Advanced Neural Science for Engineers
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Lecture 3
Introduction to Fabrication Lab

Hello everyone, welcome to the course Advanced Neural Science for Engineers. And now, today is the first lecture, we are going to show I mean first lecture of the lab module. Today, we are introducing you to all of the clean rooms that we have in IISc. I am Suman Chatterjee, I am a scholar working with Dr. Hardik J. Pandya in Department of Electronic Systems Engineering, IISc, Bangalore.

So, when we get any news or any technical report about any device any fabricated device less than 10 nanometer device dimension or any feature size like that, we always get excited. However, we never think of what type of environment may be required to fabricate such devices or what type of facilities may be required for that.

So, today, we are going to show you one of such kind, which is not well equipped to go till 10 nanometer systems or subsystems, but we can easily go till some nanometer or higher nanometer range or micron range. So, today we will be discussing or we will be introducing you to one of such clean rooms.

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You can see here so, this is our lab here in IISc in DSc. So, Advanced Microsystems and Biomedical Devices for Clinical Research, so, here we are doing some fabrication over here. So, after fabricating the devices, we have separate bio section where we usually check the device, characterize the device and after that, we usually implant it and the implantable devices can record signals from rats as of now, we are going for raT experiments only.

So, we have a complete module here for fabrication, characterization, implantation, and any type of chronic experiments. So, we will show this step by step. So, this is just the introductory module. Before detailing what is so special about a cleanroom or what are the differences in one cleanroom and the other labs like in a normal environment.

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We can see just a glimpse of our cleanroom here from outside we can see only a few deposition systems, HEPA filters or microscope, these things. We will come back to you with each and every detail of these tools later on in our later modules.

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Before going inside, from outside we will show some of the works that we have done using this facility.

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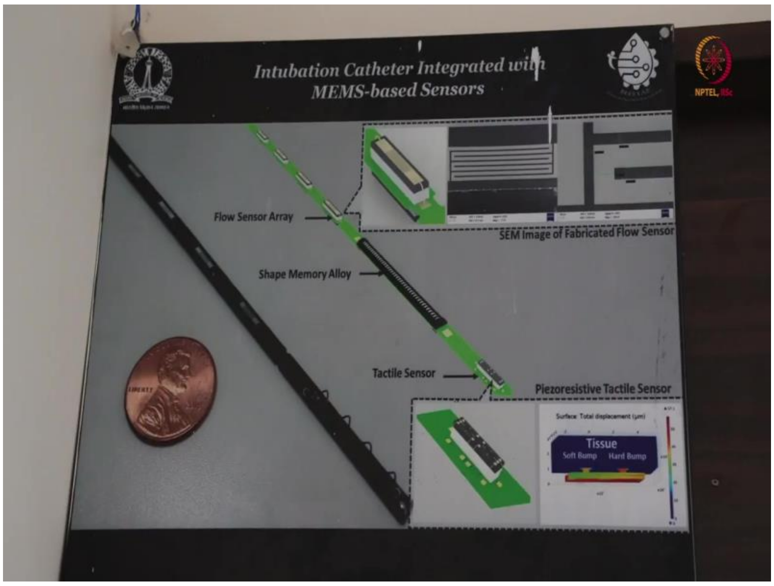

So, this is the first image is discussed about intubation catheter integrated with MEMS-based sensors. So, here we can see in the image, there is a flow sensor array and a tactile sensor, which are used for understanding the airway choking or airway obstruction. So, here we can see the flow sensor array was implemented by a series of heaters.

So, tactile sensor that is basically is a resistive tactile sensor. So, these are integrated on a flexible PCB. And here these arrays like this force sensor array, that is basically the heater, those are fabricated in our facility.

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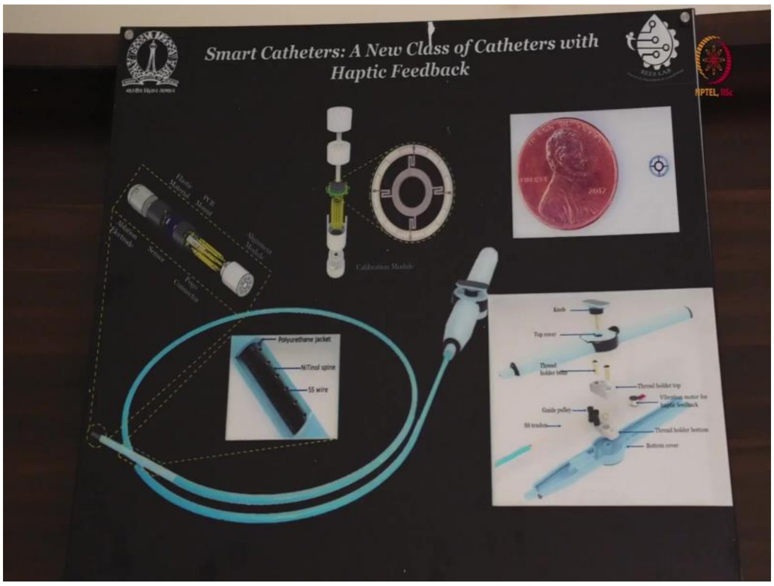

Coming to the next image. Here we are showing a smart catheter, a new class of catheters that can sense the haptic feedback. So, here we can see. If you can see on the right side, so there you will see there is a fabricated catheter on a silicon wafer. If you compare the size of the one cent coin and the fabricated device, then you will understand how small it is compared to what you can see usually.

So there lies the importance of microfabrication that you can downsize any microsystem or you can downsize any device to whatever extent you want to minimize. So here, this is the catheter module and that is packaged within a catheter that we will be using for measuring pressure or basically measuring pressure and from which way that force is coming. This is the flow sensor.

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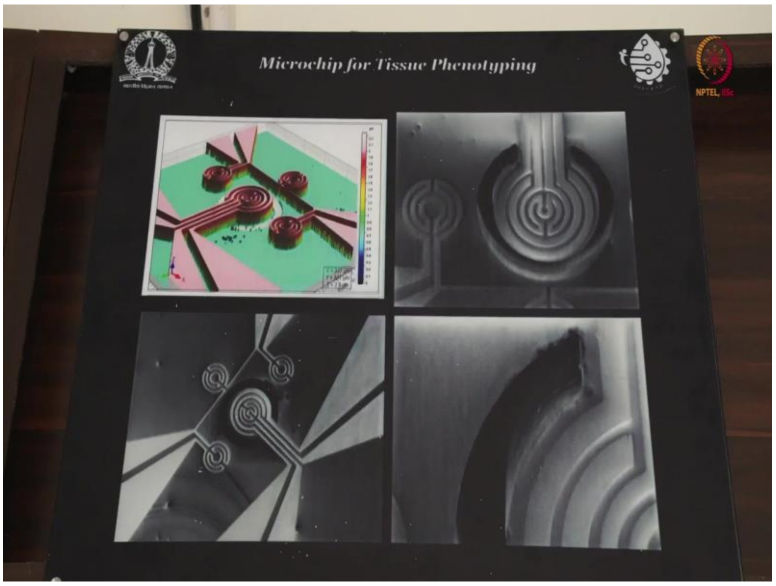

So coming to the next image. So, this is a microchip for tissue phenotyping. So, here we are doing ETM characterization is part of that project, ETM characterization is electro thermal mechanical characterization of cancer tissue. So, this is just one part of that where we are changing I mean, at the center you can see one heater and that is detached by the through holes from the other areas.

So, the heater will be used to maintain a particular temperature for the tissue and using the other three parts, it can record the impedance of that particular tissue. So, using that we are doing ETM phenotyping this is one part of that work.

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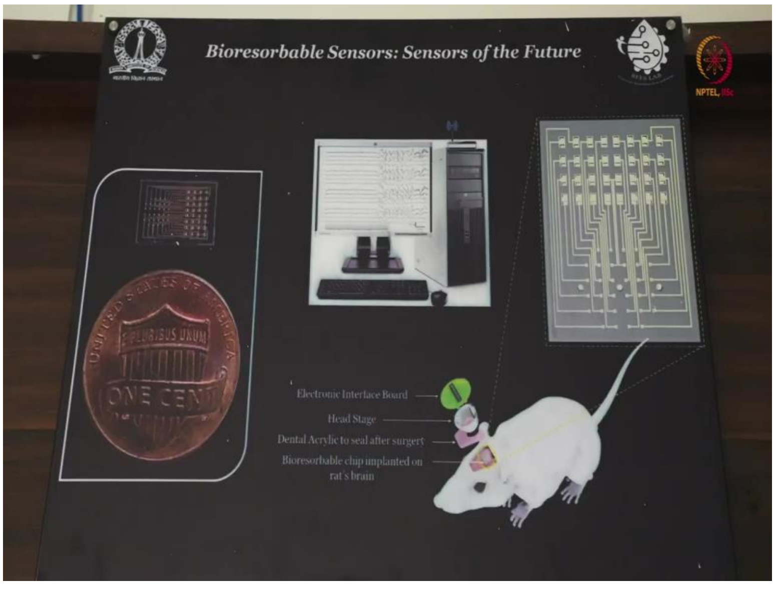

Then coming to the next one, this is a bioresorbable sensors that is silicone based bioresorbable sensors that we can see here. This is a 32 channel recording array. So, this can be implanted on a rat's brain. And using this we can record electrocorticography signals from rats under different conditions like, the baselines like normal ECG signals as a baseline then maybe epileptic activities, then maybe recovered baseline as well.

Then if there is some other evoked potentials that also you can measure by this 2D arrays. So, basically as you can see, these 32 channels, these electrodes, which are shown here, these electors can record it from electrodes can record from the cortical surface of the rat and contact pads are there to take the connections from there.

So, here also you can see compared to that, one cent coin, the fabricator device is pretty smaller and can be implanted on the rat's brain. And here is the complete assembly like electron interface board, the head stage and how to fix it using dental acrylic or what can be the 3D printed module you can see here.

So, everything we can get a glimpse of that and in the course, we will be discussing some similar type of devices, similar type of implantable devices for recording electrocardiography signals and if possible, we will show the complete fabrication process of one such device.

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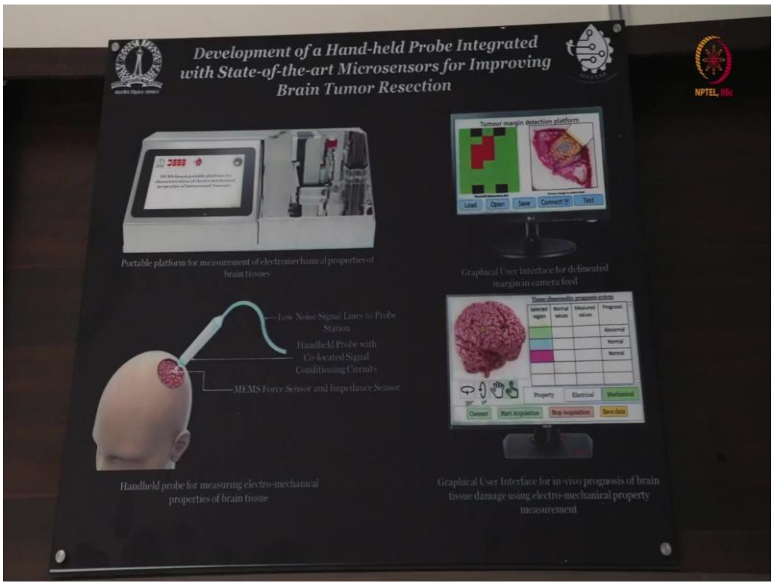

Coming to the next image, this is basically some hand-held probe integrated with micro sensors for improved brain tumor resection. So, here this is a good amount of packaging is there with fabricated device. So, right side top image you can see one fabricated image that can be useful to delineate or to understand the tumor margin and it is connected to the probe that surgeon can use during operation.

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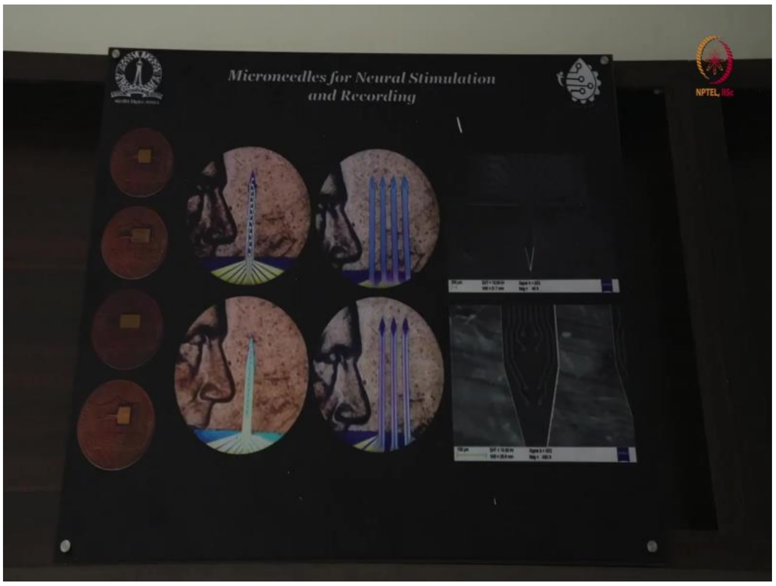

Now, coming to the next image. Here on microneedles for neural stimulation and recording. So, here we can see and the leftmost side you can see single shank micro needle, three shank micro needle as well as four shank microneedles. So, here you can see on top of a cent, one cent coin, this microneedles are places so, that you can get a competitive idea how small the tips can be.

So, as per the design we know, all these arrays or all these shanks are less than 150 micrometer wide and thickness around 200 micrometre that we can see it in images also. So, from there we can understand that these three shank or four shank or single shank devices were fabricated.

And in the modules in our course lecture already this recording of the local field potentials from a brain depth is already discussed in the course module. So, here we can record SEEG signals basically, which is, stereo electroencephalogram signals. And if we modify the top surface of the electrode array, then we can stimulate the idea as well. So, this is whole idea of the project. So, we are just giving one glimpse here.

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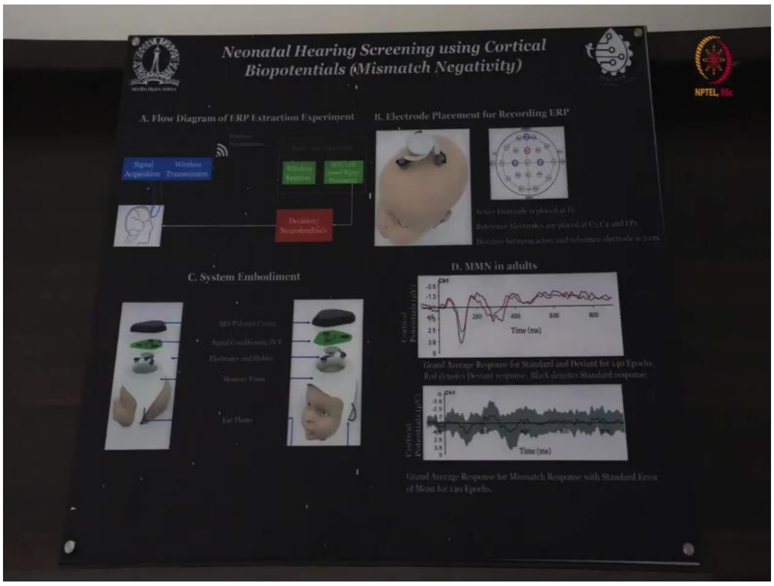

Coming to the next image, we can see that this project is about neonatal hearing and screening using cortical biopotentials, basically the mismatch negativity. So, here if we see we are recording it from outside the cortical surface, this is all of the projects that is regarding analysis of the EEG signals as such we cannot see any fabrication here, but this is also another work from our lab.

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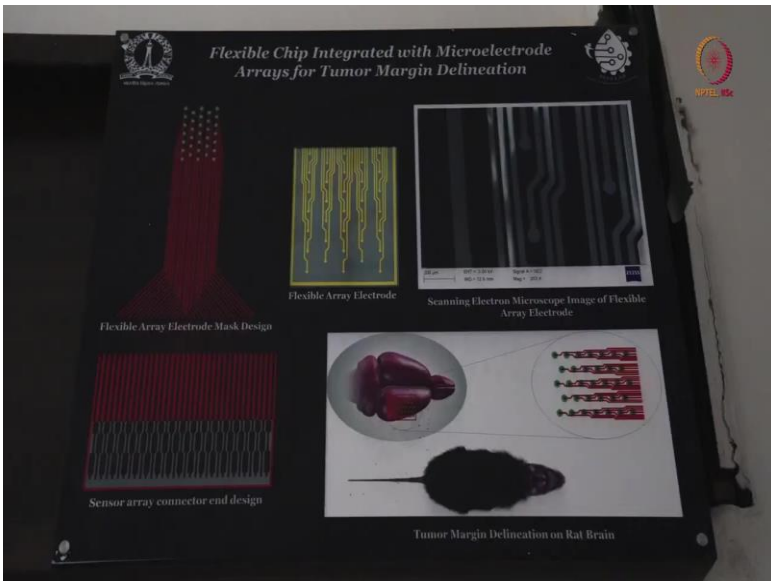

As you can see here in this image. So, this is showing a flexible chip integrated with micro electrode arrays for tumor margin delineation. Here we can see these 32 channels, electrodes, these electrodes are fabricated using titanium and gold and on a flexible substrate that is polyamide. So, on polyimide this is the design what we have seen here, not only tumor delineation, we can record electrocartiography signals in different stages like maybe epileptic activities, then baseline activities or recovered baseline activities.

Then any evoked potentials using these channels. So, here these 32 channel, electrode array you can see and the representative image is also showing that we can place it on the rat's brain quite comformally, so that we can record the signals as we want to. And here we can see the ACM image as well, so, that we can understand that this device could be successfully fabricated and will come in details in the later modules.