Electronic Systems for Cancer Diagnosis
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Lecture – 12
Fabrication of MEMs-based Biochip for cancer diagnosis Contd.

Hi welcome to this module here what we are discussing? In the last lecture we have seen a Biochip; MEMS base biochip that we can use to understand the tissue property or learn the changes in the tissue property. What are the changes? Electrical changes, thermal changes, mechanical changes three changes right.

So, when you talk about thermal changes; you need to fabricate a micro heater and for that we have seen in the last module how to fabricate the micro heater using MEMS based process right.

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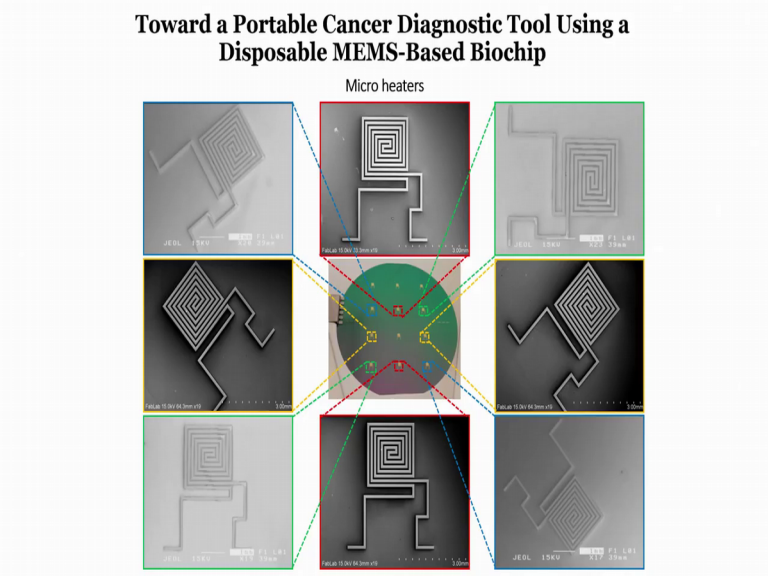

So, if you see on the slide this is what we have seen yesterday several micro heaters that you can fabricate on the oxidize silicon wafer.

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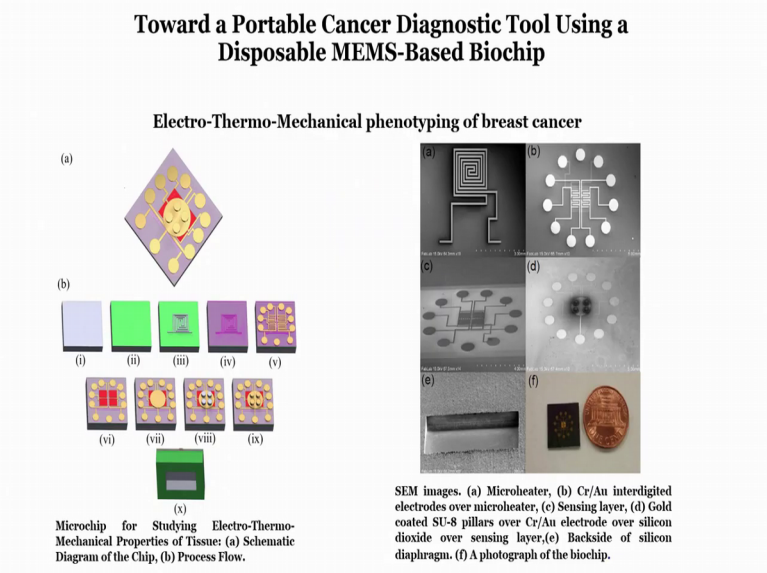

Now today if you see over the heater there is an interdigited electrodes right and over interdigited electrodes there is piezoresistive material. So, we will see today how can we fabricate sorry interdigited electrodes on the micro heater. And then over interdigited electrodes piezoresistive sensing material which are shown in the four squares here and this one. So, I will show you in terms of process flow.

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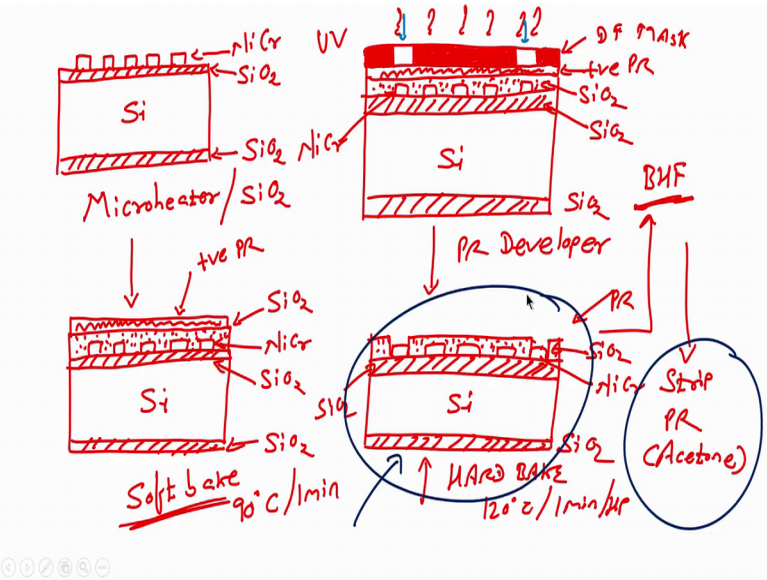

So, we should start from a wafer and wafer is oxidized silicon wafer and on oxidize silicon wafer, you have a micro heater right. So, you have nichrome you have S i O 2,

you have silicon, you have S i O 2; this is your micro heater over oxidized silicon substrate.

The next step here would be to deposit or to grow a silicon dioxide or an insulating layer; an insulating layer on the micro heater. So, the dotted version is the silicon dioxide, insulator can be silicon nitride as well right, but we are growing silicon dioxide. This is your nichrome, this is your silicon dioxide, this is silicon dioxide and this is your silicon.

Now we have to understand if I go to the backs the previous slide; there is a contact here and here which is this one sorry; if because this is a chip here and here these are the contacts which are this context.

So, I have to keep it open for accessing the heater right at the end when the bio chip is ready. So, for that I have to remove or etch the silicon dioxide from the contact region. To do that the next step would be after this the next step would be to spin coat photoresist; this is my positive photoresist. After spin coating photoresist, I will go for soft bake at 90 degree centigrade for 1 minute on hot plate. Next step is to load the mask to. So, I would have my nichrome; I will have photoresist and a mask; photoresist silicon dioxide 1 micro heater and this is my mask. I will use a dark fill mask, this is a positive photoresist, silicon dioxide, nichrome heater, silicon dioxide; silicon dioxide, silicon dark field mask right.

So, what we have done? We have used a dark field mask; we have used a positive photoresist and then we will expose this mask with UV light. What will happen? Since it is a positive photoresist, the unexposed region will be stronger and the exposed region would be weaker correct. So, in this case the exposed region is this 2.

So, after this if I continue then what will I do? I will develop the wafer. I will use photoresist developer to develop the photoresist; I can say developing wafer or developing photoresist. And then I will get silicon dioxide, my heater, silicon dioxide and photoresist in this area right; photoresist is shown by the wavy design.

So, I have now photoresist silicon dioxide; nichrome heater, silicon dioxide, silicon dioxide correct? After that I will dip this wafer in buffer hydrofluoric acid, but just dripping the wafer in buffer hydrofluoric acid before that we have to do post bake right soft bake I will say hard beak.

So, before hydrofluoric acid will go for hard bake; you know the temperature 120 degree centigrade, 1 minute on hot plate right. After that after this step I will go for BHF; BHF is Buffer Hydrofluoric Acid. When we do BHF when we place this referring BHF what will happen? The silicon dioxide over the contact will get etch; the silicon dioxide over the contact region will get etch like this; now you can see the contact? Correct?

After this the next step would be after BHF; the next step would be to strip off the photoresist, strip of the photoresist that can be done by placing the wafer in acetone that you can done by placing the wafer in acetone.

So, if I place the wafer or dip the wafer in acetone then what will I have? I will have my context of the micro heater opened and remaining area of the micro heater covered by silicon dioxide right easy. So, this is what we get once we process once we do the micro fabrication process that is we have a micro heater, we grow a silicon dioxide.

Now how we will grow silicon dioxide? There are many techniques right we will go for plasma enhanced chemical vapour deposition or that is why we are depositing silicon dioxide using chemical technique and the advantage is that now we can go for a lower temperature compared to LPCVD.

So, why we can use PECVD and what is the importance we will talk during this fabrication class. But right now just understand that we have deposited a silicon dioxide layer over nichrome which is a micro heater using PECVD and then we perform photolithography; which is you have to spin coat the photoresist.

Here we have use positive photoresist then go for a soft bake which is a 90 degree 1 minute hot plate and then we load the mask. The mask is a dark field mask because we are to open the contact area right, then we expose the mask or expose the wafer with UV and the unwanted or unprotected or you can say this is a dark field mask.

So, the unexposed area will be stronger and the exposed area would be weaker because we are using positive photoresist. When we do that; what we will get? We will get the photoresist over all the area on the sub on the heater except on the context. Then what we can do? Then we can do a hard bake; hard bake is done it 120 degree centigrade for 1 minute or hot plate followed by BHF etching, the silicon dioxide etching and then finally, we strip off the photoresist with help of acetone to get the heater over we silicon

dioxide is there. And the context are accessible because there is no silicon dioxide on the contact of the heater right.

So, this is the next step now over this we have to develop the interdigited electrodes. So, if you go back if you see the slide; I will show you this one right. So, now, what we have done? On this heater you have silicon dioxide all the way you have silicon dioxide except on the contact region right. Only in the contact area; only in the contact area you do not have silicon dioxide alright.

So, after this we need to need to go for fabricating interdigited electrodes alright. So, that we can have piezoresistive material patterned on this interdigited electrodes. So, let us see the next step fabricating interdigited electrode on micro heater in between there is an insulating layer. So, we will start with this wafer and let us see what you have. So, when I do stripping of photoresist in acetone what will I have? I will have this particular wafer right.

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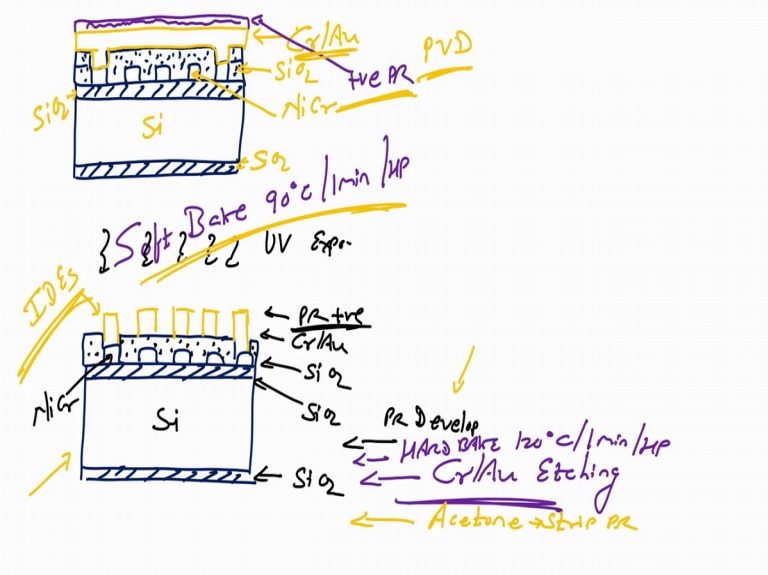

So if I want to fabricate an interdigited electrode; let us take the wafer there is a oxide there is a micro heater. And there is an insulating layer right which is your silicon dioxide on the micro heater; except on the contact area. Then the next step would be; the next step would be to deposit metal on the micro heater and this metal is our chrome gold.

The reason of using chrome before we deposit gold for is for improving the edition. This is my silicon dioxide, this is my micro heater, this is again silicon dioxide, this is silicon and silicon dioxide cool? Now next step would be on this you have to spin coat photoresist. So, I will spin coat photoresist on this alright, this is my positive photoresist; we write it down positive photoresist alright.

Then I will go for soft bake; soft bake is done at 90 degree centigrade for 1 minute on hot plate. After that what is the next step? The next step is that we will go for loading the mask right. So, I have to load the mask, this is oxide silicon, oxide and then we have heater and then we have silicon dioxide right.

On that what we have? On that we have chrome gold right on chrome gold what we have? On chrome gold we have a photoresist on photoresist will have a mask ok. And this mask is a bright field mask to form interdigited electrodes and also sorry and also to protect the metal on the contact of micro heater.

So, this is a bright field mask this is to protect the metal on the contact of the micro heater, which is write over here and here as well as to do form the interdigited electrodes; this is my bright field mask. This is photoresist positive this is chrome gold and silicon dioxide right. Then nichrome, then silicon dioxide, then silicon finally, silicon dioxide.

After this what is the next step? All of you know right UV exposure; UV exposure. When we expose the UV and develop the wafer what will happen? The area that is unexposed will become stronger; since it is a positive photoresist and the area which is exposed will become weaker right.

So, if I after this if I dip the wafer; if I dip the wafer in PR developer; then what will happen? I will see my photoresist in this area correct. Then after PR developer, we will go for chrome and gold etching right if I would.

So, if I go for chrome and gold etching after PR developer is it correct step? No right because before that we have to go for hard bake 121 minute hot plate; after this you can go for chrome gold etching right. So, when you go for chrome gold etching; what you will have? You will have right chrome and gold will be saved or protected where there is a photoresist; where there was no photoresist the chrome and gold got etched.

After this, what is the next step? Next step is acetone stripping or acetone strip; acetone strip is or using acetone we can strip the within acetone we can strip the photoresist. So, if I dip the wafer this wafer into an acetone then my photoresist will get stripped off. And what will I have? I will have oxidized silicon wafer with a heater and interdigited electrodes you got it?

So, I will repeat the step first you have wafer with micro heater and on that you are protecting this silicon dioxide in all the regions; except the contact region. Then you are depositing chrome gold how can I deposit chrome gold? Using one of the technique PECVD sorry PVD Physical Vapor Deposition; either you can use thermal evaporation or you can EVD evaporation or you can use sputtering.

We have chrome gold and then on chrome gold; we spin coat positive photoresist then we do soft bake for 90 degree centigrade, 1 minute on hot plate followed by loading of mask right and then exposing the our mask was bright field mask right.

And we are protecting the region where we want to fabricate the interdigited electrodes and also the contact over the micro heater and then we are exposing the wafer with the help of a pause with the help of bright field mask followed by a PR develop followed by hard bake at 120 degree centigrade followed by chrome gold etching because PR will be developed in the area that was exposed and unexposed region will be hard.

Then once you do chrome gold etching you will see that chrome and gold are etched from the region which are not protected by photoresist. And then we go for acetone strip or for stripping the photoresist and that will give us an interdigited electrodes over a micro heater and in between there is a insulating layer.

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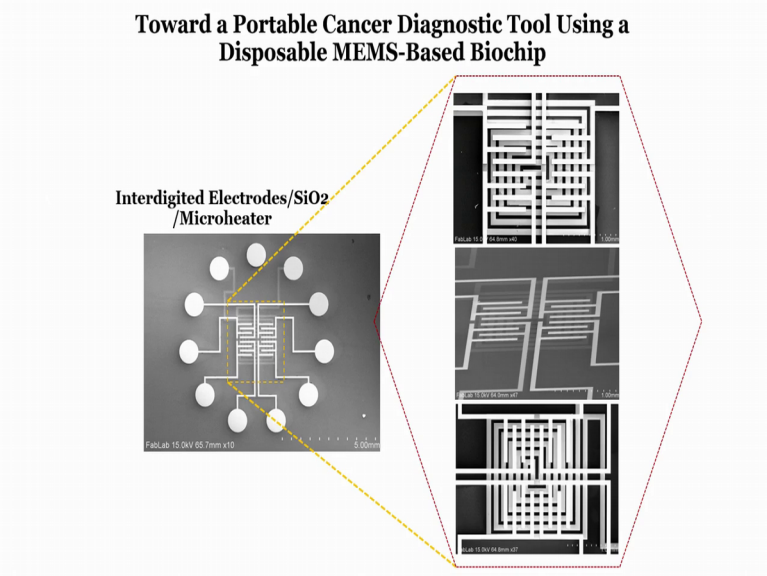

This is a fabrication and this is the actual SEM image of the interdigited electrodes over silicon dioxide over micro heater. You can clearly see a micro heater below interdigited electrodes and in between there is a sandwich layer of silicon dioxide. Silicon dioxide being a transparent material you can see the micro heater through the silicon dioxide alright. So, in the next module what we will see? We will see how can we deposit a piezoresistive material on this interdigited electrode to fabricate piezoresistive sensor.

So, I hope in this module you learn quickly how to deposit an insulating layer on micro heater, how to open the contact and then how to fabricate an inter digited electrodes over the insulator over micro heater.

Just go through it once again and I will see you in the next class where we will do more of this particular step; to fabricate a chip that is that can that has an integrated heater and integrated piezoresistive sensors and an integrated electrical sensors right. Till then you take care I will see you next class, bye.