Electronic Systems for Cancer Diagnosis
Dr. Hardik J. Pandya
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore

Lecture – 20
Silicon substrate devices for breast cancer diagnosis

Hi, welcome to this particular module. Here what I want to show it to you is in the previous modules we have seen a process flow for fabricating three different kind of chips. If I want to say two chips and one sensor that will make more sense, because we have fabricated piezoresistive microcantilever. And then we have also seen interdigited electrodes, and then we have seen a flexible sensor with electrical and mechanical model with that can understand or that can measure the electrical and mechanical modalities. And then we have seen a chip which is integrated with electrical, mechanical and thermal sensors to understand the electro thermo mechanical properties of the tissues.

This tissues we are talking about is from the oral cancer or the breast cancer. Now, what we are interest study is can we design a system that can understand the change in the tissue property as cancer progresses. So, let us see now whatever we have learned how the thing looks like right, and that will give you a better idea of the dimensions and the chipset we are talking about. So, first let us see the slide and then I will show you the chip ok.

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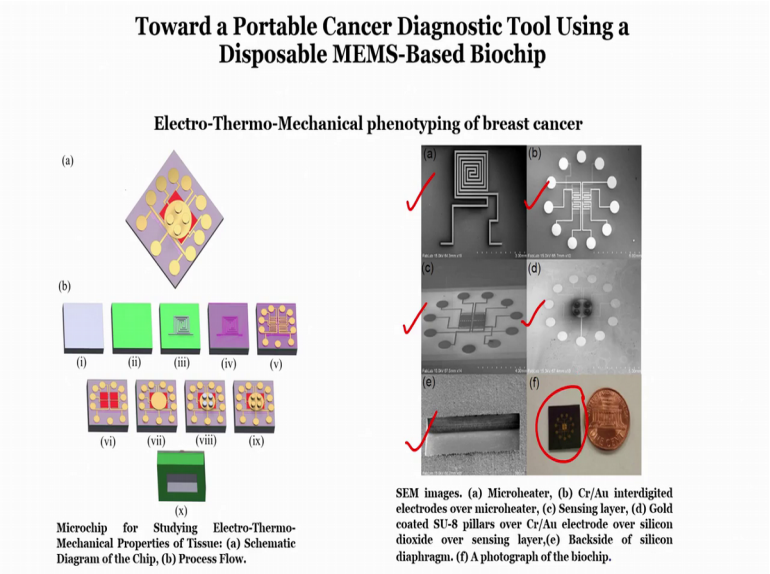

If we see the slide, this is the chip that we are talking about. And you if you remember this chip that we discussed as a heater, and then there is a insulator right, heater, then insulator, then interdigited electrodes, over that you have piezoresistive sensor, over that insulator, over that you have gold electrodes with SU-8 pillar, and SU-8 pillar we are coating with a gold. Then we have a diaphragm on the back side of the chip, because when you press the piezoresistive sensor, the silicon should bend. And if you have thin diaphragm it will bend depending on the tissue stiffness right. And this is how the chip looks like, but it is difficult to see exactly what are the things within the chip. So, let me now show it you how exactly the chip looks like.

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If you see my hand, then you will understand this is the chip that I am holding in my hand. If you see these are the chips 1, 2, 3, 4, 5, 6 ok. And one that I am showing it to you right over here right which is the center of the this chips, this chip all the chips in fact consist of the dot in the center the dot in the center of the chip consist of all three sensors together all right.

So, it is really tiny. If you see it is really tiny and that is why we say it is a microelectromechanical systems based sensors all right. So, this is a MEMs based biochip. And as you can see the center of the chip there is a gold circle right that itself is a gold pad and over that gold pad there are SU-8 pillars which unfortunately you cannot see through the that the camera, but we need to have a high magnified view of that and

that is why we are showing it to you or particularly in this slide I am showing it to you the SM image of the chip right, it is very clear. So, this is how the chip looks like. This chip we will place inside the 3D printed casing, and then we will perform the experiments right. So, this is one thing.

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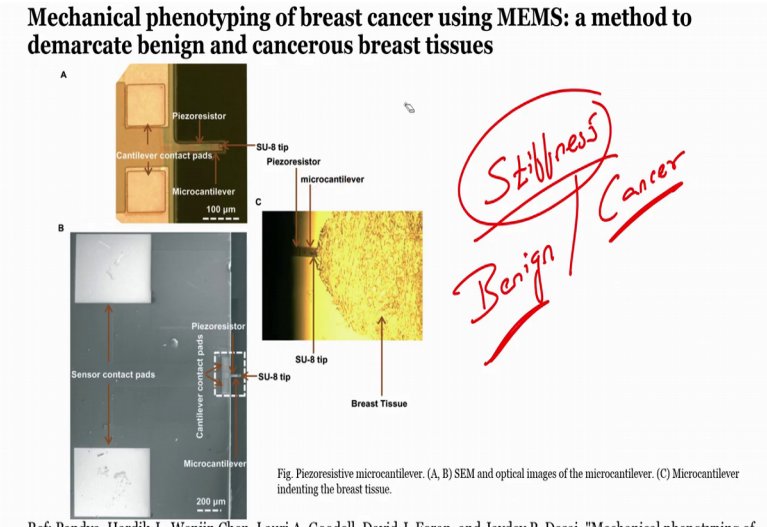

Now, if you go back to the slide and you see the second one which is the piezoresistive sensor. Now, you understand that there is a piezoresistive microcantilever it was used to it was used to understand the stiffness of the tissue, stiffness how stiff the tissue is where tissue is from benign region or this from cancer region right, benign region or cancer region, what is the tissue stiffness. This if you want to understand then we can fabricate a piezoresistive microcantilever, and as you can see here we are indenting the tissue right with the help of MP 285 micromanipulator. And when you indent the tissue what will happen depending on the stiffness of the tissue, the cantilever will bend this is the cantilever that we are talking about right, and this is a chip this is a chip ok.

So, I will show it to you why I am drawing the circular on the cantilever in around the chip. This is the chip right. And this guy is a cantilever. Of course, the complete chip we intend to use because this is connected to the contact of the cantilever, this is connected to the contact to the cantilever, and this is the cantilever beam and there is a SU-8 tip at the edge of the cantilever beam ok.

So, now if you see if I want to show it to you how this chip looks like, let us see in my hand. If you focus on my hand, you will see, if you can zoom in please again, if you can zoom in yeah thank you. So, whatever maximum you can zoom in still you cannot see the microcantilever chip and that is the beauty of the microfabrication. This chip is really tiny I am showing you this two chips right over here, the top of this particular disk. And the chip that you can see right is just without you cannot see the cantilever, the cantilever is about 130 microns, you cannot see it right. Human hair is from 80 to 100 microns.

The chip consist of the microcantilever which is 130 micron, you cannot see with your naked eye or it will be very difficult to see with a naked eyes, but what you can see here is the chip right without microcantilever right of course, there is a microcantilever, but you cannot see the microcantilever thats what I mean without microcantilever. So, the chip has a piezoresistive microcantilever, but you cannot see the cantilever, but you can see the chip right. So, this is how the chip looks like; it is extremely tiny right, extremely tiny. So, very difficult to handle compared to this is very difficult to handle the chips which is having the piezoresistive microcantilever right.

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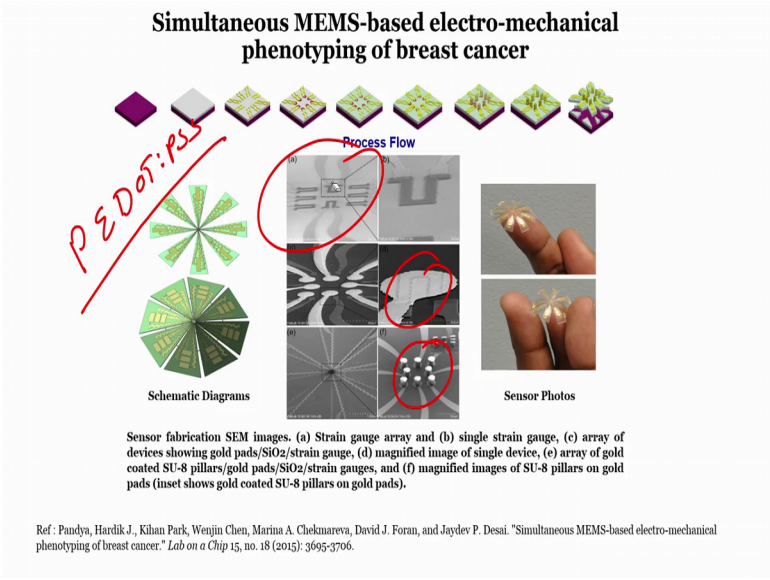

Now, let us see the third version. So, if you come back to the slide what I will show it to you I will show it to you the third version that is our flexible sensor right. The flexible sensor and it consisted of what or it was integrated with what it was integrated with electrical sensor that is your gold pad and SU-8 pillars which were conductive, and it

was having the piezoresistive sensor. Piezoresistive sensor consist of PEDOTPSS; PEDOTPSS is what? It is a conducting polymer right. It is a conducting polymer and its shows the piezoresistive property, that means, whenever we press the material then there will be change in the resistance of the material right so that is the piezoresistivity of the material.

So, we have used the PEDOTPSS as a piezoresistor, we have patterned it. You can see a single piezoresistor here, then we deposited insulating material we open the contact area, then we had gold pad. Gold pad you can see right over here. And finally, after gold pad we were having SU-8 pillars right and we made SU-8 pillars conductive right.

The chip looks like the one here right and in when you when you make it up when you when you etch it or when you strip it from the base layer that is your oxidized silicon wafer, it is a flexible material as I have shown you as you can see from the optical image right. And it is a flexible material you can see right over here in fact, you have seen in the videos as well.

Now, my point is how does it look like if I want to make this on the oxidize silicon substrate. Again you understand that everything that I am showing it you, you should wear gloves and it should be a clean room environment, but since this is the class I am trying to show it you without glass, but this is not a correct technique ok, this is not correct technique, but just to show it to you.

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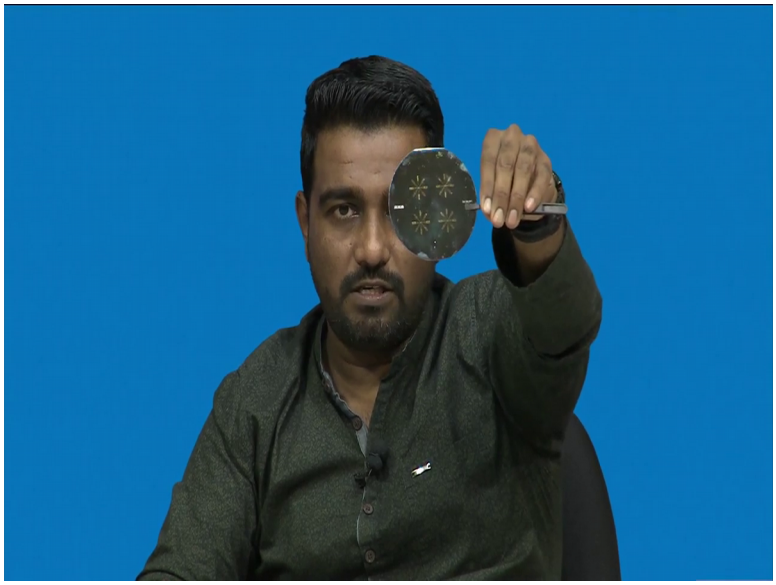

So, these are the sensors. These are the chips in which at the center of the chip at the center of each chip, at the center of the each chip right, center of 1, 2, 3 and 4 right. And the center there is piezoresistors, and there is the gold pad. And over gold pad what is that over gold pad we have SU-8 pillars, and that SU-8 those SU-8 pillars in fact because we have 8 of those SU-8 pillars are conductive. This chip consist of 8 piezoresistors and 8 gold pads. So, you can say piezoresistor for mechanical property of tissue, gold pad for a electrical property of tissue.

And as you can see all the things that is star thing shape we can see are the contacts to the piezoresistor or to the gold pad. The sensor is in the center of this chip, is in the center of this chip. So, you will say again extremely tiny that is why we say this is a microsensor or MEMs based device right MEMs based sensor all right. So, this is the one that I wanted to show it to you, so that you have idea how it looks like.

Of course, the one that I have shown on this particular oxidized silicon substrate it is it is on oxidized silicon substrate these not on PDMS. It if it was on PDMS we can also become flexible material; now but that the results that we have obtained is using the flexible sensor ok. So, now, I hope that you understand how the sensor looks like when we when we actually fabricated right. So, it is not only to understand how the process flow looks like, but also to understand how the final device looks like.

Now, what you will do with this device you will understand the change in the output of this device. Now, in case of the first chip that has a thermal changes we can see the change in temperature, then second also change in resistance and there is a change in resistance, again because there is a piezoresistive material. In second one cantilever it was a piezoresistive cantilever, we will see change in the resistance. In the third one, it was a piezoresistor and gold pad, we will see change in resistance in both the cases whether it is mechanical or electrical.

Since mechanical there is a piezoresistor we will show it in resistance; and electrical of course, depending on the resistance of a tissue you can see change in current. There current will corresponds to the change in the tissue resistance, such we have to understand the change resistance, but in most of the cases you will see that if the piezoresistor is not so sensitive you have to work on the electronic module of the system,

and then electronic conditions circuit becomes very important part when you want to amplify the signal coming out of the sensor or a transducer right.

So, we will see electronic conditioning circuit sometime later as a part of this particular lectures. And the idea of this particular module what was to just show it to you what kind of sensors that you are right now learning looks like when you actually fabricated alright. So, this is end of this particle module. I will see you in the next module. And we will talk about very interesting problem and there is screening of cancer patients.

So, if the if someone comes or if the if the doctor comes to a let us say small village right or a small district, let us say primary health care centers then how the screening is done. And can we design an alternative system or a system based on electronics such that the screening will become easier and more powerful right. So, we will talk about that in detail in the next module. And till then you take care, I will see you in the next class.

Bye.