Electronic Systems for Cancer Diagnosis
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Lecture - 08
Photolithography: Designing Mask Aligner

Hi, welcome to this particular module and this is the second module for the lecture Mask Aligner right.

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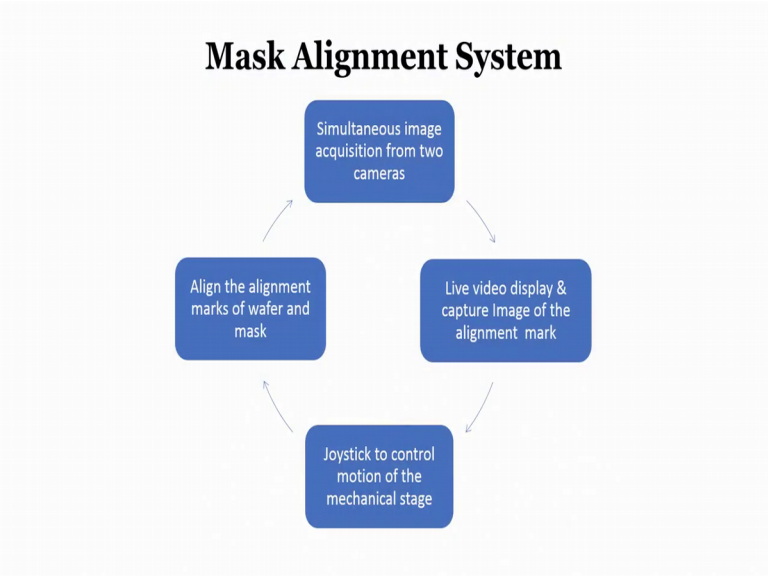

So, if you recall in the mask alignment system, what we have discussed? We have discussed that we need a few stages. First is of course, the joystick to move your x y and theta stage or mechanical stage, there is a align we need to align the alignment marks of wafer and mask. We need to simultaneously acquire the image from two cameras or a spit fill camera we can use. We need to have a live video display or an capture capture the image of the alignment mark. These are this setups that are required for alignment mark system.

At the same time, we also understood that we have to use a source which is a UV source and then we also need the mask holder as well as the wafer holder. We have seen how alternatively with a workshop for a mechanical workshop, we can design several components of a mask aligner. Now once you have designed the mechanical components of mask aligner, you need to integrate with electronics right. So, you need to program it

form a GUI which is graphical user interface to operate your mask aligner. Now the system that we are designing here is a one mask process, but we are planning to integrate and we can do multiple masks as well, but we cannot do front to back alignment. So, what exactly front to back alignment is that, if I want to etch a cantilever right or you want to etch a diaphragm my top surface, let us say let me give an example so that it is easy.

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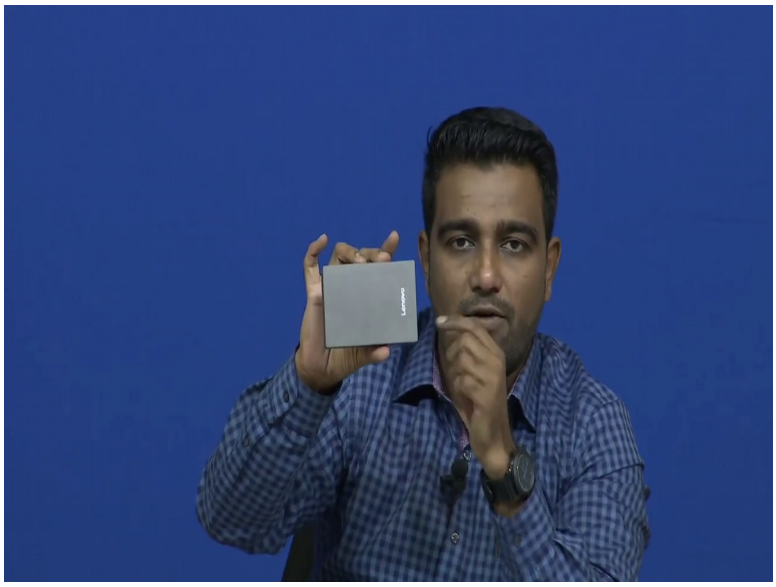

So, if you see this hard drive right; this is Lenovo all right. There is something written here. Now I want to etch diaphragm on exactly backside of this surface or this pattern right. How I know when I see the backside and I perform lithography, how I know that it is aligning with the front side?.

So, if this is the front side pattern side and this is a back side, how can I perform front to back lithography right. This is what we have seen in the videos when we were looking at the lithography system; front to back alignment using MJB 4. So, the mask aligner that we are right now discussing is only front aligner; it cannot do front to back alignment, but with front alignment also we can do, we can fabricate lot of devices all right.

So, having said that once you have the mechanical components ready with you mechanical stage is ready with you, you need to integrate those with electronics. And when you integrate those with electronics, you use a basic programming languages and

C, C plus plus right, little bit of java and use it to operate and create a GUI, then it will look something like what I am showing it to you now.

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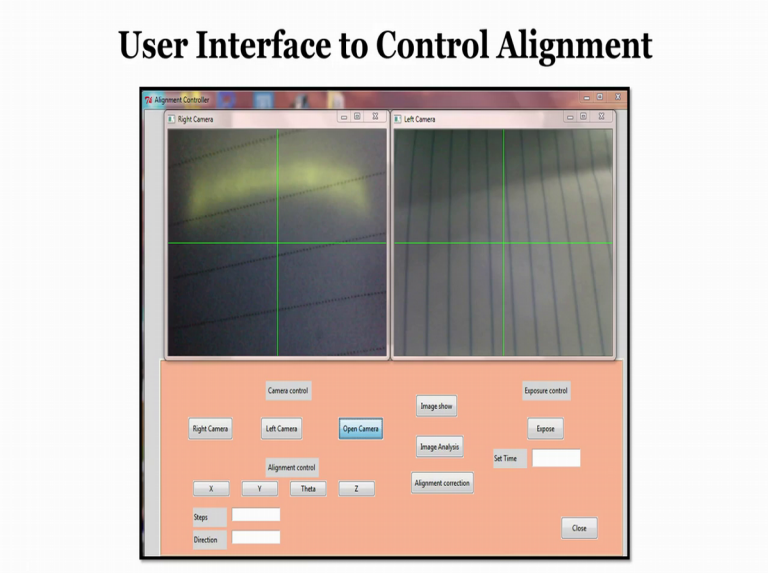

If you see the see the slide, this is what it should look like right. Of course, depends on the user depends on you how you want to create your control alignment interface, but if you see here our right and left camera can see simultaneously.

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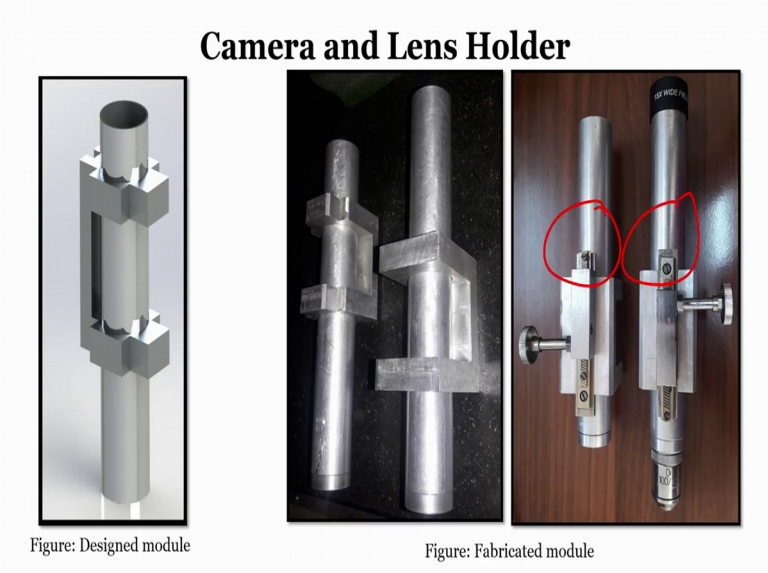

Figure: Designed module

Figure: Fabricated module

So, how this camera comes into picture? If you see this one right, these are the camera and lens holder right that we were talking about. So, left and right both camera can

simultaneously view the mask right at the same time; that is what we are looking at. This is a left camera, this is a right camera right and we can simultaneously look at both the cameras. Now other than that, what is that? So, we can we can place a button, we can press open camera. When the camera opens, you can use left camera, you can use right camera, you can use alignment control like X Y theta Z for your alignment of the stage right.

You can click here and say so image analysis; you can use this one for exposure control. How much exposure to the wafer you need to make? You need to understand how much UV, you are UV light with how much power you are exposing your substrate so, exposure control. You can set the time, how much time you want to expose your substrate ? It can be 5 seconds, can be 10 seconds, can be 15 seconds depending on the material that you are using. If it is a thin photoresist or thick photoresist; if it is su 8, the the time would change. So, this time can be set until which the UV light will fall on the substrate through the mask and then after the set time it will stop.

Finally, there is a alignment correction. So, we are trying to automize the system by alignment correction. Once it is aligned, then you can start the system. So, the point is you can design very easily this kind of user interface control alignment system to integrate with your mask driver.

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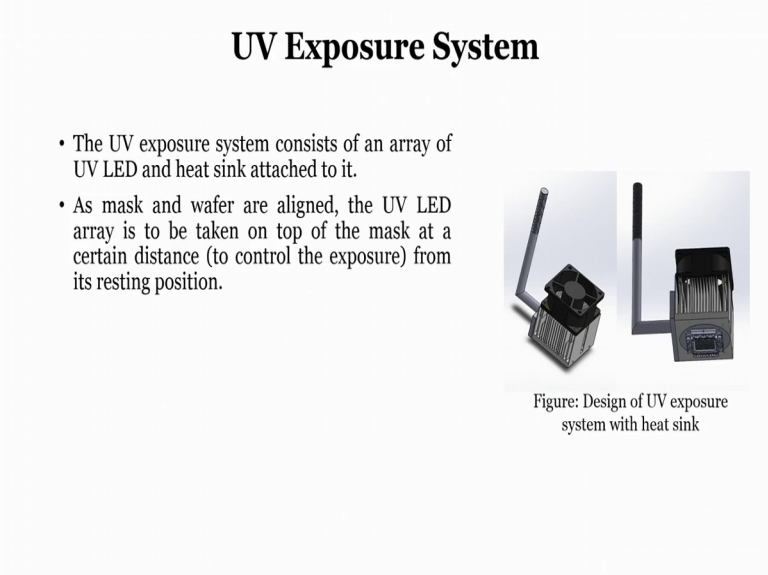

Now when you talk about this the main important point or the most important aspect of the mask aligner in any mask aligner would be this source right because finally, we had to expose our UV light ah; our substrate with UV light right.

So, if you have seen in conventional UV mask aligner and the light source gets heated up tremendously. Also you need to change the bulb here in there right. How about we use an alternative UV light source? For example, UV led if we integrate UV led as a light source and we use that light source instead of UV lamp, would we get a better understanding or easier way or we can reduce the cooling and then that will be really awesome because you just buy led array and anyone can change it easily right.

As the system is such that you just if the led array goes bad, you replace it and change it with another led array. If you go for a conventional a UV lithography system is a big exposure system you need to open it, you need to take out the UV lamp, put another UV lamp, again close it right and there is a optics and lot of other things within the UV alignment system or mask aligner system. Here it is extremely simple. This is what we want to try to bring the simplicity to the system and at the same time reduce the cost.

Now so, the alternative approach that we are trying to implement is to use UV exposure system. So, if you see here in UV exposure system, we are trying to use UV led UV led and heat sink attached to it as a mask and wafer are aligned the UV led arrays is to be taken on the top of the mask, this will come in the top of the mask you will see the video in the next slide to see how the system is operating. So, as mask and wafer are aligned, the UV led array is to be taken on the top of the mask at certain distance to control the exposure, we had to we had to optimize this distance from its resting position. So, how does this whole thing works right whatever we have discussed, how does it work?

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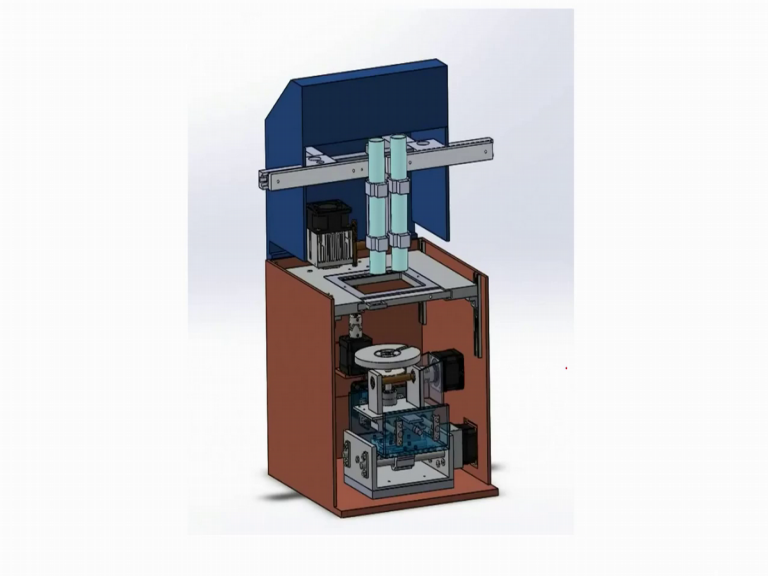

So, this is just an model to understand the system right. You can you can see here, there is a wafer holder and here you can see there is a mask holder right. And it is before will come to the mask holder and that it will get attached. It is a hard contact hard contact lithography. These are the lenses that we have right and or you can say camera; this is the light source that we have right.

So, let us see let us play the video and you will understand. While we are playing the video, I will tell you what are the components, what are the tools. This is these are the actuators, drivers to drive the X Y and theta stage. So, let us see. So, now, we are trying to show that we can move the mask alignment stage. This is a Z direction of course; this is a 3 D sound box diagram. This is temporary or you can say a basic video to show how the system works. Now we see when we move the camera, it can be moved in both the direction. So, that when you place it exactly on this particular surface we can you can see both the alignment marks simultaneously, that is the idea.

Now this is your UV source right. So, there is a UV source. We it comes after you align the mask, you press a button UV exposure, UV source will come right. And when it comes, then you have to see what exactly lies under the UV source. When you see that you can clearly see that there is a array of leds, you can see right array of leds. So, this array of leds is directly on the exposing the mask and this mask there is a wafer over here that will get attached to the mask and then the exposure will happen.

So, this is another thing. After the exposure is done right, you need to keep the source back. So, the source will go back and if you see this we can the lens will come back after the other things are done, is it back it to its reset position right. And then this is the once the things are done, everything will be reset to its original position. It is just a simple box type mask aligner system as you can see its simplicity right and we want to see whether we can obtain the similar features which we can get through costly equipment right and or close to get similar features to a costly equipment. We have not tried the minimum feature size in this case; however, we assume that we can get close to five microns very easily.

So, the this is how my idea of showing you the entire mask aligner or whatever we have done is to help you out to encourage you that you guys can do it in your laboratory, in your college right. You do not have to have a hi-fi laboratory, hi-fi technology next to you to start working on your research problem right. Yes if you have excellent, if you do not have it, create one right make a system.

Make the system in your department, make a system in your university, make a system at your home right. If you really see that you know the technology coming, technology development comes not only when you have a hi-fi equipment surrounding you; technology development can come when you can have when you have a novel ideas right. Novel ideas bringing it together and working on a prototype, then from prototype when it works you can convert to a product.

So, anyway point is that do not do not always think that if you do not have certain facility, you cannot perform research right that is why I am showing you an alternative technology even I have I am in the institute where we have one of the best facilities that micro engineer would like to have right. We have everything to name from photolithography unit, to reactive ion etching, to wet etching, to dry etching.

We have a E-Beam Evaporation, sputtering and we have XRD, AFM, SEM, TEM for you name and we have it. But what about if we do not have it right? If we do not have it if you do not have a costly mask aligner, we can create one that is the idea just to show it to you and before I tell you that you can create one I tried by myself, we are working on it. You can try you can bring up on alternative easier way of performing photolithography right.

So, anyway I will end up my lecture in this particular node and I will see you in the next lecture with a another interesting application of micro engineering. Till then you take care look at all these slides and try to get the idea of why and how you can create a novel mask aligner, why it is important, how you can create it. Yeah take care, I will see you next class; bye.