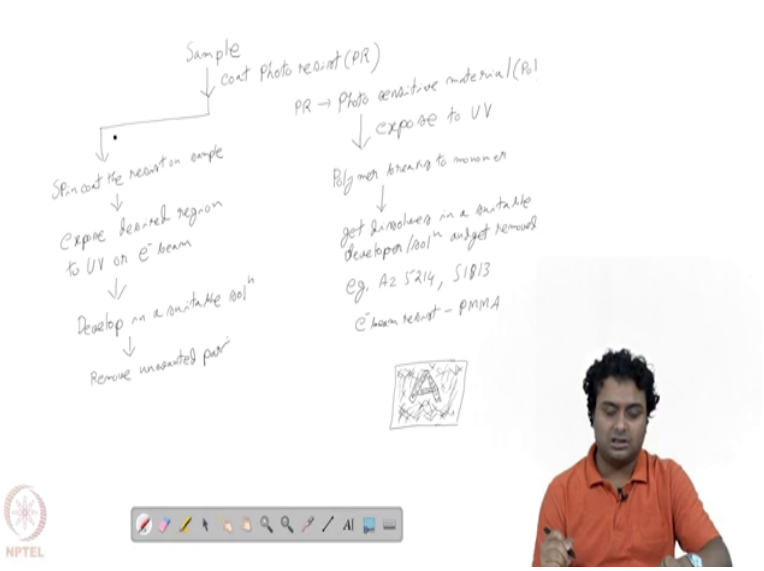
A Brief Introduction to Micro Sensors

Dr. Santanu Talukder
Department of Electrical Engineering and Computer Science
Indian Institute of Science Education and Research, Bhopal

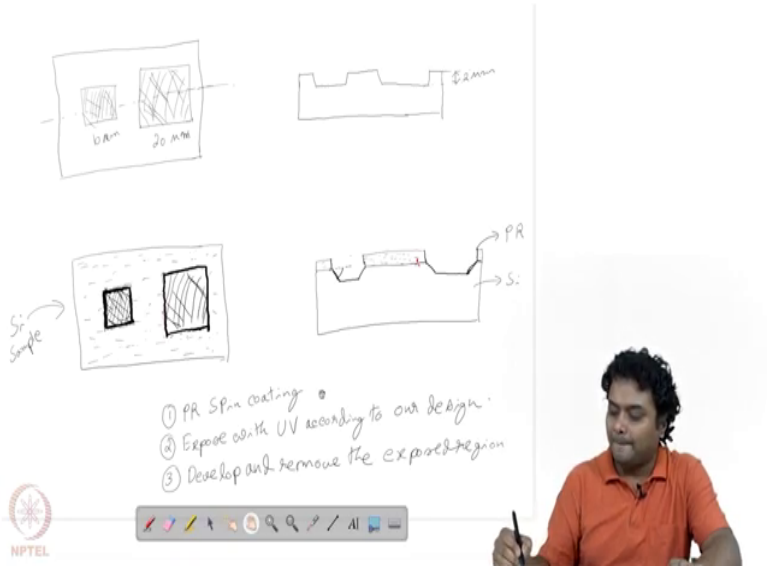
Lecture - 16
Lithography

(Refer Slide Time: 00:31)



Hello guys. So, we are in the last class, we were discussing about lithography right. And now, what we will see that step by step a lithography process, where we will generate a particular desired structure.

(Refer Slide Time: 00:48)



So, let us see; let us assume this is the structure we need to create. So, this is the structure I am; I will be drawing both the top view and the cross sectional view. So, while you are making this kind of diagrams or designing any of this kind of devices, we need to understand; what is top view and what is cross sectional view.

So, to explain that I will give this example, like let us say this is your sample or device and top view is like while we are looking from the top side right. So, you will be seeing this phase. Whereas, cross sectional view is let us say you take a cross section and then you see from this side like in this case, the camera side. So, you will be seeing this phase.

So, let us say we need a particular structure which is this is the top view, this is a silicon wafer and there, we need two square wells. So, one big, one small, two square wells. So, this is the same material, you see this is the same material. This here also it is silicon, here also it

is silicon, but both the silicon only; but it is etched ok. So, let us say silicon is etched till like total silicon wafer is about 500 micron thickness and here it is etched about 2 micron or 1 micron.

So, you have to etched well where the silicon has been removed to a depth of 1 micron or 2 micron. And you can we can define some dimension to this lines also. Let us say this is about 10 microns, 10 micrometer and this may be about 20 micrometer. And how the cross section will look like? Cross section will look like something like this. So, this is the silicon and then, so I am taking the cross section along across this line; across this line, I am taking the cross section.

So, then you will be seeing some depth here. Again there will be the big or the larger well like this, something like this right. And this is the etched depth which is let us say, we call it 2 micron. Now, what we will do? We will we always start with a simple silicon wafer. Simple silicon wafer, how does it look like? See, it is just like, let us say this is our sample.

So, this our silicon wafer ok. And silicon sample or silicon substrate you can tell ok. So, we start with that and we will show we will show step by step how we can achieve the this desired pattern ok. So, the first step is photo resist, spin coating or P R spin coating, photo resist or P R spin coating. Now, after spin coating of photo resist what will happen? It will be photo resist will be deposited on everywhere.

So, let us say now, photo resist is spin coated. So, this is the PR layer and it is coated over the total silicon sample. Over the total silicon surface and this is how the top surface will look like everywhere it will be coated with PR and the cross section will look like a thin layer of photo resist or polymer will be coated on that. So, this is P R and this is silicon. Now, next level is, a next step is that expose with UV light, according to our design ok; according to our design.

So, as I am saying that this will be like direct writing, let us say we are talking about initially direct writing right. And direct writing means, I will be writing just like a pen. So, this pen will move according to our required design ok. So, that coordination all the information will

be given to the laser writer or whatever system we are using. And then it will move the laser beam according to our required design. So, let us first see, which is the geometry like this. There we need a small square and there we need a large square.

So, this is geometry. And, now I will move the laser beam; I will move the laser beam in this geometry. So, this region as you can see, this region is only exposed with the laser light right. As I am doing manually, so it is not a complete coverage, but let us say while you will be using a system then it will be a complete coverage and this region will be completely exposed with the laser and similarly for this region also right.

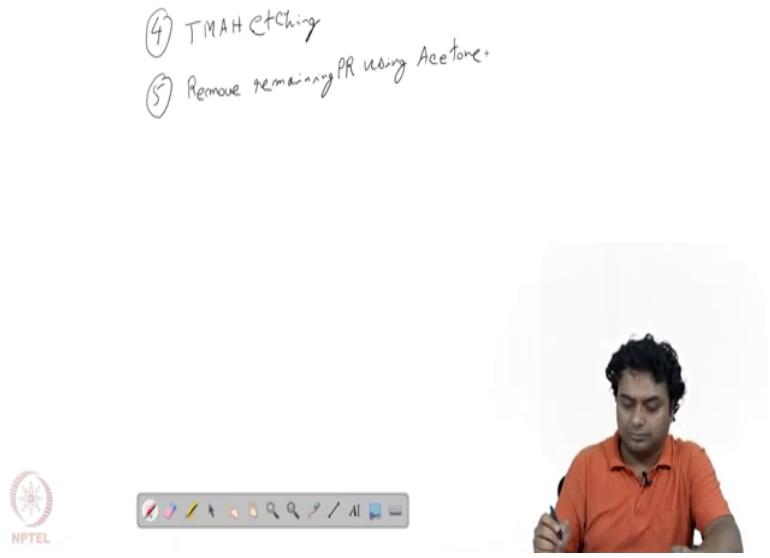
Similarly, for this region also it will be complete cover; so it is it goes like this that here only in this region. We have according to our design it will be moving. So, let us say we get this kind of coverage. So, this two regions which are like a red is actually exposed with UV and the other regions are not right.

Now, what is the next step? Next step is that we develop and remove the exposed region ok. Before, I go to that actually in the cross section, in the cross sectional image also I need to show, then how it looks like which region of the PR is exposed.

So, let us say like this and then we have big square, so here it is exposed ok. Now, while we do development of this sample, then we know that this region which is exposed to U V that has become the polymer has polymer already broke there and became monomer that will get dissolve in the suitable developer solution. So, this region will get dissolve and this will get removed. So, let us remove this region ok.

So, polymer or PR has been removed from this region and this region right similarly here also. So, while erasing I just removed the silicon surface also, I am just redrawing it ok. So, now what do we get? We get here one region, from where the PR has been removed, the photo resist has been removed and a bigger square also where the PR or the photo resist has been removed, the top region and also in the cross sectional image also will get accordingly.

(Refer Slide Time: 12:25)



Now, what we do? We put this sample, so the next next step is K O H etching or let us say we can use TMAH etching. So, now if we do TMAH etching of this sample, then what will happen? This region which is covered with the PR that will not get etched because this is not exposed to the TMAH solution right, or K O H solution, whatever etching do you use. But this region or this region which is exposed to the solvent or to the K O H or TMAH solution, that will get etched.

So, because of that this region we get etched and here the silicone will be silicon will have some kind of etching depth in this region ok. So, this is how the silicon get etched and, there we know that while we are doing wet etching, we get a shadow at the border right. Because of the 54 degree angle so, it will be something like this. Because of the inclined side wall, we

will be having a; we will be seeing this kind of shaded region or do we have seen earlier in our slides.

So, this is the shaded region and inside is etched right. And how this will look like? This will look like, this will get etched cross section and then so, this will get etched towards till that 2 micron or whatever was our requirement. And this angle this angle is because of the anisotropic etching right and this is this 54 point 6 degree angle, which we get for K O H etching or TMAH etching from the silicon crystal structure, so the sample will look like this.

Now, so once we have already, you see that we have already achieved have already achieved, whatever was our requirement. Now, but the PR is still remaining in the other region right. So, what we will do? We will just remove that extra PR; will just remove that extra PR using solvent like acetone.

Now, acetone removes all the PR or the polymer which is here, but it will not, but it will not erase, but it will not remove the silicon right. So, finally, we achieved our required design or pattern using lithography.