Electronic Systems for Cancer Diagnosis
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Lecture – 20
Fabrication of electro-mechanical sensor contd.

Hi, welcome with this module. And in this module, what we will be learning is how to deposit gold pad on the piezoresistive sensors that we have seen in the last module; and over the gold pad we will see how we can pattern SU-8 pillars and make them conductive.

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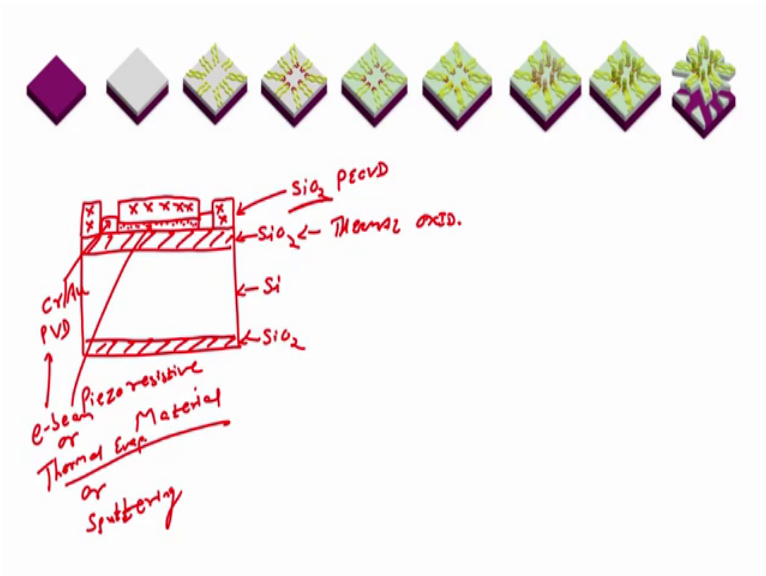

So, if you remember in the last module we have seen if you see the screen oxidized silicon wafer, contact pad, piezoresistive material, silicon dioxide on the contact pad right Si O 2, Si O 2 silicon, Si O 2, contact pad, piezoresistive material pattern to form piezoresistive sensor right. This Si O 2, we have used PECVD; this Si O 2 we have used thermal oxidation. Silicon wafer we know, chrome gold we have used physical deposition. You can use e-beam or thermal evaporation or sputterings p u t t e r i n g, sputtering right. So, now let us see how can we deposit gold pad on piezoresistive sensor. And the gold pad if I deposit gold directly on the piezoresistive sensor, it will be shorted that is why we have this insulating material right.

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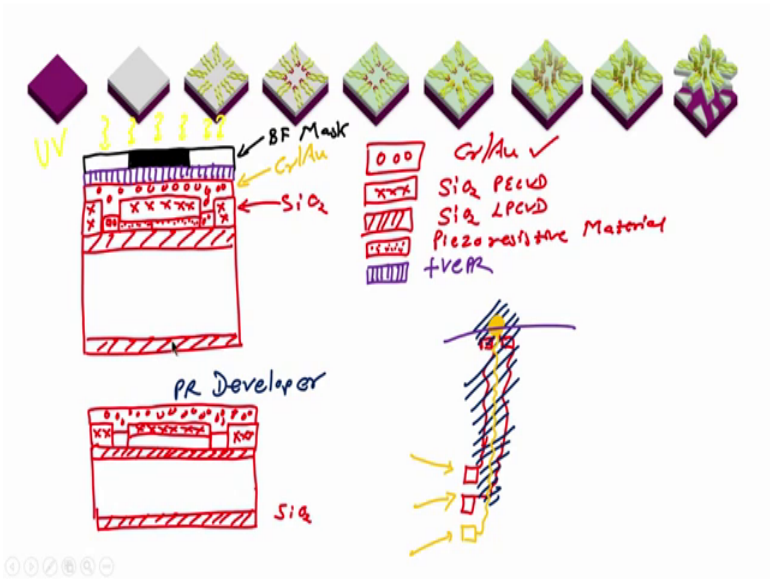

So, on this I will deposit gold. Now, this is in reality right. So, I will just draw on single smooth line, so that we do not get confused. This is my so let me make circle for chrome gold. So, this is also my chrome gold; this is my chrome gold. So, the box with circle is chrome gold. The box with x is my silicon dioxide, which is PECVD. If the box with dashed lines is silicon dioxide LPCVD; and the box with dots is my piezoresistive material, clear so no confusion hm. So, what is this I know it is chrome gold right.

Over chrome gold, over chrome gold, what we had to do we had to form, we had to form gold pads right. The if you see the structure, structure is like this. There is a piezoresistive. And on piezoresistor, there is an insulator material or insulating material right; on that what we, want we want a gold pad, and then gold pad connections will come out right. So, this is what we want.

Now, insulating material when I am drawing insulating material is or all the places like this except the contact region, except the contact region right. So, insulating material is all the way on this everywhere like this right. Now, we are having a gold pad, and we are patterning the gold pad on this insulating material, and the contact of the gold pad will come on the insulator without shorting the contact of the piezoresistive material, and it will come like this ok. So, this two are for the piezoresistor; this is for the gold pad easy.

So, now, we have to pattern this gold pad right over the insulating material say that is why we have first deposited gold everywhere right. First we have deposited gold using

PVD right. Then when I say gold you had to understand it is a chrome gold, because the thin layer of chrome is required to improve the addition right.

Now, on this what we will do the next step is, next step is spin coat photoresist, spin coat photoresist. Spin coating photoresist, let us use this pattern for the photoresist hm. So, this one is my positive photoresist. Now, what I had to do, I have to have a gold pad right cross section. If I take a cross section of this right so, the I have to first have a mask correct. Let us have a mask, and I want to only save this area I only want to have or save this much area of chrome gold, and etch the remaining area, and etch the remaining area. This is my bright field mask, bright field mask.

Now, I what I will do next is next is I will go for UV lithography right, I will go for UV lithography, this is UV lithography right. When I expose my wafer with UV lithography, and I dip this referring photoresist, photoresist developer, I did this wafer in photoresist developer, what will happen the unexposed area will be stronger, and the exposed area will be weaker correct. So, I will have my wafer oxide, oxide, again oxide, then gold pad, gold material and photoresist and photoresist will only be in this much area right, this is after photoresist developer.

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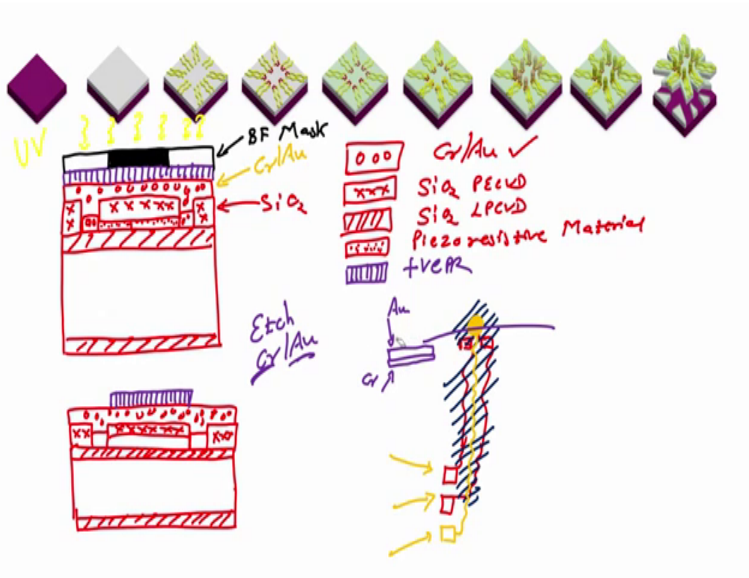

After this, what is the next step next step is, next step is we will hard bake right hard bake after hard baking, the next step is hardback is done at 120 degree centigrade for 1 minute on hot plate. After this what is a next step, next step is we will etch chrome and gold right first we will dip in the chrome etchant or gold etchant. The first is where you dip in the gold etchant, because chrome layer is below the gold layer right, chrome layer is below the gold layer so, first way to etch the gold layer.

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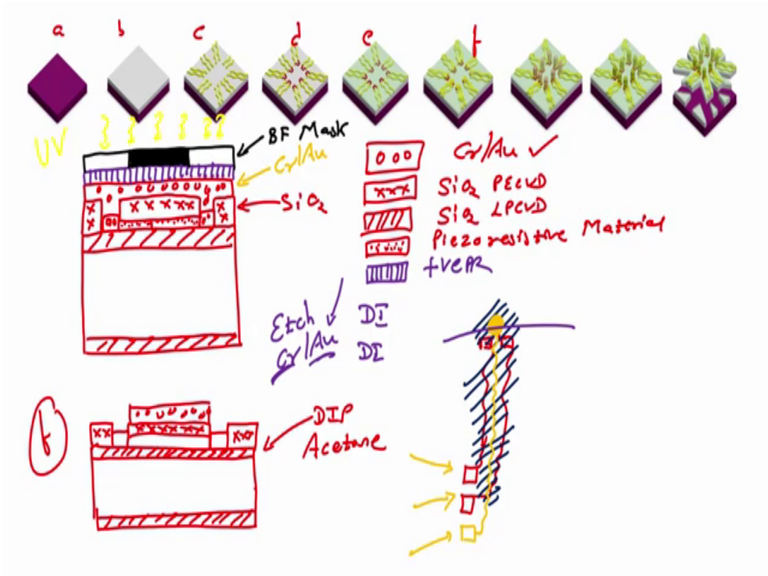

So, when we are saying etching chrome gold means first, we will dip the wafer in gold etchant, then we will rinse the wafer with DI water, then we will dip the wafer in chrome etchant, then we will rinse the wafer in DI water right. And then what will I have I will have a pattern like this right. Then after this what we will do we will dip this wafer in acetone to strip up the photoresist. If I dip this wafer in acetone, what will happen my photoresist will be strip up. And we will reach let us say this is a, this is b, this is c, d, e and f. So, we have reach the f in the schematic diagram, easy, very easy right. So, I will etch it up. Now, is it etching, we are removing right, we have rubbing it ok. So, this is f. Now, the next step is, next step is we have to pattern; we had to pattern SU-8 pillars on gold pad. We do pattern SU-8 pillars on gold pad right.

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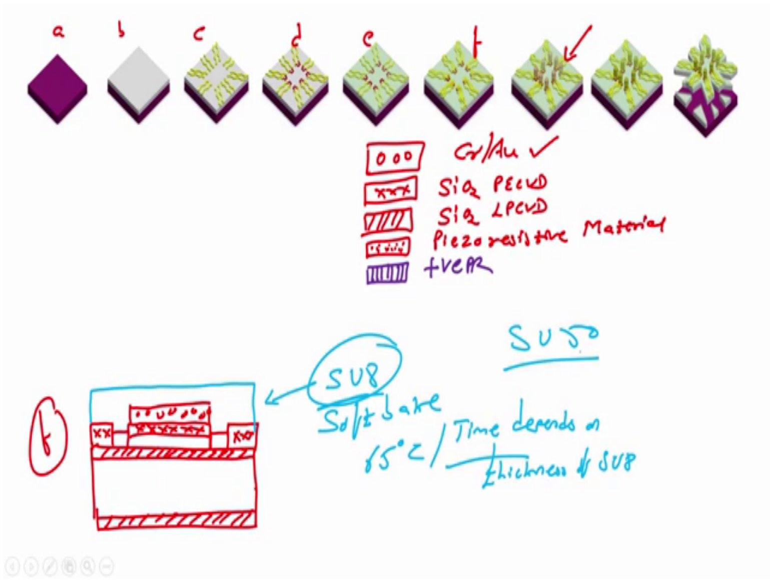

So, to do that our next step would be to spin coat to spin coat SU-8 to spin coat SU-8 on this wafer ok. If I spin coat SU-8 on this wafer, then what is my next step my next step is that I have to form the SU-8 pillars right. So, I have to first soft bake it, soft bake is done it 65 degree centigrade for 1 minute on hot plate right. This is my SU-8; then soft bake 65 degree centigrade right not 1 minute, it depends on the thickness of SU-8 right, thickness of SU-8 on a hotplate or in a oven.

So, time depends on thickness of SU-8. This is already given in a data sheet. We do not have to remember 65 degree centigrade, what is SU-8 that you do remember. What is the SU-8, SU-8 50, SU-8 75 their different kind of SU-8 with a last two digits SU-8 50 for example, right. So, you have to see SU-8 50 is what is the thickness that we get by spin coating on the using the spin coater what is thickness what we obtain hm. So, we it is very important to understand the SU-8 thickness, because based on that your soft bake time would be determined.

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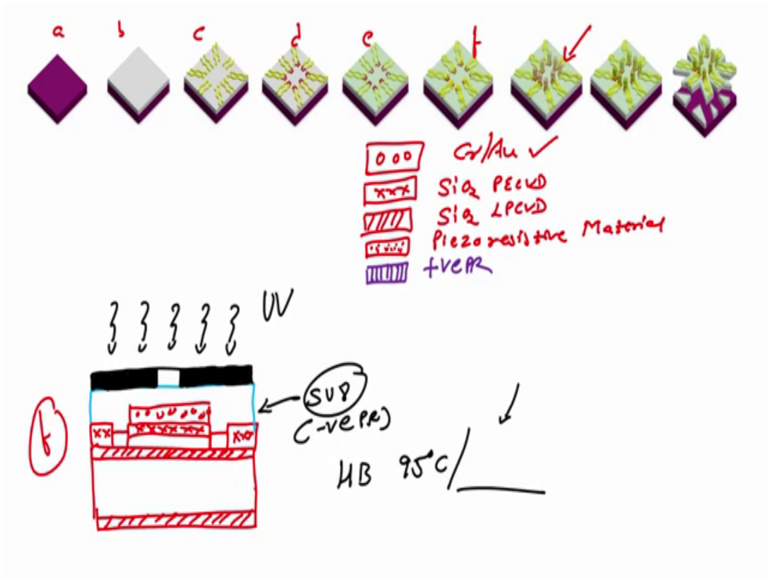

After soft bake we have to load the mask, we have to load the mask. And it is a negative photoresist. We already know SU-8 is a negative photoresist. So, we will use a dark filled mask, a dark fill mask, because, because the unexposed region in the case of negative photoresist, this is our SU-8, SU-8 works as a negative photoresist ok. So, the unexposed region in the case of negative photoresist will be weaker right. In the case of positive photoresist was stronger; in the negative photoresist, it will be weaker.

So, when I expose this wafer with UV, what will happen, what will happened, the unexposed region would be weaker; and exposed region would be stronger. So, after the UV exposure what is the next step in case of SU-8 hard bake right, hard bake, hard bake is run at 95 degree centigrade. Again 95 degree centigrade is one point, but what is the time, time depends on the thickness of the SU-8 material right. After hard bake, we will develop the photoresist that is your SU-8 by dipping the wafer in a SU-8 photoresist developer right.

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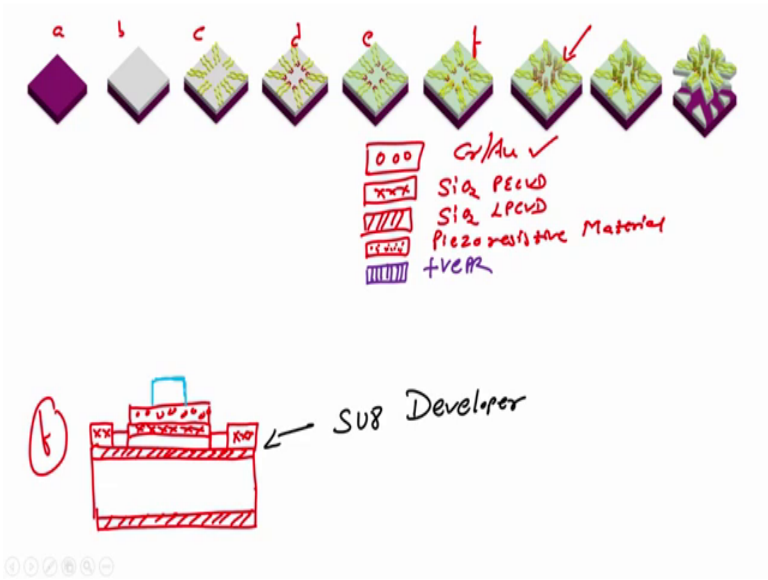

So, if I dip this wafer in a SU-8 developer, what will happen, the SU-8, we will remain only in this area right. And then I can go for further annealing at 120 or 140 degrees centigrade to make the pillar harder. This is my SU-8 patterned right to form to form SU-8 pillar right.

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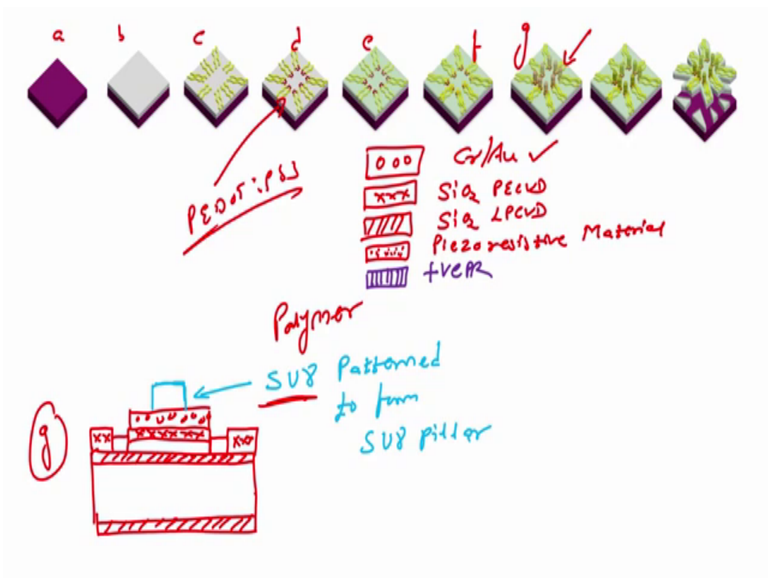

Now, in principle we will make 8 different pillars right, we will make 8 different pillars, because our sensor demands 8 pillars. There are 8 electrodes and 8 piezoresistive sensors right. So, we have reached now we have reached e, is it correct,. See a, b, c, d, e, f, e, no, a, b, c, d, e, f, g. So, we, we from f we have reached g ok.

Now, what is the next step we have to make SU-8 conductive, but can you make SU-8 conductive, we cannot make a SU-8 conductive, because SU-8 is a polymer SU-8 is a non- conductive polymer. There are conductive polymer which we have just used for piezoresistive sensor and that is your p dot p s s, p dot p s s is a piezoresistivecan be used piezoresistive sensor, because piezoresistive material and it is a conductive polymer. We are talking about SU-8 which is a non-conducting polymer.

So, how can we make a non-conducting polymer conducting, we do not want to make a non-conductive polymer conducting, we want a thin layer of metal over SU-8, so that it can act as a channel to flow the electrons through it so or over it. Let me, let me explain it to you in terms of schematic. So, you understand it better right.

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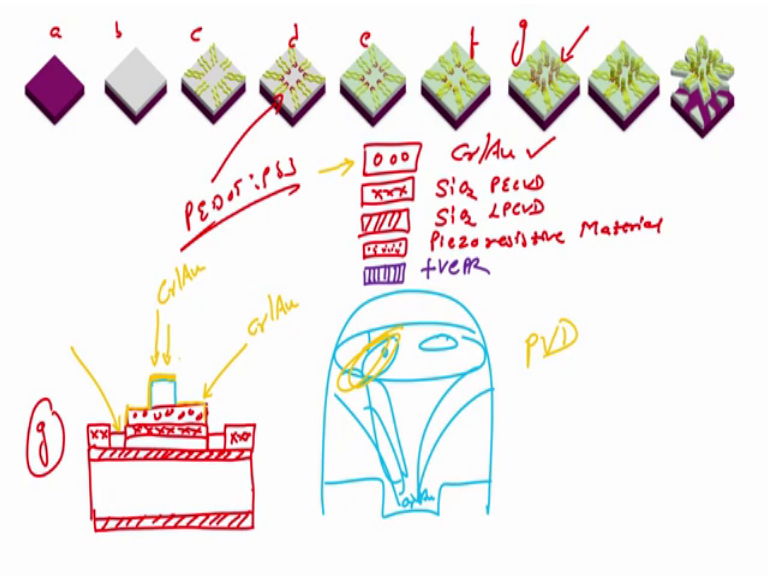

So, just if you can look at the screen, what after this, once I have a SU-8 pillar right once, I have a SU-8 pillar, I will put this wafer in a thermal evaporator at 45 degree angle. There is efforts are at 90 degree angle I will load it at 45 degree angle. So, there is a SU-8 pillar like this right, what will happen, when you evaporate the material, when you evaporate the material right that is your that is a chrome and gold the one side of the SU-8. The top layer of the SU-8 and one side of SU-8 will be coated with chrome gold, will be coated with chrome gold.

And what is this material this material is already a chrome gold, this is also chrome gold right. So, this will be conductive from here till here right, we can have conductivity, because it is chrome gold, this layer is also chrome gold, we know it see here written somewhere know chrome gold right. So, using physical vapor deposition, we can end by loading the vapor in a certain angle, we can coat single side of the chrome gold of the SU-8 pillar along with the top side. And thus we can make the conductive path or we can have the conductive path on the SU-8 pad.

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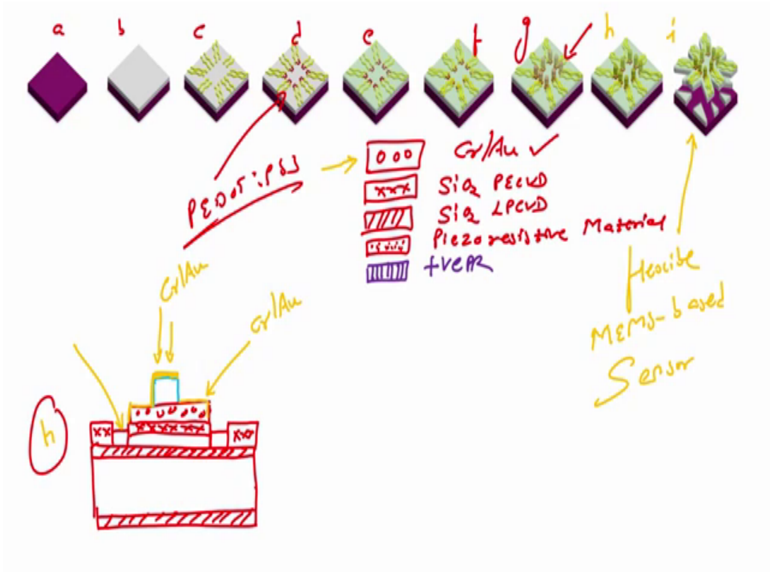

So, we will be here h right, h, what is a next step, next step is I where you had to cut the PDMS and release it to realize the to realize the flexible MEMS based sensor to realize the flexible MEMS base sensor, got it guys.

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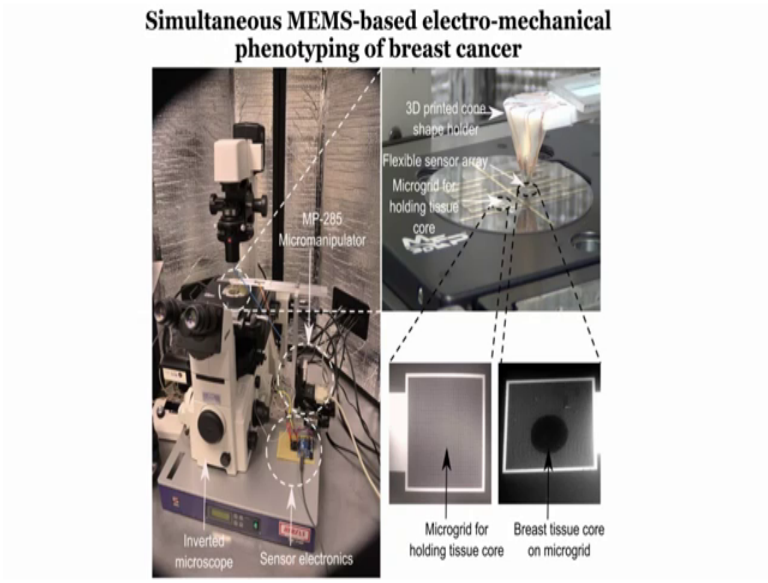

So, once you have the flexible MEMS base sensor, what you will do with that, what you will do with that. So, we will see this thing in the next module let us finish this module right over here, because this is the end of the fabrication of a flexible MEMS based sensor. And in the next module what we will see is how can, we use this sensor to test the tissue, what to do measure the tissue properties. In particular we are interested in mechanical properties and electrical properties, since we have piezoresistors and a conductive electrode right.

Till then you look at the lecture. And I will I will get back to you in my next module with the application of this flexible sensor right, which is indicated with two different sensing moralities one is electrical and one is mechanical right.

Till then you take care, I will see you in the next class. Bye.