has to keep it under record, but after the process she will keep her samples and then she will do the same. So she will start the process will.

(Refer Slide Time: 26:06)

So in this module, we have discussed the fundamental things about cleanroom, how to define cleanroom, what type of cleanrooms we have, then what is the usage of this pass box, how she put it all in from the side and took it from the other side not directly taking the samples inside and then how she gown like wearing all the PPE in a particular order.

Then she took the samples from that side and went till the hood for the next chemical process. So we have seen these things today why these sticky mat is used, why these type of PPE kits are required, all these things we have discussed. In our next module, we will start with the actual fabrication process from the next module. Till then take care. Thank you.