Sensors and Actuators
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Lecture – 59
Biosensors for Electrothermal sensor

This module is again a continuation of your last module. In this module, let us see that how we can create micro actuators or microrobots not really microrobots robotic arms with microchips alright, for understanding the tissue properties. Before that, we will see how we can develop the sensors.

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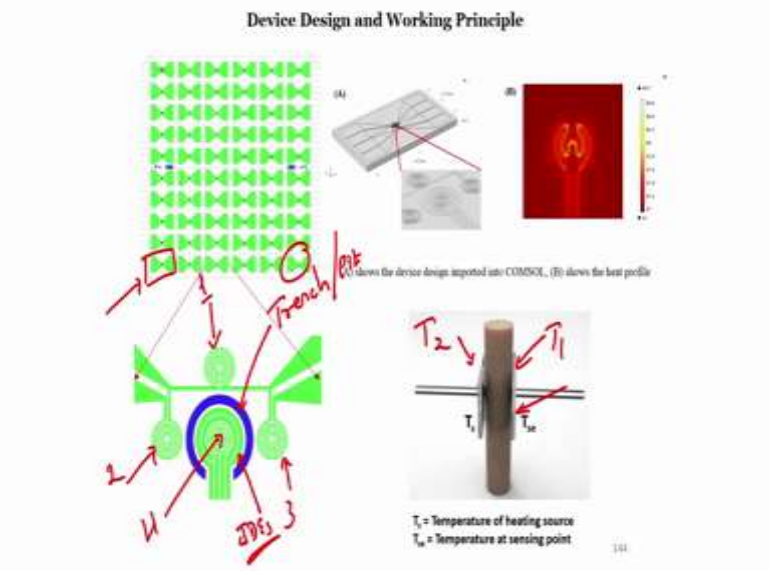

So, if you see the slide in this slide, we can see that there are three thermistors 1, 2 and 3; thermistor 1, thermistor 2, thermistor 3 and in the center there is a heater, alright. So, what happens is let me first understand this let me tell you about this chip first, now this design first this is a trench or pit, right pit; this one, the thicker ones, or your interdigitated electrodes, which one? This line and this line right, if you see this one it goes here, here and here; this line goes across it here and here, right. So, and in the center, there is a heater, correct.

So, now, this is your chip design. How to fabricate this chip? We will see in the next slide how to fabricate this chip the; and why we have fabricated, why how we are using it. Now, we understand that there is a tissue in the center and this chip is on both ends,

which chip? This one. So, now, if this is a magnified version of or this one single chip, this is the enlarged figure of this particular single chip.

So, if I attach this chip on one side of the tissue and another chip on another side of the tissue right and I apply I heat it from one side with the help of heater, I can measure the change in temperature with the help of thermistor on another side of the tissue. And; that means, that I have T 1 here, I have T 2 here; that means, I can measure the thermal conductivity, correct.

Now, I have interdigitated electrodes. So, as soon as this chip touches the tissue I can measure the impedance of the tissue; I can measure the surface impedance and I can measure the bulk impedance of the tissue, right. So, this is how the simulation can be done for the heater at least and you can see it is almost uniform in the center of the chip and that is very good news because then we can use this chip for heating the tissue uniformly.

And you can also see that this is without trench, but if I have a yeah this is with this particular part you see right, and these are the interdigitated electrodes and this is a heater in the center. So, there is a simulation for that which is a heat profile of the heater and this is the fabrication.

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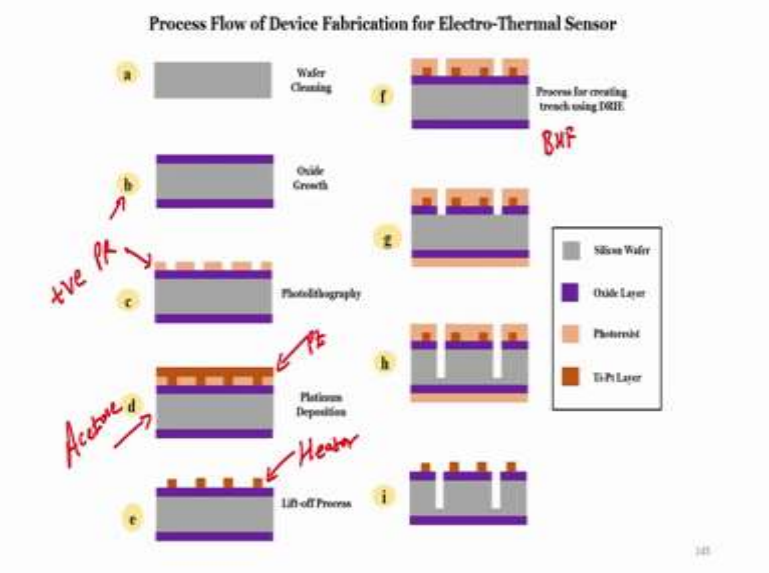

So, we start with a wafer which is silicon wafer we clean it, then we grow oxide which is a schematic b and after growing oxide, we performed lithography and this is liftoff technique. So, first is your photoresist. You have patterned your photoresist like this which is your positive photoresist. On positive photoresist, you have deposited platinum and then you have dipped this wafer in acetone. When you dip this wafer in acetone, what will happen? You will have interred you have heaters; you have the heater, right.

Then, you can create a trench; for creating trench you can again perform the lithography and open the window, remove silicon dioxide, silicon dioxide can be etched with the help of BHF buffer hydrofluoric acid. Once you remove silicon dioxide you can etch silicon using DRI, right. So, your trench is created and then on that, you can also create your interdigitated electrodes, but here we just showing the thermal sensors, right.

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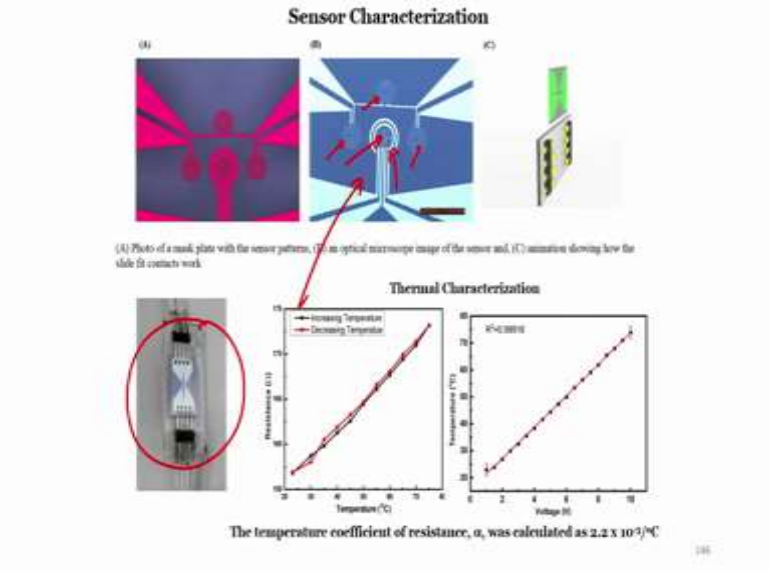

So, the let me go to the next section. Here you can see then the optical image of the sensor which is right over here right; again, like I said thermistors, thermistors, thermistors, and heater all right, this is your interdigitated electrodes. And if you see this particular chip, then it can place within the like a sim holder; sim cardholder because we do not want to do soldering or wire bonding as after one measurement you have to throw the chip, because for biological samples you cannot use the chip same chip again and again. So, you have to fabricate a chip that is cheaper in cost as well as the holder should be easy, you can just place the chip rather than doing wire bonding and soldering.

So, if you see further you can see here that the, this is the actual photograph of the chip some characterization where we can see that the alpha was calculated about 2.2 into 10 to power minus 3 per degree centigrade, R square value was really good and as well as we had done some hysteresis profile increasing temperature with decreasing temperature.

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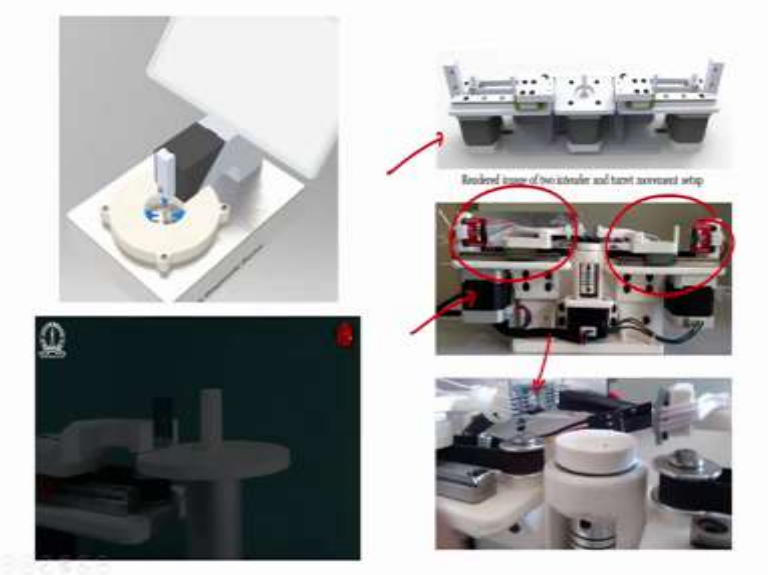

Now, these are the actual system. So, again there are 2, 3 videos actually this is the first video.

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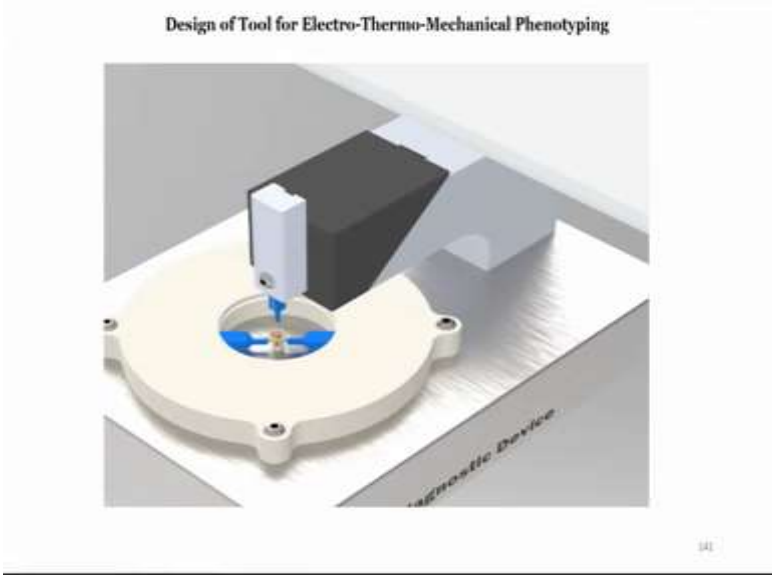

In the video what you have seen, you have seen that there are indenters and in the indenters, there are the blue color thing which is indenters at the tip of the indenter we have attached the chip that we have I have just shown it to you. And, these chips are used for understanding the electrical and thermal properties while the top indenter it presses tissue from the top.

If you see the rendered image on the right side of the screen then you can understand that there are the two actuators and here is actual photograph where there is an arm 1 versus arm 2 and at the tip of this arm you can see here that we have the chip attested for the for measuring the tissue, alright.

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So, I will just switch to the next section and that is on the heart we will talk about atrial fibrillation, but let us talk about atrial fibrillation in the next module. I just was wanted to give you a very quick update about the newer design of the chip that we are fabricating as a part of the research. And, it is really important for you guys also to think a novel kind of sensor design that can be easier to fabricate and can be used for understanding the tissue properties.

Now, we are talking about breast cancer, but we are not limited to breast cancer. We can use different tissue-related cancer it can be ovarian cancer, it can be cervical cancer, it can be prostate cancer and wherever tissues are there we can understand how the tissue

property changes, right. So, once you understand the sensor fabrication and you can design novel sensors or new sensors you can measure different properties, alright.

So, in my next module, I will be talking more on the heart diseases and how the atrial fibrillation which is one of the important diseases which causes death inpatient, how it can be treated and why sensors are very important including actuators are why very important because we have to design a novel catheters with a maneuvering system to treat that particular disease.

So, till then I will take leave from you for now and I will see you in the next class with a more interesting problem to identify and to fill the gap and a very interesting actuator and sensor system to find a solution in terms of medical devices, right. Till then you take care, bye.